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ARO71: Investigation of three bloomery iron working sites on the east shores of Loch Eck, Cowal Peninsula, Argyll in 1996 and 2015

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ARO71: Investigation of three bloomery iron working sites on the east shores of Loch Eck, Cowal Peninsula, Argyll in 1996 and 2015

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Summary

In 2015 three bloomery mounds by Loch Eck, Argyll were revisited for further scientific and environmental analyses, as well as for radiocarbon dating. One of these sites had previously been investigated in 1995 and 1996, as part of the Scottish Bloomeries Project. The results from the project demonstrated that smelting took place on Loch Eck for at least 300 years from the thirteenth to seventeenth century AD. The main fuel was birch charcoal supplemented with the use of other local woodland resources. Although these were primarily smelting sites, industrial waste suggested that initial smithing also took place there. These mounds are evidence of an important but largely concealed Medieval industry that has much to reveal about the scale and nature of the iron smelting industry in Argyll and that across Scotland.

Introduction

This publication details the results of three small excavations on the eastern shores of Loch Eck in the Cowal Peninsula of Argyll. The excavations are separated in time by some 20 years, but the combined results cast light on a period in Scottish Highland history and an industry that rarely garners much attention. The revisiting, survey and subsequent part-excavation of a number of bloomery mounds on the shores and hills overlooking Loch Eck in 2015 was supported and funded in no small part by a grant from Forestry Commission Scotland and in-kind support from GUARD Archaeology Ltd, together with post-excavation funding from Historic Environment Scotland. One of the sites targeted for survey and excavation in 2015 had originally been part-excavated in 1995-6 in conjunction with Effie Photos-Jones as part of the Historic Scotland-funded Scottish Bloomeries Project. The results of the earlier excavations at one site, Allt na Ceardaich 1, had only ever been partially published before (Photos-Jones et al. 1998; Atkinson and Photos-Jones 1999b), hence the 2015 project sought to reflect upon the earlier work within the scope of the project.

Site Location and Archaeological Background

Field investigations were conducted on the eastern shores of Loch Eck in the Cowal Peninsula of Argyll (Atkinson et al. 2016). The fieldwork took place in May and September 2015 and focused primarily on three sites: Allt na Ceardaich 1 (NGR: NS 1425 9275), Allt na Ceardaich 2 (NGR: NS 1426 9277) and Whistlefield Road (NGR: NS 144 936), and although other potential bloomery site locations were also visited in the surrounding area (Figure 1). The 2015 project acted as a training opportunity for younger graduates and members of the local community.

Information provided by the late Elizabeth (Betty) Rennie from the Cowal Archaeological and Historical Society archives suggested at least nine bloomery sites may have been present at one time around the shores of Loch Eck (Table 1). This grouping or concentration of mound sites within the Cowal area was notable, particularly within the Loch Eck forest where up to six mounds were potentially sited, three of which being present along the Allt na Ceardaich itself. This was of especial interest as the place name evidence suggested that this ‘river of the smith’ must have been an important location during the later Medieval period. Assessment of these sites offered the opportunity to firmly locate, partially excavate and date a number of potentially contemporary sites and could expand our understanding of the bloomery tradition in the Scottish Highlands as a whole.

Site Name	NGR	Description	Dimensions
Allt na Ceardaich 1	NS 1425 9275	Large horseshoe mound and stone structure	12 m by 10 m by 1 m
Allt na Ceardaich 2	NS 1426 9277	Conical mound part truncated by ditch	5 m dia by 0.5 m high
Allt na Ceardaich 3	NS 143 923	Slag heap 155 m above loch	-
Cambusdhu	NS 132 964	Slag heap below forest road	-
Loch Eck 1	NS 142 920	Slag heap 60 m from burn on 30 m contour	-
Loch Eck 2	NS 143 923	Slag heap 30 m from burn on 70 m contour	-
Loch Eck 3	NS 152 915	Slag on forestry track at 310 m contour	-
West side	NS 133 953	Slag on Rubha na Seamraig	-
Whistlefield Road	NS 1441 9360	Sub-circular shaped mound	5 m by 4 m by 0.5 m

Table 1: Bloomery sites on Loch Eckside, Argyll (derived from information provided by the late Elizabeth Rennie of Cowal Archaeological and Historical Society)

Figure 1: Bloomery site locations around Loch Eck, Argyll.

Methodology

The 2015 programme of archaeological works was based around three phases of fieldwork. The initial phase included visits to the nine potential sites along the shores of the loch identified by members of Cowal Archaeological and Historical Society and as detailed in Table 1. This was followed by limited excavation and sampling of two bloomery mound sites at Allt Na Ceardaich 2 (Trenches 1 and 2) and Whistlefield Road (Trenches 3 and 4). Excavation included digging of slot trenches into the centre of each mound and recovering charcoal samples from basal layers together with representative slag, ore and furnace lining samples where they were encountered.

The third and final phase of the 2015 project was centred on the large curvilinear bloomery of Allt Na Ceardaich 1 and aimed to complement and enhance the results of the unpublished 1996 excavation season (Atkinson and Photos-Jones 1999a). Trenches were located over the western portion of the mound (Trench 5) and over the eastern portion of the mound (Trench 6), with a third smaller trench (Trench 7) added during the works to locate the terminus of the main curvilinear mound itself (see Figure 4 below) and relate the 2015 work to the 1996 excavation.

In addition to trenches a sequence of auger samples were taken across the centre of the area enclosed by the mound to assess whether different species of tree charcoal may have been stored in different areas.

Site Survey Results

The results of the stage 1 site survey works revealed the presence of mounds at three locations: Allt na Ceardaich 1, Allt na Ceardaich 2 and Whistlefield Road. Two sites at West Side and Loch Eck 3 were inaccessible at the time of survey. The remaining sites were visited, but no mounds were identified at the six-figure grid reference locations provided in the original archive records or within their surrounding vicinity. Consequently, stages 2 and 3 of the project were targeted on the three located sites only (Figure 2).

Excavation Results

All radiocarbon dates are quoted at 2-sigma (95.4% probability).

Allt na Ceardaich 1

The site was located within dense immature forest up slope from the old road running broadly parallel with the main A815 from the Ardentinny Road, just beyond the Whistlefield Inn. The mound is located close to the banks of the Allt na Ceardaich Burn.

The 1995/1996 excavation works on the site identified this as a large horse-shoe shaped mound of slag around 0.6 m in height made up of a series of deposition events, in effect a series of smaller mounds (Figure 3). These measured 6 m, 12 m and 9 m in length and between 4 m - 6 m in width (Atkinson and Photos-Jones 1999a, 104-125). A complex of associated features was also investigated during this work, including a central furnace area, stone set hearth and a series of stake and post-hole features (Figure 4).

Stones visible at ground level to the north-east interior of the mound are part of the central drystone structure which partially enclosed the furnace area. The mound stood to an exterior height of 0.8 m and an interior height of 0.55 m. Vegetation obscured the extent to the south-east, particularly towards the bank of the burn where some erosion may have occurred.

The site of Allt Na Ceardaich 1 was first revisited in May 2015 and was subsequently part-excavated in September 2015. It was apparent that the site had been heavily impacted upon by recent forestry cropping, planting and self-seeding trees (birch), with a number of plantings on top, within and around the features present. Previous excavation work in 1995-6 had concentrated on the furnace location and within the central rectangular sunken depression delineating by the extensive u-shaped slag heaps. A single trench had been excavated through the southern slag heap at this time (Trench 8 – Slot A from 1996).

The 2015 excavation targeted the western (Trench 5) and eastern (Trench 6) arms of the slag heap, with a third exploratory trench (Trench 7) excavated to define the northern extent of

Figure 2: Bloomery sites encountered around Whistlefield Inn.

Figure 3: Allt na Ceardaich 1 excavation shot from 1996.

the western slag heap. The aim of the season's work was to address the longevity of the mound and the process and direction of slag disposal practices at the site. The hope being that suitable datable material could be recovered from each trench to ascertain more about the history of iron working at this location.

Trench 5 was positioned across what was believed to be the terminus end of the arc of the bloomery mound itself. It was apparent from the outset that this original belief that the terminus extended this far was incorrect. The deposits encountered on the eastern portion of the trench were mixed with modern contamination within the shallow deposits. Thus, supporting the view that backfill of the original 1996 trench was present here. It soon became apparent that the side of the 1996 trench was visible within the section face.

Undiagnostic slag was present in small accumulations visible in the north-western section of the trench and within the topsoil (5001). The upper deposits lay directly on top of what appeared to be a series of shallow occupation layers (5004) rich in birch charcoal with traces of hazel, oak and willow also present.

