
http://repository.nms.ac.uk/270

Deposited on: 17 October 2014
two different patterns, summarised in Figure 6.51: sites where debris far outweighs products; and those where products equal or exceed the debris. The three ‘producer’ sites in the former category are all churches around the Clyde estuary. It seems the jewellery saw only limited use at these religious sites, suggesting that, despite manufacturing evidence being commonplace in the area, there was some localised exchange system for the products.

The Inchmarnock assemblage is a valuable addition to our knowledge of oil shale and cannel coal working in the early historic period. It is the first site to have produced evidence of both major production methods, which raises questions of the relation between them that require further work. The debris provides a vivid insight into this craft process, and also feeds into wider questions on the nature of craft production and exchange in the region and beyond.

6.11 FERROUS METALWORKING DEBRIS

ANDREW HEALD AND DAWN MCLAREN

Introduction

A total of 32.3kg of material was visually examined, which allows it to be broadly categorised using the criteria of morphology, density, colour and vesicularity. In general, assemblages of slag can be divided into two broad categories. The first group includes the diagnostic material which can be attributed to metalworking. In the case of ironworking a range of slag morphologies are produced. Only a few, for example tapped slag and hammerscale, are truly diagnostic (of smelting and smithing respectively). The second category includes the non-diagnostic slags, which could have been generated by a number of different processes but show no diagnostic characteristic that can identify the process. Within this group there is often a significant amount of material which is unclassifiable, making the allocation of individual pieces (particularly small samples) to specific types and processes difficult (Crew & Rehren 2002, 84). That said, in many cases these undiagnostic residues, such as hearth or furnace lining, may be ascribed to a particular process through archaeological association.

The slag has been described using common terminology (eg McDonnell 1994; Spearman 1997; Starley 2000). A full catalogue of the material is given in the archive report. Further scientific analyses would be necessary to classify the material more conclusively. This was only undertaken on a few samples by Lore Troalen and Jim Tate in NMS Conservation and Analytical Research Department [noted in the catalogue].
Classification

There are five diagnostic ferrous slags and residues present:

1. **Plano-convex slag cakes (PCSC):** A plano-convex accumulation of slag formed in a pit, which can come in a range of sizes. It is difficult to be sure whether these were produced during smelting or smithing although their dimensions and weight compare closer to slag cakes associated with smelting on other Iron Age sites (e.g., McDonnell 1994, 230; McDonnell 2000, 219). That said, scientific analysis illustrates that their compositions vary (e.g., some have a high manganese content, others do not), suggesting that different cakes may be related to different parts of the ironworking process.

2. **Slag Amalgams (SA):** Randomly shaped pieces of slag including plano-convex slag cakes and hearth lining which have fused together to form larger masses.

<table>
<thead>
<tr>
<th>Short description</th>
<th>Abbreviation</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIAGNOSTIC SLAGS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plano-convex slag cakes</td>
<td>PCSC</td>
<td>17,293</td>
</tr>
<tr>
<td>Slag amalgams</td>
<td>SA</td>
<td>3,830</td>
</tr>
<tr>
<td>Unclassified slag (Fe?)</td>
<td>US</td>
<td>4,509</td>
</tr>
<tr>
<td>Hammerscale HS</td>
<td>HS</td>
<td>39</td>
</tr>
<tr>
<td>Slag spheres SS</td>
<td>SS</td>
<td>12</td>
</tr>
<tr>
<td><strong>UNDIAGNOSTIC SLAGS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearth lining</td>
<td>HL</td>
<td>401</td>
</tr>
<tr>
<td>Fuel Ash slag</td>
<td>FAS</td>
<td>272</td>
</tr>
<tr>
<td>Vitrified amalgams</td>
<td>VA</td>
<td>709</td>
</tr>
<tr>
<td>Vitrified residue 1</td>
<td>VR1</td>
<td>1,038</td>
</tr>
<tr>
<td>Vitrified residue 2</td>
<td>VR2</td>
<td>636</td>
</tr>
<tr>
<td>Vitrified residue 3</td>
<td>VR3</td>
<td>364</td>
</tr>
<tr>
<td>Fe conglomerate</td>
<td>FeC</td>
<td>3,223</td>
</tr>
</tbody>
</table>

3. **Unclassified slag (US):** Randomly shaped pieces of iron silicate slag generated by the smelting or smithing process.