Trench 6 was positioned on the eastern side of the mound. Excavation of a rectangular trench running through the slag heap was pursued (Plate 2). The basal deposit (6004) appeared as a medium compact dark brown/grey with frequent inclusions of charcoal including birch, hazel, alder, ash, rowan type, willow and oak. This extended to a depth of 0.43 m in places with a distinct relatively little diagnostic slag present within the matrix. A fragment of birch charcoal was radiocarbon dated to cal AD 1392 – 1442 (SUERC-67337).

Lying directly above (6004), deposit (6003) also appeared to have a high organic content with a considerable quantity of tap slag and undiagnostic slag present within the matrix. This deposit extended to a maximum depth of 0.55 m, tapering towards the edge of the slope and contained significant amounts of birch and rowan type with lesser quantities of alder, hazel and oak. A representative sample of birch was radiocarbon dated to cal AD 1421 – 1497 (SUERC-67338).

Trench 7 was the final trench to be excavated on site and was introduced to establish the true terminus of the eastern mound. The trench extended to a depth of 0.46 m from which

two distinct deposits were visible. The lower deposit (7001) appeared to contain spheroidal hammerscale and undiagnostic slag within a birch abundant medium. This was sealed by a layer rich in tap slag (7002). Directly above this deposit, layer (7003) appeared to be a shallow charcoal-rich topsoil deposit that contained undiagnostic slag. This deposit was visible across most of the mound, so it is likely that this lower deposit marks the terminus of the mound itself.

Prior to backfilling, a series of seven auger samples were taken across the centre of the site between Trench 5 and 6. These auger samples, spaced 0.5 m apart revealed that birch was dominant across the area sampled, although hazel was also present in every auger sample. Oak was only present in significant quantities in the four south-eastern auger samples, however given the relatively low occurrence of charcoal and the mixing of species it seems unlikely that charcoal was kept separately in different locations (see *Archaeobotany*, below).

Figure 4: Allt na Ceardaich 1 trench plan.

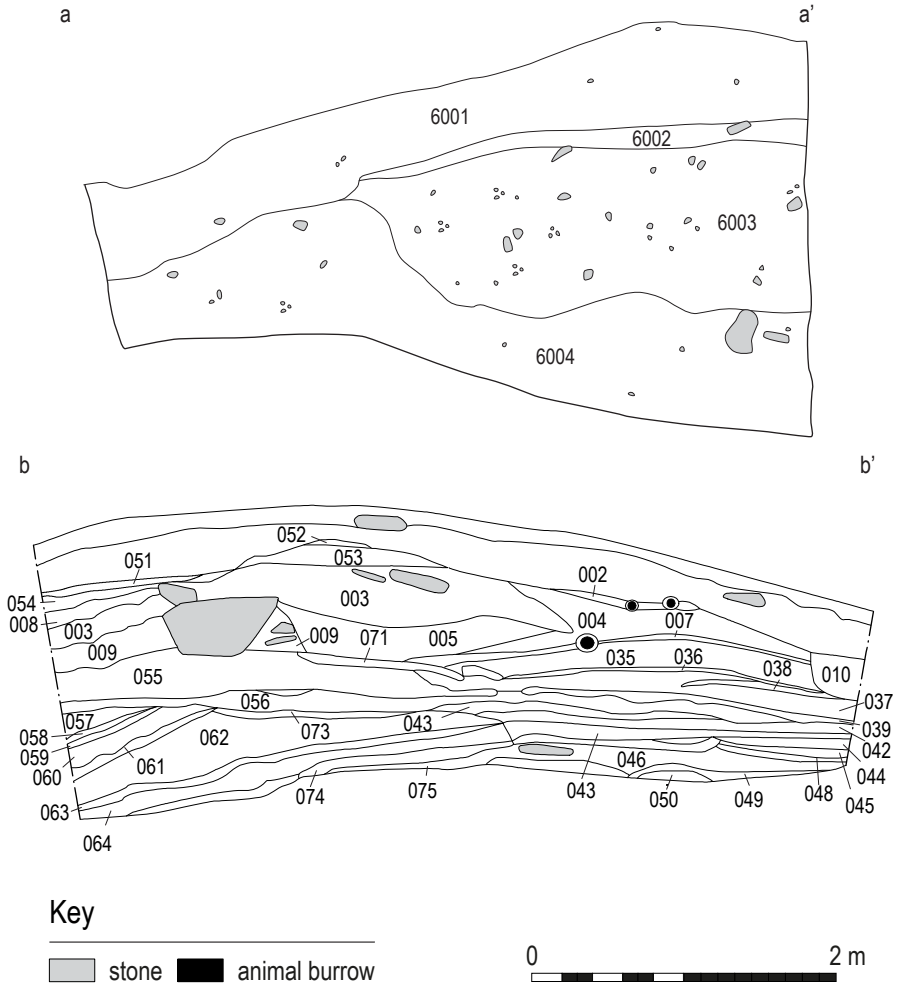

Figure 5: Section through Allt na Ceardaich 1 Trench 6 (upper) with the 1996 section through southern slag heap Trench 8 (lower).

Allt na Ceardaich 2

The site of Allt Na Ceardaich 2 was located in dense immature forest close to the 70 m contour on the north-western bank of the Allt na Ceardaich. The site appeared to consist of an elongated mound that curved slightly towards the south-west and measured around 9 m long by 2.9 m broad and stood to 0.4 m in height. The mound had been bisected centrally by a forestry ditch and further damage was evident in the form of a number of large trees and root systems impacting both sides of the mound in various places. The presence of a large area of disturbance at the eastern end of the mound caused by flooding had exposed a large section of mound's stratigraphy.

Trench 1 was excavated through the eastern portion of the mound (see Figure 6). Here the mound appeared to consist of a single charcoal and slag-rich deposit (1003), which contained significant quantities of burnt stone, slag and charcoal. It was visible in section extending to a depth of 0.6 m. Analysis of the slag recovered from layer (1003) revealed the presence of small amounts of spheroidal hammerscale together with tap slag and assorted waste indicative of smelting: the implications of this are discussed further below (see *Industrial Waste*, below). No other finds were recovered and no visible layering was evident within the stratigraphy, although significant amounts of birch charcoal were present, with lesser quantities of hazel and rowan type (see *Archaeobotany* below). A sample of hazel charcoal was recovered from layer (1003) and returned a radiocarbon date of cal AD 1390 – 1440 (SUERC-67339).

A series of large angular schist slabs (1004) were also present within this trench, projecting in an east-west direction. They appeared regular in plan and in courses two or three slabs high. The function of the slabs remains obscure. However, they did appear to extend below the large tree stump visible in the centre of the mound (Figure 7). It is tempting to view these slabs as having a similar function to those witnessed during the 1995 investigations at Allt na Ceardaich 1 and Tamveich Burn (Atkinson and Photos-Jones 1999b, Illus 3; Atkinson 2003; Photos-Jones et al. 1998, Fig 4).

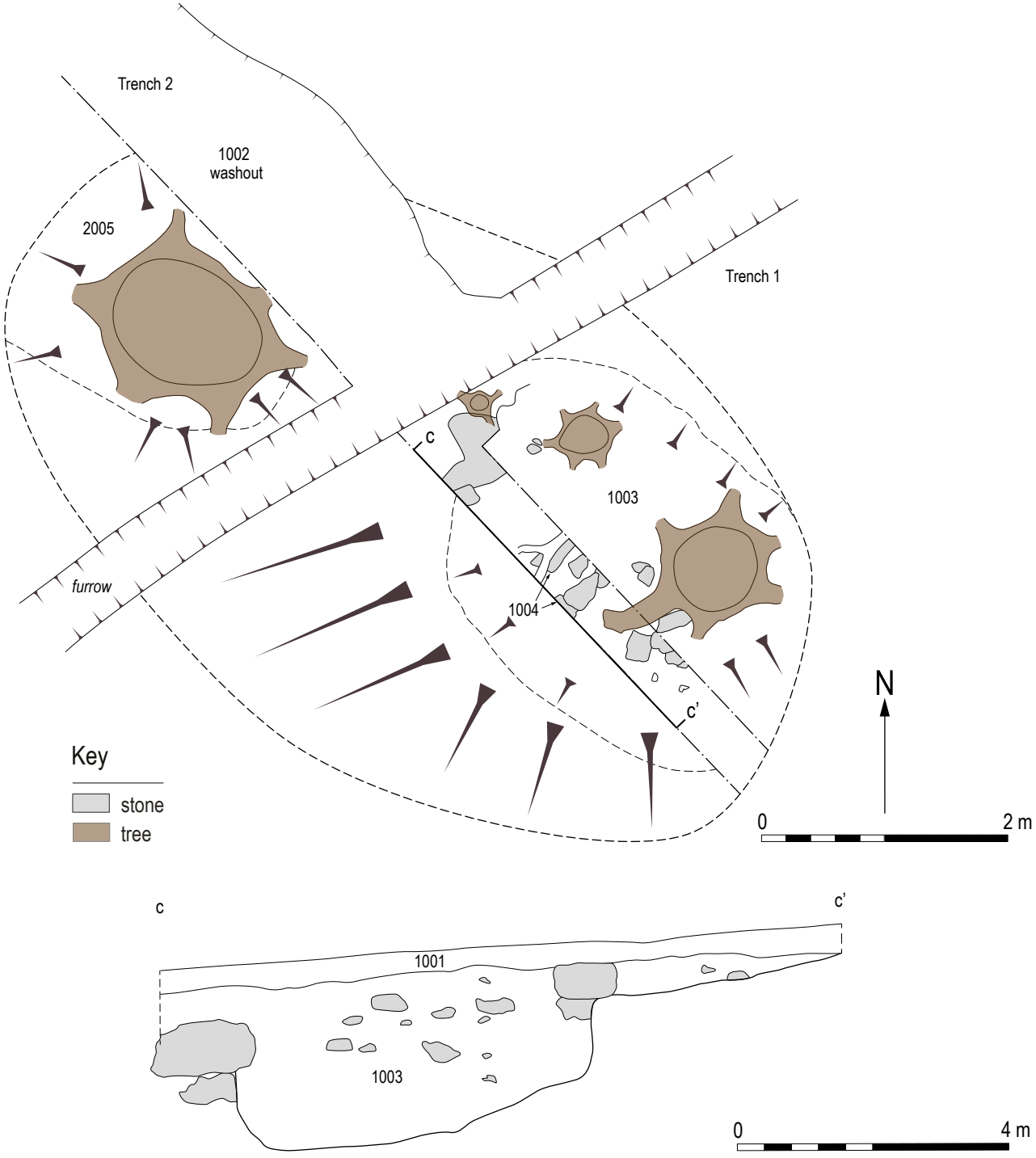

Figure 6: Allt na Ceardaich 2 with Trenches 1 and 2 and the section through Trench 1.

Figure 7: Allt na Ceardaich 2 detail shot of schist slab structure.

Trench 2 was recorded through the western portion of the mound and incorporated a naturally eroded area below a large tree stump, which was situated on top of the mound (Figure 6). The eroded section was composed of a layer of charcoal, burnt stone and slag (2005). This deposit extended to a depth of 0.4 m and contained spheroidal hammerscale, slag prills and mixed industrial waste (see *Industrial Waste,* below). No other significant artefacts were revealed, however birch charcoal dominated similar to layer (1003) in Trench 1, with smaller traces of alder, hazel, rowan type and willow also present (see *Archaeobotany,* below). A single piece of birch (*Betula*) from basal layer (2005) was radiocarbon dated to cal AD 1308 – 1362 (SUERC-67340), suggesting the two sections of mound had been deposited contemporaneously (see *Discussion* and *Radiocarbon Dates*).

Whistlefield Road

The Whistlefield Road site was documented as being no more than 100 m east of the A815 and North of Whistlefield Road and was located approximately 61 m north-west of the A815/ Whistlefield Road junction on a hillock within the forest overlooking a small tributary burn feeding into Lock Eck (Figure 2).

The mound had originally been visited and sampled as part of the Scottish Bloomeries Project phase of works in 1995 (Atkinson and Photos-Jones, 7-8). The mound was covered in sphagnum moss during both visits. However, the tree cover had matured since the earlier visit (Figure 8). Three large trees had been planted on top of the mound, which extended 4.1 m in length by 3.5 m in width and had a height of c. 0.4 m. Two trenches (Trench 3 and 4) were excavated across the central portion on the mound allowing a general cross section of the feature to be ascertained (Figure 9).

Figure 8: Whistlefield Road working shot.

Trench 3 was excavated though the north-east section of the mound and revealed slag and charcoal-rich layers were present (Figure 9). The basal layer (3005), a dark brown silt and organic-rich deposit contained frequent fragments of undiagnostic waste, traces of spheroidal hammerscale and burnt stones throughout and extended to a depth of 0.3 m. Analysis of the charcoal present indicated birch, hazel and smaller amounts of rowan type were present (see *Archaeobotany*, below). A sample of the birch charcoal from layer (3005) returned a radiocarbon age of cal AD 1467 – 1639 (SUERC-67345). Lying above the latter, a further heavily compacted layer (3003) appeared to represent the waste from the final firing of the furnace itself.

Trench 4 located on the north-west side of the mound (Figure 9) displayed a series of distinct deposits. The lower deposit or basal layer (4006) was heavily compacted with a high organic content and frequent stones and slag inclusions throughout. The deposit extended to a depth of 0.23 m and analysis revealed the layer contained mixed undiagnostic industrial waste (see *Industrial Waste*, below) combined with birch and hazel charcoal with smaller traces of ash and oak also present (see *Archaeobotany*, below). A sample of birch charcoal from deposit (4006) returned a date range of cal AD 1444 – 1524 (SUERC-67346) for this initial deposition event.

Directly above (4006) the sequence of layers and their make-up reflected that witnessed within Trench 3 and included similar characteristics. Bulk samples were again recovered from these layers and revealed the presence of spheroidal hammerscale, slag prills and undiagnostic slag, together with birch and small quantities of oak and hazel charcoal. Samples of tap slag together with what may be a possible tuyere were also retrieved from surface deposits (see *Industrial Waste* for further discussion).

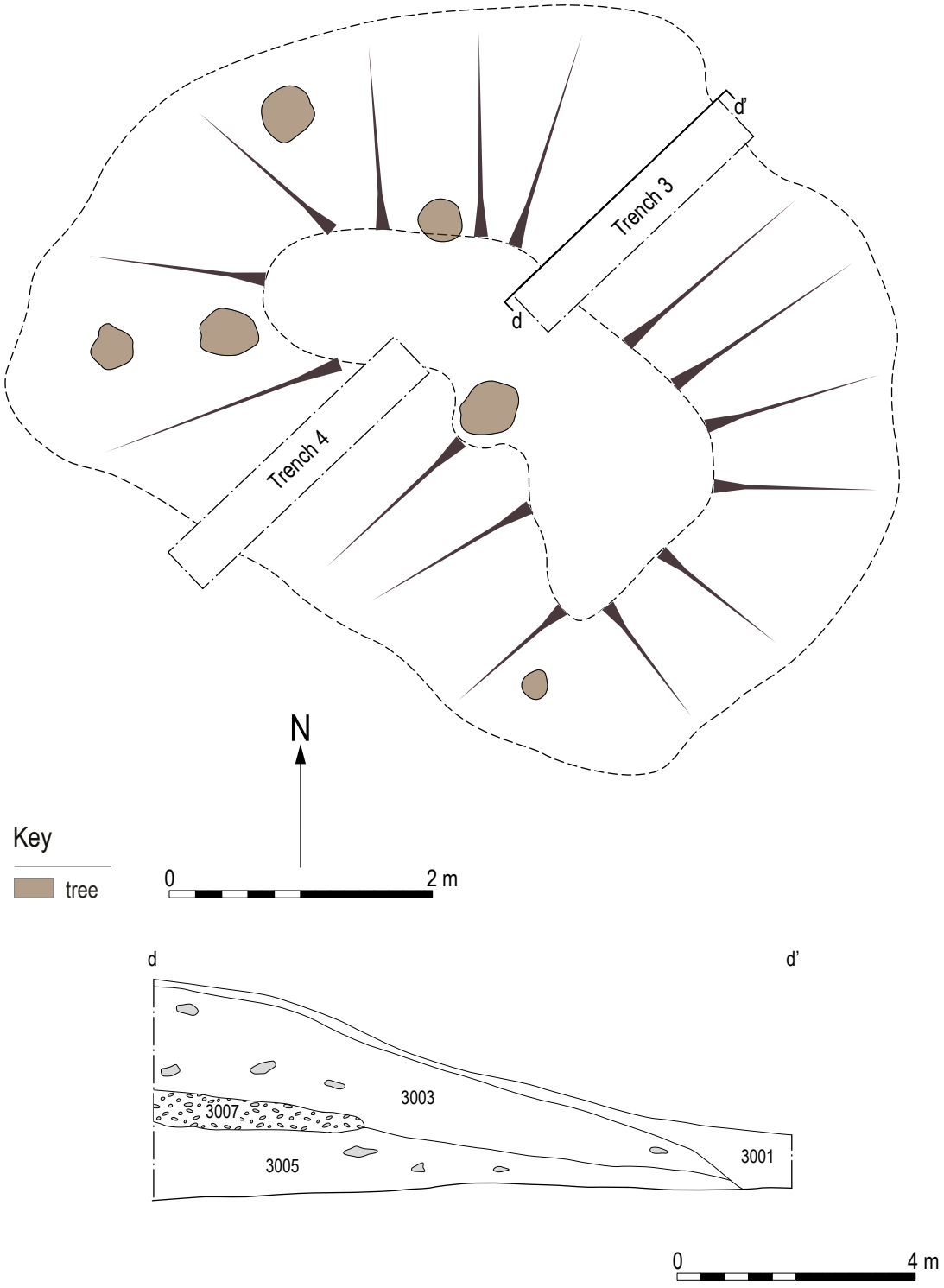

Figure 9: Plan and section of Trench 3 at Whistlefield Road.