4. **Hammerscale (HS):** Small flakes of iron produced by the impact of hammers on hot iron during either the refining of iron blooms or the working of wrought iron. When found in sufficient quantities, this is usually indicative of *in situ* metalworking.

5. **Slag spheres (SS):** Spheres ejected as spherical globules of molten slag during ironworking. When found in sufficient quantities, this is usually indicative of *in situ* metalworking.

In addition, there are other non-diagnostic slags and residues:

1. **Hearth or Furnace Lining (HL/FL):** The clay lining of an industrial hearth, furnace or kiln that has a vitrified or slag-attacked face. It is not always possible to distinguish between furnace and hearth lining. Often the material shows a compositional gradient from unmodified fired clay on one surface to an irregular cindery material on the other (Starley 2000, 339).

2. **Fuel ash slag (FAS) and vitrified amalgams (VA):** Slag formed when material such as sand, earth, clay, stones or ceramics are subjected to high temperatures, for example in a hearth. During heating, these materials react, melt or fuse with alkali in ash, producing glassy (vitreous) and porous materials. These slags can be formed during any high temperature pyrotechnic process and are not necessarily indicative of deliberate industrial activity.

3. **Vitrified residues:** Due to the sampling strategy employed on the site, a fair quantity of small vitrified residues (1 mm–10 mm) were recovered. Again, these are mixtures of various types of material, fused together through heat. Three different types were recovered: those that were comprised mainly of sand, clay, stone and other material and were magnetic (VR1), those that shared similar constituents but were non-magnetic (VR2) and finally fused masses of soil (VR3). Although it is impossible to relate these small pieces to any specific process, it is likely that VR1 was related to ferrous-metalworking.

4. **Fe conglomerate:** Random pieces of compact conglomerate with a significant Fe chemical component.
The total quantity of debris recovered is shown in Table 6.10 and Figure 6.52. Visual analysis suggest that the assemblage is composed predominately of plano-convex slag cakes, both by weight and by number of specimens. There are 31 PCSCs and another 25 possible fragments. The slag amalgams should also be viewed in this class; all are composed of plano-convex cakes, with additional slags. There are, therefore, almost 60 plano-convex slag cakes from Inchmarnock. Together with the unclassified slag, which is likely to be derived from ironworking, the slag assemblage represents one of the largest ironworking assemblages from early historic Scotland.

Differentiating between smithing and smelting slags visually is difficult. As noted, the weight and size of the cakes make many examples closer to smelting than smithing slags (see McDonnell 1994, 230; McDonnell 2000). That there was little diagnostic iron smithing micro-slags (eg hammerscale, slag spheres or vitrified resiudes) were recovered from 4001 suggest that this is probable. It is suggested here, therefore, that the overwhelming majority of slag from Inchmarnock (~75–68%) derives from a specific area: the northern part of the site, which was associated with metalworking, predominantly during Phase 1. Although slag from Phase 1 was scattered across much of the excavated area the majority comes from the northern end. Excavation here indicated the presence of a possible ‘craft zone’ associated with the early historic monastic settlement. Excavation identified a series of early ironworking features and a series of intercutting buildings defined by possible beamslots and clusters of postholes. The area primarily in and around Structure 1 is of note. At least 10 features have notable distributions of slag (Table 6.11). Of these, four are particularly important.

**Feature Group 1 (4228; 4193; 4195/4073; 4192; 4005; 4072)**

Feature 4228 comprised 4193 (a ‘bowl’) and 4195/4073 (a possible ‘flue’). These features were filled by 4192 (the ‘bowl’) and 4005, 4072 (the ‘flue’). All of the fills produced varying types and quantities of ironworking debris. Context 4005 had the largest range and quantity including plano-convex slag cakes, hearth lining, and unclassified ironworking slags. A small quantity of...
hammerscale was also recovered. Radiocarbon dates indicate that this activity took place around cal AD 780–980.

Feature Group 2 (4136; 4135)
Beside the above feature was an irregular scoop (4136), filled by 4135. Again, plano-convex slag cakes, unclassified ironworking slags and minute quantities of micro-ironworking slags were recovered.