Specialist Reports

Radiocarbon Dates

The radiocarbon assays for the three bloomery sites at Loch Eck are presented in Table 2 and include the dates achieved during the 1995/6 campaigns. In all cases charcoal samples were recovered from secure contexts at the three sites, with the exception of one sample from Allt na Ceardaich 1. This sample (GU-4415) was recovered from a bulk sample retrieved from the furnace box and was composed of multiple wood species (birch, hazel and willow). As such, its credibility is debatable even though it suggests the final firing of the furnace may have occurred the first half of the sixteenth century. The case for its inclusion as a trusted date is not helped by the 1480 – 1630 AD plateau in the calibration curve.

Archaeobotany

by Susan Ramsay

In total, 19 bulk samples were analysed for the presence of botanical remains. They were processed by flotation, using standard methods and sieves of mesh diameter 1 mm and 500 µm for flots (and wet sieved samples) and 2 mm and 4 mm for retents from flotation. In addition, seven auger samples from Allt na Ceardaich 1 were also processed.

Macrofossil Analysis

Dried flots and sorted retents were examined using a binocular microscope at variable magnifications of x4 - x45. For each sample, estimation of the total volume of carbonised material >2 mm and >4 mm was made and modern contaminants were scored using a scale of 1-3 'plus' marks. All carbonised and uncarbonised seeds were identified and any other plant macrofossil remains were noted. Reference was made to Schweingruber (1990) to aid identifications and vascular plant nomenclature follows Stace (1997).

Site Name	Lab No.	Trench	Context	Material	Radiocarbon age BP	Calibrated 1-sigma (68.3% probability)	Calibrated 2-sigma (95.4% probability)
Allt na Ceardaich 1	OxA-9324	-	20	Alnus	452 ± 35	1425-1468	1400-1500
Allt na Ceardaich 1	OxA-9344	-	13	Betula	652 ± 34	1350-1390	1280-1400
Allt na Ceardaich 1	OxA-9345	-	50	Betula	680 ± 31	1280-1310	1270-1330
Allt na Ceardaich 1	GU-4415	-	3007	Betula, Corylus & Salix	310 ± 50	1486-1648	1450-1660
Allt na Ceardaich 1	SUERC-67337	6	6004	Betula	524 ± 30	1400-1435	1392-1442
Allt na Ceardaich 1	SUERC-67338	6	6003	Betula	430 ± 29	1435-1460	1421-1497
Allt na Ceardaich 2	SUERC-67340	2	2005	Betula	562 ± 29	1321-1349	1308-1362
Allt na Ceardaich 2	SUERC-67339	1	1003	Corylus avallana	533 ± 30	1398-1431	1390-1440
Whistlefield Road	SUERC-67341	3	3003	Betula	351 ± 29	1572-1630	1539-1635
Whistlefield Road	SUERC-67345	3	3005	Betula	343 ± 29	1558-1631	1467-1639
Whistlefield Road	SUERC-67346	4	4006	Corylus avallana	382 ± 30	1450-1513	1444-1524

Table 2: Radiocarbon dates from the Loch Eck sites.

Allt na Ceardaich 1 (Tables 3 and 4)

In Trench 5 only topsoil deposit (5001) was analysed for the presence of carbonised remains. This deposit produced very significant quantities of birch charcoal, with traces of hazel, willow and oak also present.

In Trench 6 the basal deposit (6004) contained significant amounts of birch charcoal but was the only context examined from the three bloomery sites that also produced large fragments of alder charcoal. In addition, lesser amounts of hazel, oak, ash, rowan type and willow were also present in the assemblage. Directly above this deposit layer (6003) was a more compacted deposit with a large quantity of slag present and a charcoal assemblage dominated by birch, with only a trace of alder present. However, rowan type charcoal made up a significant proportion of the total mass of charcoal in this context, although this was mainly the result of a single large fragment of roundwood.

Within Trench 7 the lower deposit (7001) produced a small amount of slag and a charcoal assemblage dominated by birch, with traces of oak and hazel also present.

A series of seven auger samples were also taken to determine whether particular types of charcoal were being stored in different locations (Table 3). These were small volume samples, but indicated birch and hazel charcoal were present in all samples, whilst oak charcoal was present in all but two samples (17 and 18). There was also a trace of willow charcoal in sample 13. Given the low quantities of charcoal recovered, these differences may just be due to random variations within a mixed charcoal deposit. It is clear that charcoal was not kept separately by type since birch and hazel are always present.

Allt na Ceardaich 2 (Table 5)

The charcoal from context (1003) was mostly birch, with smaller amounts of hazel and rowan type also present. A second trench was cut through the western part of the mound revealing a single charcoal and slag-rich deposit (2005). The charcoal assemblage was similar to that witnessed in layer 1003, with birch by far the commonest type present and smaller amounts of hazel and rowan type also present. In addition, traces of alder and willow were also identified.

Whistlefield Road (Table 6)

Within Trench 4 the basal layer (4006) contained only small amounts of birch, hazel, ash and oak charcoal. The upper deposit (4004) again contained relatively small quantities of charcoal, with only birch, hazel and oak present.

Trench 3 revealed a similar series of deposits as noted within Trench 4. The basal deposit (3005) produced a charcoal assemblage of birch, hazel and oak, but in larger quantities than were recovered from (4006). The upper deposit (3003) was dominated by birch charcoal, with small amounts of alder, oak, hazel and willow also present.

	Context	5001	6003	6004	7001
	Sample	11, 12	04, 05, 06	03, 07, 08, 09, 10	02
	Description	Shallow topsoil deposits	Ashy silt	Charcoal deposit	Charcoal-rich deposit within mound
Volume of charcoal >4 mm		125 ml	200 ml	570 ml	75 ml
% charcoal >4 mm identified		60%	100%	80%	100%
Charcoal					
Alnus cf glutinosa	alder	-	1 (0.6 g)	7 (43.15 g)	-
Betula spp	birch	343 (14.58 g)	35 (25.94 g)	311 (62.86 g)	92 (22.36 g)
Corylus cf avellana	hazel	14 (0.65 g)	2 (0.03 g)	49 (7.06 g)	6 (0.27 g)
Fraxinus spp	ash	-	-	8 (2.48 g)	-
Maloideae	rowan type	-	2 (4.85 g)	13 (1.77 g)	-
Quercus	oak	4 (0.19 g)	5 (0.22 g)	83 (9.85 g)	17 (0.88 g)
Salix spp	willow	4 (0.40 g)	-	20 (1.61 g)	-
Carbonised seeds					
Corylus avellana nutshell	hazel nutshell	-	-	1 (0.02 g)	

Table 3: Botanical remains from Allt na Ceardaich 1.

	Context	Auger	Auger	Auger	Auger	Auger	Auger	Auger
	Sample	13	14	15	16	17	18	19
	Description	Auger sample	Auger sample	Auger sample	Auger sample	Auger sample	Auger sample	Auger sample
Volume of charcoal >4 mm		10 ml	2.5 ml	5 ml	5 ml	2.5 ml	10 ml	10 ml
% charcoal >4 mm identified		100%	100%	100%	100%	100%	100%	100%
Charcoal								
Betula spp	birch	15 (0.32 g)	6 (0.26 g)	12 (0.66 g)	15 (0.55 g)	6 (0.48 g)	16 (1. 05 g)	24 (1.66 g)
Corylus cf avellana	hazel	1 (0.62 g)	6 (0.16 g)	6 (0.16 g)	3 (0.19 g)	7 (0.15 g)	15 (0. 60 g)	9 (0.23 g)
Quercus	oak	8 (0.28g)	4 (0.11 g)	4 (0.26 g)	2 (0.13 g)	-	-	1 (0.03 g)
Salix spp	willow	1 (0.05 g)	-	-	-	-	-	-

Table 4: Botanical remains from Allt na Ceardaich 1 auger samples.

	Context	1003	2005
	Sample	01, 02	03, 04
	Description	Slag mound deposit	Slag mound deposit
Volume of charcoal >4 mm		150 ml	220 ml
% charcoal >4 mm identified		40%	33%
Charcoal			
Alnus cf glutinosa	alder	-	2(0.29 g)
Betula spp	birch	171 (25.43 g)	176 (29.38 g)
Corylus cf avellana	hazel	8 (1.02 g)	8 (1.38 g)
Maloideae	rowan type	22 (3.50 g)	5 (1.25 g)
Salix spp	willow	-	7 (0.88 g)

Table 5: Botanical remains Allt na Ceardaich 2.

	Context	3003	3005	4004	4006
	Sample	01, 02			
	Description	Bloomery mound - final firing	Bloomery mound - initial firing	Bloomery mound - final firing?	Bloomery mound - initial firing?
Volume of charcoal >4 mm		25 ml	150 ml	10 ml	10 ml
% charcoal >4 mm identified		100%	33%	100%	100%
Charcoal					
Alnus cf glutinosa	alder	7 (0.29	-	-	-
Betula spp	birch	60 (5.76 g)	26 (7.90 g)	42 (2.10 g)	25 (0.90 g)
Corylus cf avellana	hazel	3 (0.10 g)	11 (4.12 g)	5 (0.09 g)	10 (0.52 g)
Fraxinus spp	ash	-	-	-	4 (0.10 g)
Maloideae	rowan type	-	2 (2.29 g)		-
Quercus	oak	13 (0.62 g)	-	1 (0.11 g)	(1.0.02 g)
Salix spp	willow	1 (0.02 g)	-		-
Carbonised seeds					
Corylus avellana nutshell	hazel nutshell	1 (0.89 g)	-	-	-

Table 6: Botanical remains from Whistlefield Road.

Discussion

The charcoal assemblages recovered from the three sites show remarkable similarities (Figures 10-13). It is clear that birch is by far the most frequent charcoal-type present and suggests that this was the principal charcoal type used to fuel the furnaces, although hazel sometimes contributed up to 20% of the mass of charcoal identified. Only Allt na Ceardaich 1 had a significant proportion of alder charcoal by mass, but this was a slightly anomalous result as seven large pieces of alder roundwood from context (6004) were responsible for almost all the mass of alder charcoal identified from this site.

There is no strong evidence for different charcoal taxa being used in different locations or at different times and so it appears that birch was generally being favoured over other types, although it was not used exclusively. Birch wood produces a high-quality charcoal (Lines 1984) and so may have been deliberately selected for charcoal production, although it would also have been a significant component of the local woodlands. Use of birchwoods to produce charcoal for iron smelting or forging is recorded in the early part of the eighteenth century near Achray in the Trossachs (Smout 2003, 111). The range of other wood types present at the Loch Eck bloomery sites would also have been available in the local area, suggesting that ease of collection may also have been a consideration in the selection of wood for charcoal production.

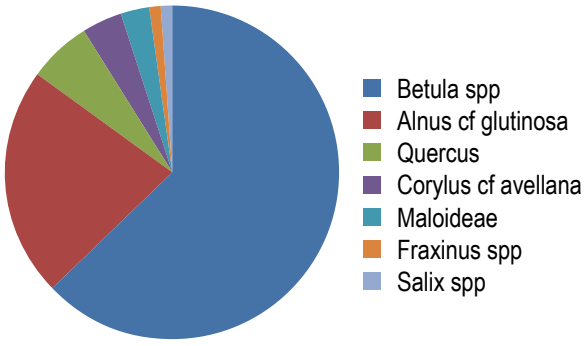

Figure 10: Proportion (by mass) of each charcoal type from Allt na Ceardaich 1 bulk samples.

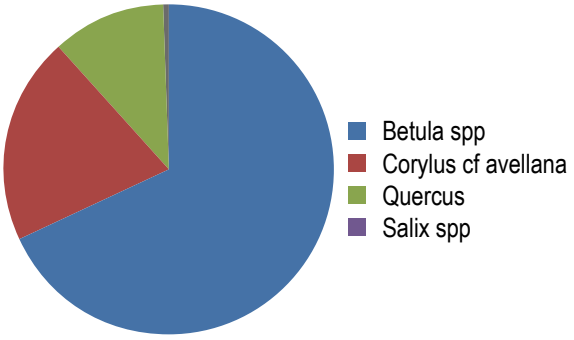

Figure 11: Proportion (by mass) of each charcoal type from Allt na Ceardaich 1 auger samples.

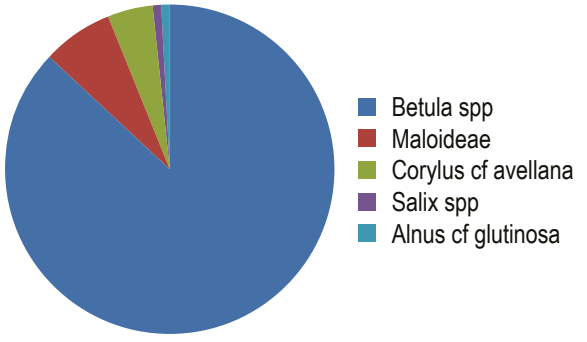

Figure 12: Proportion (by mass) of each charcoal type from Allt na Ceardaich 2 bulk samples.

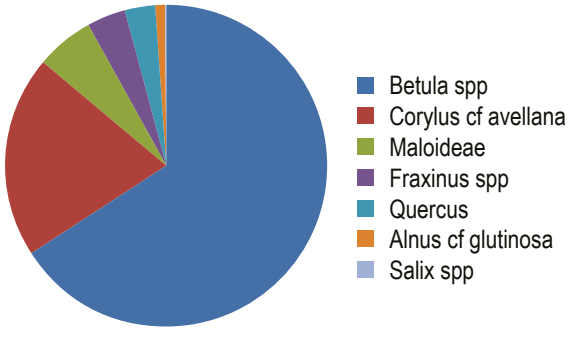

Figure 13: Proportion (by mass) of each charcoal type from Whistlefield Road bulk samples.

Industrial Waste

by Christine Rennie

In total, 64,470 g of slag and related high-temperature waste was recovered during the fieldwork and post-excavation processing of environmental samples. The 41 small finds recovered during the fieldwork account for some 16,406 g of this weight, while the remaining 48,064 g was obtained from environmental samples. The small finds were selected by the excavators in order to demonstrate the range of slag types found in a particular context and have, therefore, not been treated as fully representative of the quantity of waste within their contexts.

Methodology

The 41 small finds were examined using a hand lens at x10 magnification by eye and were categorised on the basis of morphology alone. The visible characteristics of the waste, principally texture and porosity, were noted, and comparison made with examples from the National Slag Collection held at Ironbridge Museum. Each small find was weighed, and quantification data are presented in Tables 7 to 9. Assessments were conducted in relation to current best practice (Keyes 2010; Fillery-Travis 2011). The waste retrieved during post-excavation processing of bulk soil samples was visually inspected, and weighed by context in line with current best practice (ibid).

Results

Allt na Ceardaich 1

The three trenches excavated at this location were positioned in order to investigate the eastern and western arms of the slag mound, and to define the extent of the western slag mound. The slag mound was horse-shoe shaped and was made up of a series of smaller mounds representing several deposition events (Atkinson et al. 2016, 9). Details of the quantities and types of waste can be found in Table 7.

In Trench 5 contexts (5001) and (5004) yielded only small amounts of mixed industrial waste that consisted of small pieces of tap slag, furnace lining and undiagnostic waste, all of which was retrieved from environmental samples. The bulk of this (97 g) was from silty topsoil deposit (5001), while a tiny amount (3.9 g) was retrieved from charcoal-rich deposit (5004), which the excavators interpreted as an occupation layer.

Trench 6 yielded considerably more waste than Trench 1. A single piece of tap slag (2378 g; CAT 40) and smaller samples of tap slag (114 g; CAT 36 and 38), as well as mixed waste (1971 g) came from an environmental sample of ashy silt deposit (6003). Some 436.4 g of small pieces of mixed waste consisting of tap slag, furnace lining and undiagnostic waste came from the bulk sample of charcoal deposit (6004). CAT 40 had a wrinkled upper surface, suggesting that the liquid slag flowed down-slope, and that the molten waste within the slag was still moving when the upper surface cooled.