Feature Group 3 (4226; 4077; 4079; 4086; 4076; 4078; 4085)
A shallow gully (4226, comprised of 4077, 4079, 4086) was located to the south of the above features.
INCHMARNOCK

Three fills from this feature (4076, 4078 and 4085) produced evidence of ironworking including plano-convex slag cakes, unclassified ironworking slags and magnetic material that may be associated with ironworking. Radiocarbon dates indicate that this gully was filled around cal AD 650–780.

Feature Group 4 (4160; 4161)
Beside Feature Group 3 was a pit (4161), filled by 4160. A plano-convex slag cake, unclassified ironworking slags and small amounts of micro-ironworking slags were also recovered. Radiocarbon dates indicate that this feature was filled between cal AD 410–780.

In summary, four groups of features produced a suite and quantities of slag suggestive of in situ ironworking. It is also noteworthy that other features excavated in the area (the majority listed in Table 6.11) also produced varying amounts of slag. Although few are diagnostic of ironworking, merely some unknown pyrotechnic process, it is likely that much of the slag was associated with this industrial activity. Ironworking requires a suite of features and areas to undertake the work; we should not expect diagnostic slags from all of them. The radiocarbon dates indicate that the area saw more than one episode of metalworking activity.

Wider discussion
Monastic sites are well known for being foci for crafts, including metalworking (Price 1982, 52–6; Barber 1981, 366; Alcock 2003, 334), and specific areas appear to have been set aside for such crafts. In this light the evidence from Inchmarnock fits well with the slag evidence from other monastic sites across Scotland, for example Iona (Barber 1981, 349), Tarbat (Carver 2004) and Whithorn (eg Hill 1997, 27, 67, 129, fig 3.1). The stratified Inchmarnock ironworking debris from a series of features and associated radiocarbon dates provides a further opportunity to study where smiths worked and the suite of accoutrements they used. The distribution of whetstones, concentrated in the area to the west of Structures 1–3 (Conolly, Chapter 5.5; Franklin, Chapter 6.8), clearly complements that of the ironworking debris. A possible anvil stone was recovered from the same area (Franklin, Chapter 6.8).

Assessing the role of the smith in the social and economic life of Inchmarnock is more difficult. In his review of Irish ironworking Scott (n.d., 101) highlights the different type of smiths we should expect on monastic settlements. On the one hand Scott views most of the industrial activity as the equivalent of that on ‘lower-tier secular sites’ where the making or repair of a knife or an axe for use in the work of the community would be a part of its self-sufficient internal economy. On the other hand, he admits that we must be conscious of the possible presence of master smiths working in some monastic communities.

In order to understand the role of the monastic smith it is necessary to take a broader look into the organisation of ironworking in the early historic period. This is far from easy, hindered by the lack of systematic analysis of ironworking both in the immediate area and beyond. There have been few useful discussions of ferrous metalworking in Iron Age Scotland (although see McDonnell 1994; McDonnell 1998 for an initial model of iron-working in Orkney and Shetland) and recent discussions of the practice in western Scotland in the first millennium AD have been superficial (eg Photos-Jones 2005). This is undoubtedly due to the difficulty in finding comparable sites and contemporaneous production (see also Alcock 2003, 93). Many slag assemblages were excavated decades ago and slag finds were often not retained. Even when slag was kept it is difficult to ascertain what process it is related to.

Despite this predicament it is pertinent to raise some issues that should be addressed in the future. If we are to understand the meaning of slag on archaeological sites we need to relate the material to other objects on the site and assess assemblages in the surrounding area.

It is clear that other sites in and around the area of Inchmarnock have produced slag. Although identifying and dating the material is often difficult – many come from either sites where there is no context or that saw millennia of use, such as caves (eg Columba’s Cave, Tolan-Smith 2001, 51) – a number have evidence of ironworking during the early historic period. These include: Auldhill, Portencross (Cullen 1998, 59–60); Kildonan Bay (Fairhurst 1939, 212); Loch Glashan (Photos-Jones 2005); Dunadd (McDonnell 2000); Iona (Barber 1981, 349) and Bruach an Druimein (RCAHMS 1988, 204).