Although much smaller than Trenches 5 and 6, Trench 7 contained a relatively large amount of waste. This included 0.7 g of spheroidal hammerscale and 44 g of small pieces of tap slag and mixed undiagnostic waste from charcoal deposit (7001), and tap slag (431.7 g; CAT 2 to CAT 8) from context (7002). A further 22 g of mixed tap slag, furnace lining and undiagnostic waste came from context (7003).

Auger samples, which were taken at 0.5 m intervals in the area between Trenches 1 and 2, contained miniscule amounts of hammerscale

Context	Tap slag	Spheroidal Hammerscale	Flake Hammerscale	Uncatalogued mixed waste
5001	-	-	-	97 g
5004	-	-	-	3.9 g
6003	2492 g (CATs 36, 38, 40)	-	-	1971 g
6004	-	-	-	436.4 g
7001	-	0.7 g (CAT 44)	-	44 g
7002	431.7 g (CATs 2-8)	-	-	-
7003	-	-	-	22 g
Auger	-	<0.1 g (CAT 42)	<0.1 g (CAT 41)	-

Table 7: Industrial waste from Allt na Ceardaich 1.

consisting of less than 0.1 g of spheroidal hammerscale and less than 0.1 g of flake hammerscale.

Allt na Ceardaich 2

Metalworking waste (Table 8) was collected from two contexts on this site (1003) and (2003) that formed the slag mound.

Context (1003) was a deposit of charcoal, burnt stones and slag about 0.6 m thick, which appeared to fill a pit below the slag mound (Atkinson et al. 2016, Figure 3). From this context, 3822 g of stone with fused slag (CAT 18), 0.6 g of spheroidal hammerscale (CAT 49), 80 g of tap slag (CAT 37), 30.8 g of slag prills (CAT 33 and 55) and 13,500 g of mixed uncatalogued and undiagnostic waste was collected. A possible stone feature (1004) consisting of two or three courses of large angular pieces of schist was recorded in the eastern side of the slag mound. The stones are not reported to have been heat affected, although they do form the upper edge of a feature that was filled with (1003), from which a stone with adhering slag was collected (CAT 18).

The second slag mound deposit (2003) also comprised charcoal, burnt stones and slag and was 0.3 m to 0.4 m thick. The waste from this deposit consisted of 0.8 g of spheroidal hammerscale (CAT 50 and 53), 66.5 g of slag prills (CAT 52 and 56) and 8304 g of uncatalogued mixed and undiagnostic waste.

Whistlefield Road

In Trench 3, context (3003) consisted of charcoal-rich silt with frequent inclusions of slag, from which 6.9 g of slag prills (CAT 47), 0.1 g of spheroidal hammerscale (CAT 48) and 769 g of uncatalogued tap slag and undiagnostic waste was collected (Table 9).

Deposit (3005) was also charcoal-rich and contained frequent inclusions of slag. Some 0.5 g of spheroidal hammerscale (CAT 43) and 228 g of uncatalogued tap slag and undiagnostic waste was collected from this deposit.

Unstratified waste from Trench 3 contained 3668 g of tap slag (CAT 11, 25, 26, 27, 29 and 30), a possible tuyere weighing 626 g (CAT 12) and 1126 g of undiagnostic waste (CAT 1, 28, 31, 32, 35 and 39).

In Trench 4, a deposit charcoal in layer (4004) included 0.2 g of spheroidal hammerscale (CAT 45), 12 g of slag prills (CAT 46) and 795 g of uncatalogued tap slag and undiagnostic waste. Deposit 4006 also comprised charcoal and 1626 g of uncatalogued tap slag and undiagnostic waste was recovered from an environmental sample of this deposit.

Unstratified waste from Trench 4 consisted of 3376 g of tap slag (CAT 9, 13, 14, 15, 19 and 20), 3064 g of furnace lining (CAT 10 and 16) and 96 g of undiagnostic waste (CAT 17 and 24).

Context	Tap slag	Spheroidal Hammerscale	Slag prills	Stone with adhering slag	Uncatalogued mixed waste
1003	80 g (CAT 37)	0.6 g (CAT 49)	30.8 g (CATs 33, 51, 54, 55)	3822 g (CAT 18)	13500 g
2005	-	0.8 g (CATs 50, 53)	66.5 g (CATs 52, 56)	-	8304 g

Table 8: Industrial waste from Allt na Ceardaich 2.

Context	Tap slag	Spheroidal Hammerscale	Slag prills	Furnace lining	Possible Tuyère	Uncatalogued mixed waste
3003	-	0.1 g (CAT	6.9 g (CAT 47)	-	-	769 g
3005	-	0.5 g (CAT 43)	-	-	-	228 g
4004	-	0.2 g (CAT 45)	12 g (CAT 46)	-	-	795 g
4006	-	-	-	-	-	1626 g
Trench 3 (U/S)	4394 g (CATs 11, 25-27, 29-32, 35, 39)	-	-	-	1026 g (CATs 1, 12)	-
Trench 4 (U/S)	3472g (CATs 9, 13, 14, 15, 17 19, 20, 24)	-	-	3064 g (CATs 10, 16)	-	-

Table 9: Industrial waste from Whistlefield Road.

Discussion

The tap slag collected at all three sites investigated in 2015 was generally heavy, dense and magnetic, indicating that a large amount of iron was present in the waste material. While such iron-rich slag could be, and often was, re-smelted, this does not appear to have occurred at the Loch Eck bloomeries sites. Previous analysis of slag from the Cowal peninsula concluded that "either the ore was substantially iron-rich or that a great proportion of the iron was lost in the slag through a rather low-yield, insufficient smelt" (Atkinson and Photos-Jones 1995, 3).

Allt na Ceardaich 1

The metalworking waste from the 2015 fieldwork at Allt na Ceardaich 1 is consistent with a site where smelting was carried out. While smelting waste constitutes the overwhelming volume of the waste assessed, very small amounts of smithing waste were also collected, indicating that, at the very least, initial consolidation (primary smithing) of the iron bloom was carried out at the smelting site. Spheroidal hammerscale was retrieved from an environmental sample from context (7001) in Trench 7 (CAT 44), and from an auger sample taken in the area between Trenches 5 and 6 (CAT 42), while flake hammerscale (CAT 41) was also found in an auger sample. Although neither of these locations is particularly close to the smithing area identified in 1995, hammerscale can be dispersed over a fairly wide area.

At Allt na Ceardaich 1, the expected location of the furnace(s) would be within the open end of the horseshoe-shaped slag mound, with the waste material being dumped close to the furnace and accumulating over time. Fieldwork in 1995 established that this was indeed the case (Atkinson and Photos-Jones, 15). The large dimensions of the slag mound suggest re-use of the locale over a fairly lengthy time period, or an organised local smelting industry. The size of the hearth structure at Allt na Ceardaich 1 would also point to the longevity of potentially large-scale smelting at the locale (Atkinson and Photos-Jones 1999b, 276).

Previous work at Allt na Ceardaich 1

Earlier work carried out at Allt na Ceardaich 1 established the site represented a typologically early bloomery (Atkinson and Photos-Jones 1995, 5), that was the location of "quasi-permanent installations" including drystone walling, a working floor, a charcoal storage area and a stone and timber structure housing the hearth (Atkinson and Photos-Jones 1999a, 275). The smithing hearth was identified in 1996 at the northern end of the eastern arm of the slag mound. Although bog iron was identified as the ore used in smelting, no source for the bog iron used at either Allt na Ceardaich smelting location was established.

SEM-EDAX analysis of material from the slag mounds indicates that some of this waste "must have originated from smithing or billet making" (Atkinson and Photos-Jones 1999b, 275).

Allt na Ceardaich 2

The types of ironworking waste from Allt na Ceardaich 2 indicate that both smelting and consolidation of the iron bloom were carried out there. The presence of spheroidal hammerscale, albeit in very small quantities, provides evidence for smithing, while the tap slag (CAT 37) and bulk samples of assorted waste are indicative of smelting.

Although the 2015 excavation at Allt na Ceardaich 2 did not reveal any definitive structural components such as a hearth, furnace, smithing area or charcoal storage area, Context (1004) may represent the remains of a furnace superstructure, with later waste material dumped into what had been the negative-cut furnace base context (1003).

The hammerscale retrieved from bulk samples taken from contexts (2005) (CAT 50 and CAT 53) and (1003) (CAT 49), located at the west and east of the site suggests smithing of the bloom was being undertaken (Figure 14). However, the likely position of a smithing hearth remained unclear.

Figure 14: Allt na Ceardaich 2 Hammerscale.

Whistlefield Road

The assemblage from Whistlefield Road also indicates that both smelting and at least primary smithing were carried out at this location. Small quantities of spheroidal hammerscale were retrieved from contexts (3003) (CAT 48) and (3005) (CAT 43) in Trench 3, and from context (4004) (CAT 45) in Trench 4. Such dispersal of the hammerscale may indicate that smithing debris was cleared together with smelting slag onto the waste mound.

Some tap slag samples from Whistlefield Road had a wrinkled upper surface (CAT 9, CAT 19-21), suggesting that the liquid slag flowed down-slope, and that the molten waste within the slag was still moving when the upper surface cooled (Figure 15).

Figure 15: Whistlefield Road tap slag.

Two pieces of slag (CAT 1 and 12) are far thicker than any other tap slag from Whistlefield Road, and their cylindrical shape is reminiscent of a tùyere, although the pieces are solid rather than hollow (Figure 16). These appear to be two broken parts of a single piece of slag, the morphology of which suggests a failed smelt where slag was not tapped, but escaped from the furnace via the blowing hole (tùyere).

Final Comments

The type of metalworking waste recovered during the fieldwork indicates that both smelting and primary smithing of the iron bloom were carried out at all three of the locations investigated. Of the three sites, structures relating to smelting and smithing were previously identified at Allt na Ceardaich 1, and the 2015 fieldwork may have identified a structure associated with smelting at Allt na Ceardaich 2. The slag mounds at all three locations were large, most especially that at Allt na Ceardaich 1 and, for such volumes of waste to accumulate, smelting must have been carried out over relatively long periods of time (see *Discussion,* below).

Discussion

Prior to 1995, little concentrated effort had been put into understanding the archaeology of bloomery iron production sites in Scotland. The interest which had been pursued came from antiquarians (e.g. MacAdam 1887), local historians (e.g. Dixon 1886) or amateur archaeology groups (Aitken 1973). Many of the basic questions in relation to bloomery sites in Scotland remained unanswered, particularly key questions on absolute dating of these sites, the sources of ore being used and how they related to the social milieu of the period in question. The Historic Scotland-funded *Scottish Bloomeries Project* was established to address these questions and led to the publication of four articles in various publications in the late 1990s (Atkinson and Photos-Jones 1999b; Hall and Photos-Jones 1998; Photos-Jones et al 1998; Photos-Jones and Atkinson 1998). These articles have subsequently formed the basis of understanding for this class of monument.

Since the late 1990s, a number of other investigations have cast further light on the location and form of the bloomery tradition elsewhere in the Scottish Highlands (Johnston et

Figure 16: Whistlefield Road possible tùyere.

al. 2006; Atkinson and Wombell 2015; Alexander 2019; Alexander and Eckersall 2026). A summary of the dating and known distribution has also been published in the literature and provides a degree of clarity on this class of Medieval monument (Atkinson 2003). Although the body of work produced in recent years has started to provide a clearer understanding of bloomery iron working in Scotland, detailed questions remain to be answered in relation to particular groups of sites. This was the case in relation to the 2015 project and the apparent clustering of bloomery mounds around Loch Eck.

The starting point for the 2015 project was the apparent presence of multiple bloomery mounds, particularly in close proximity to Allt na Ceardaich 1. Assessment of each location proved difficult to achieve, with access issues and possibly discrepancies in the grid reference locations of previously identified sites being the main cause. This is probably in part due to the lack of accurate GPS available beneath the forest canopy, as well as the fact that many of these sites were last identified in the 1960s and 1970s when GPS technology was not available. This is also likely confounded further by the fact that these sites may have been heavily disturbed by forestry activities since they were first identified, with felling and re-planting having occurred.

However, the three sites which were located all held potential to be further understood through the recovery of stratified datable material. Further to this, the sites at Allt na Ceardaich 1 and 2 and Whistlefield Road have mounds of fairly large proportions, which have survived the vagaries of previous cropping and replanting. Excavations carried out previously at Allt na Ceardaich 1 raised related questions of the scale of operations around the mounds, making all of these sites of interest to understanding the nature and complexity of the industry in this part of Argyll and by extension across the nation.

The recovery of charcoal samples from basal layers beneath the slag heaps at all three sites, combined with the dates achieved from earlier investigations at Allt na Ceardaich 1 in 1995 and 1996 allows conclusions to be drawn on temporal grounds (see *Radiocarbon Dates*, above). The earliest dates from Trench 8 at Allt na Ceardaich 1 suggests smelting may have started around 1300 and continued for around 150 years with dates from Trench 6 providing clear evidence of use in the early to mid-fifteenth century AD. A degree of contemporaneity clearly exists with nearby Allt na Ceardaich 2, which provided dating evidence for use starting in the first half of the fourteenth century and possible evidence of final use in the first half of the fifteenth century AD. Whistlefield Road by contrast appears to be somewhat of an outlier. Dating of charcoal from basal layers in Trenches 3 and 4 seems to suggest that smelting did not commence until the second half of the fifteenth century and was evidently still taking place up to around 1600. In brief, the project has clearly identified that smelting was happening on Loch Eck for at least 300 years and all the dates achieved fall within the known range of thirteenth to seventeenth century AD (Atkinson 2003, 38-39).

Specialist analysis of the archaeobotanical samples and industrial waste collected also provides further support to the view that birch was the predominate charcoal being used during this period for smelting purposes (see *Archaeobotany*, above), although it is also clear that the smiths active at all three locations utilised any suitable sources for charcoal for their endeavours including alder, oak, hazel, ash, rowan type and willow present in many of the samples recovered. Although much of the industrial waste recovered was represented by tap slag and mixed waste as would be expected from a smelting site, the presence of furnace lining at Whistlefield Road was also evident. In addition, Rennie (see *Industrial Waste*, above) also identified slag prills, spheroidal and flake hammerscale suggesting at primary smithing of the iron billets was also being undertaken at each site investigated.

The goals of the project were largely achieved and the results add extensively to our levels of understanding of this industry in Scotland during the Medieval period.

Concluding Comments

Although it was not possible to locate many of the sites previously noted by the Cowal Archaeological and Historical Society, the partial excavation of three sites on the Allt na Ceardaich and at Whistlefield Road has allowed further analysis of the processes and industrial activities undertaken on Loch Eckside in the late Medieval period to be assessed. It also permitted questions related to the dating and contemporaneity of these installations to be posed and answered, and throws much needed light on the complexity of a industrial system that we know little about.

Acknowledgements

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Figure 17: Allt na Ceardaich 2 working shot.

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All links were active at the point of publication

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Appendix 1: Industrial Waste Catalogue

SF	Sample	Area codes	Trench	Context	No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Type	Description	Context description	Catalogue Reference
003		ANC 1	Tr 7	7002	1	140	81	39	28	Tap slag	Dense, some vasicles, some oxidisation on exposed surfaces. Ropey upper surface. Some tiny unidentified crystals on exposed surfaces. Grey matt colour.	CV rich topsoil deposit that extends across the surface of the bloomery mound.	2
003		ANC 1	Tr 7	7002	1	94	53	51	22	Tap slag	Dense, few vasicles, ropey upper surface, accretions of heated soil on lower surface. Some oxidisation on exposed surfaces. Some tiny unidentified crystals on exposed surfaces. Grey matt colour	CV rich topsoil deposit that extends across the surface of the bloomery mound.	3
003		ANC 1	Tr 7	7002	1	36	69	44	32	Tap slag	Light, porous material with some vasicles. Some vitrification on presumed upper surface. Some tiny unidentified crystals on exposed surfaces.	CV rich topsoil deposit that extends across the surface of the bloomery mound.	4
003		ANC 1	Tr 7	7002	1	90	72	46	35	Tap slag	Fairly dense, few vasicles. Accretions on all surfaces, including quartz. Some oxidisation on all surfaces.	CV rich topsoil deposit that extends across the surface of the bloomery mound.	5
003		ANC 1	Tr 7	7002	1	46	45	45	32	Tap slag	Fairly dense material with some vesicles. Some oxidisation on exposed surfaces. Some accretions, including tiny unidentified crystals on exposed surfaces.	CV rich topsoil deposit that extends across the surface of the bloomery mound.	6
003		ANC 1	Tr 7	7002	1	22	34	32	28	Tap slag	Fairly light material with some vesicles. Charcoal flecks anf tiny unidentified crystals adhering to exposed surfaces, some vitrification and oxidisation on exposed surfaces	CV rich topsoil deposit that extends across the surface of the bloomery mound.	7
003		ANC 1	Tr 7	7002	1	3.7	21	16	12	Tap slag	Light material with oxidisation and tiny unidentified crystals on all surfaces.	CV rich topsoil deposit that extends across the surface of the bloomery mound.	8