This shows that ironworking took place on a range of sites including nuclear forts, duns, monastic sites, crannogs and open settlements. In other words, almost every site type in the area has produced evidence for ironworking. This is hardly surprising. Most iron objects were largely functional and everyday, such as knives, agricultural tools and structural fittings (see Alcock 2003, 95–101 for a useful summary). In other
words, the occurrence of slag on many archaeological sites may represent everyday repair or manufacture of prosaic, functional objects (see also Mytum 1992, 211). That said, this does not mean that we should assume that the practice was common place everywhere. There are many areas for fruitful research.

A starting position should be analysis of the iron objects from sites which have also produced slag; it is not the slag that will indicate what was made, nor the status of the smith, but the surviving objects. For example, we should expect that the ironworker on a monastic settlement would be required to make a range of objects, from nails for buildings to tools for sculpture, and bells for religious purposes. Do any of these survive and what do they infer about the scale and status of the craft?

From here we should broaden analysis to the slag and iron objects from a range of contemporary sites. For example, are there sites which have produced no evidence for ironworking debris, but where iron was in use? Was there ironworking, but little or no consumption? Did ironworking and use go on together? Quantity and survival should always be considered; some sites may produce slag but not of the type or quantity to suggest that a full-time specialist existed on them. Are there differences between sites?

These are questions which were first raised over 30 years ago (reviewed in Rahtz 1973) but still remain unanswered. Previous studies have shown that the presence and absence of object types and crafts may give insights into questions of status, hierarchies and inter-site relationships. This has largely been confined to the exotic end of the spectrum: imported pottery, fine metalworking and jewellery (eg Dark 1994: Campbell 1991: Campbell 2007). It is clear that sites such as Dunadd stood apart from other settlements in the area, with their inhabitants able to acquire, use and distribute exotic (Alcock & Alcock 1987; Alcock 1988; Campbell 1996: Campbell 1999). These studies into local and regional politics are now being augmented by analysis of the more prosaic material. For example, analysis of the Argyll data set has suggested that there may well be differences in the range of iron objects used on different sites (Hunter & Heald forthcoming). It is time that the slag was brought into the discussion.

What the Inchmarnock smiths produced, for whom, and what status this conferred is difficult at present to answer. However we should be content with the recovery of one of the few in situ metalworking areas in early historic Scotland.

6.12 CRUCIBLES AND OTHER VITRIFIED CERAMICS

ANDREW HEALD

Two crucible fragments were recovered; reconstruction of their original shape is not possible. They were analysed non-destructively by energy dispersive X-ray fluorescence (EDXRF) by Jim Tate and Lore Troalen of the NMS Conservation and Analytical Research Department to give broad characterisation of the alloys melted.

108. Body fragment of crucible. Broken on all sides and lacking diagnostic features (rim, base etc). Heavily vitrified on the outside. 47mm × 32mm × 9mm. SF606, Context 4001, Phase 3. XRF analysis reveals traces of copper.

109. Rim, corner and body fragment of crucible. The outside is fractured and the inside coloured grey due to heating. Although the original shape is difficult to reconstruct the surviving fragment suggests that the vessel would have been fairly substantial, and probably triangular in shape. Although XRF analysis did not reveal any metallic traces the object does have the characteristics of a crucible. 58mm × 52mm × 12mm. SF714, Context 4001, Phase 3.

Crucible fragment 109 was recovered from the heavily turbated deposit (4001), over the site of a pit (4154), part of the metalworking area; fragment 108 was found in the same mixed deposit, some 9m to the south. Although the context of the material does not aid discussion of on-site metalworking the crucibles are a welcome addition to the ever-expanding corpus of non-ferrous metalworking from Iron Age Scotland.

Evidence for the practice has been found on a range of sites in and around Inchmarnock. Assemblages from forts, such as Dunadd (Christison & Anderson 1905, 311–4; Craw 1930, 120–3; Lane & Campbell 2000, 106–49) and Dunollie (Alcock & Alcock 1987, 140–1), and the monastic sites of St Blane’s (Anderson 1900, 311, 6; Laing, Laing & Longley 1998, 559–61, illus. 6), Iona (McCormick 1992; Graham–Campbell 1981; Barber 1981, 349–50, fig 42, nos 303/1; 304/1) and Whithorn (Hill & Nicholson 1997) are best documented. Indeed, these sites, particularly forts, have been the focus for past discussions of metalworking during the period. Structural characteristics, together with artefactual analysis and literary sources demonstrate that these sites stood apart from other settlements, with their