CV = carbonised vegetation

SF	Sample	Area codes	Trench	Context	No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Type	Description	Context description	Catalogue Reference
002		ANC 1	Tr 6	6003	1	76	73	28	33	Tap slag	Semi-circle of slag covered with accretions. Some vesicles and oxidisation on all expose surfaces	Ashy silt, CV rich with high slag content	36
001		ANC 1	Tr 6	6003	1	38	58	30	28	Tap slag	Light material with oxidisation and tiny unidentified crystals on all surfaces. Lower surface is fairly flat.	Ashy silt, CV rich with high slag content	38
	004	ANC 1		6003	1	2678	233	201	46	Tap slag	Grey matt tap slag; ropey upper surface with some wrinkling, some oxidisation and a few vasicles. Some accretions on lower surface. The slag has run into a bowl-shaped cut . Exposed sides are vesicular and vitreous. Accretion of red mineral likely to be post-deposition.	Ashy silt, CV rich with high slag content	40
	018	ANC 1		Auger	1	<0.1	<1	<1	<1	Flake hammerscale	Grey/blue flake		41
	016	ANC 1		Auger	1	<0.1	3.4	3.4	3.4	Spheroidal hammerscale	Spheroidal hammerscale		42
	2	ANC 1		7001	2	0.1				Spheroidal hammerscale	Spheroidal hammerscale	CV rich deposit within mound	44
	4	ANC 1		203		22				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag		
	11	ANC 1		5001		36				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Shallow topsoil deposits	
	12	ANC 1		5001		61				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Shallow topsoil deposits	
	7	ANC 1		5004		3.9				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Charcoal deposit at base of occupation layer	
	5	ANC 1		6003		1628				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Ashy silt, CV rich with high slag content	
	6	ANC 1		6003		321				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Ashy silt, CV rich with high slag content	
	6	ANC 1		6004		229				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Charcoal deposit	

SF	Sample	Area codes	Trench	Context	No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Type	Description	Context description	Catalogue Reference
	10	ANC 1		6004		224				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Charcoal deposit	
	8	ANC 1		6004		10.4				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Charcoal deposit	
	2	ANC 1		7001		44				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	CV rich deposit within mound	
003		ANC 2	Tr 1	1003	1	3822	232	186	101	Possible furnace structure	Piece of schist with partially vitrified, vesicular slag on upper surface. Stone is not heat affected, so unlikely to have been used in the furnace structure.	Slag mound deposit	18
002		ANC 2	Tr 1	1003	1	80	96	45	11	Tap slag	Grey matt, vesicular tap slag. Upper surface has bubbled appearance. The molten slag has cooled over a rock or other shaped surface. Lower surface is smooth and convex. Oxidisation on all expose surfaces.	Slag mound deposit	37
	1	ANC 2		3003	21	0.6				Spheroidal hammerscale	Spheroidal hammerscale	Bloomery mound with CV rich silt deposit.	49
	4	ANC 2		2005	7	0.2				Spheroidal hammerscale	Spheroidal hammerscale	Slag mound deposit	50
	1	ANC 2		3003	2	5				Slag prill(s)	Slag prills	Bloomery mound with CV rich silt deposit.	51
	4	ANC 2		2005	1	0.8				Slag prill(s)	Slag prills	Slag mound deposit	52
	3	ANC 2		2005	12	0.6				Spheroidal hammerscale	Spheroidal hammerscale	Slag mound deposit	53
	1	ANC 2		3003	2	4.9				Slag prill(s)	Slag prills	Bloomery mound with CV rich silt deposit.	54
	2	ANC 2		1003	5	14.9				Slag prill(s)	Slag prills	Slag mound deposit	55
	3	ANC 2		2005	20	65.7				Slag prill(s)	Slag prills	Slag mound deposit	56
	2	ANC 2		1003		7500				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Slag mound deposit	
	3	ANC 2		2005		4290				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Slag mound deposit	
	4	ANC 2		2005		4014				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Slag mound deposit	

SF	Sample	Area codes	Trench	Context	No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Type	Description	Context description	Catalogue Reference
	1	ANC 2		3003		6000				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Bloomery mound with CV rich silt deposit.	
001		ANC 2	Tr 1	1003	1	6	47	13	8	Slag prill(s)	Matt grey slag prill	Slag mound deposit	33
005		WR	Tr 3		1	240	117	49	33	Slag from possible tuyere.	Fairly dense, frothy and fairly vesicular material. Inclusions of stones? Some tiny unidentified crystals on exposed surfaces.	Not known	1
008		WR	Tr 4		1	2492	259	208	67	Tap slag	Dense material with a pronounced ridge on its lower surface where the molten slag has flowed into a narrow void. Accretions of grit and stones on lower surface. Some vesicles on upper surface. Upper surface has ropey wrinkled appearance, probably caused by the waste material running downslope. The slag has cooled relatively slowly, allowing the accumulation of material being tapped off to push down onto the already cooling material, creating these pressure ridges. Grey matt colour.	Not known	9
009		WR	Tr 4		1	2950	249	162	68	Furnace lining	Dense, heavy material that is “rim”shaped. Some accretions of unidentified minerals and oxidisation on exposed surfaces. Possible tree root adhering to outer surface. Outer surface is grey and small pebbles and crystals noted on exterior surface.	Not known	10
004		WR	Tr 3		1	1500	173	158	63	Tap slag	Dense material with some vitrification and vesicles on “sides”. Very ropey appearance on upper surface. Some accretions of stone on lower surface, which also has a pronounced ridge where the molten slag has flowed into a narrow void. Gey matt colour.	Not known	11

SF	Sample	Area codes	Trench	Context	No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Type	Description	Context description	Catalogue Reference
006		WR	Tr 3		1	626	111	62	62	Slag from possible tuyere.	Fairly dense, frothy and vesicular material. It is cylindrical in shape and has some oxidisation on exposed surfaces. Shape may be due to smelt going wrong and slag entering tuyere before cooling (JAA).	Not known	12
011		WR	Tr 4		1	274	123	48	28	Tap slag	Dense, vesicular grey slag with ropey upper surface. Some vitrification of exposed surfaces.	Not known	13
011		WR	Tr 4		1	110	74	71	19	Tap slag	Fairly flat, dense vesicular tap slag. Smooth upper surface with “folded” aspect. Grey matt colour.	Not known	14
011		WR	Tr 4		1	110	53	40	22	Tap slag	Dense, matt grey tap slag with ropey upper surface.	Not known	15
011		WR	Tr 4		1	114	92	48	32	Furnace base	Fairly dense, vesicular material. Some vitrification of exposed surfaces. Slightly wedge shaped.	Not known	16
011		WR	Tr 4		1	64	64	45	24	Tap slag	Fairly dense, vesicular material. Some vitrification of exposed surfaces. Some oxidisation of exposed surfaces.	Not known	17
010		WR	Tr 4		1	326	113	95	22	Tap slag	Grey matt tap slag. Some vesicles on broken exposed interior surface. Ropey texture with some wrinkling on upper surface. Some accretions on lower surface. Flattened ropey texture on lower surface.	Not known	19
010		WR	Tr 4		1	174	68	56	25	Tap slag	Grey matt tap slag. Ropey texture with some wrinkling on upper surface. Flattened ropey texture on lower surface. Three distinct layers of material seen in expsed section.	Not known	20

SF	Sample	Area codes	Trench	Context	No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Type	Description	Context description	Catalogue Reference
010		WR	Tr 4		1	82	51	44	27	Tap slag	Grey matt tap slag. Ropey texture with some wrinkling on upper surface. Some accretions on lower surface. A few vesicles on exposed interior surfaces, which are also slightly vitrified.	Not known	21
010		WR	Tr 4		1	64	54	44	24	Tap slag	Grey vitrified material. Some vesicles on exposed interior surfaces. Base is almost perfectly flat.	Not known	22
010		WR	Tr 4		1	18	41	31	18	Tap slag	Grey matt tap slag. Ropey appearance to upper surface, some accretions on lower surface. Some vesicles on exposed surfaces.	Not known	23
010		WR	Tr 4		1	32	52	29	31	Tap slag	Light, vesicular material with accretions on all surfaces. Some oxidisation on all surfaces.	Not known	24
001		WR	Tr 3		1	176	97	80	61	Tap slag	Grey matt tap slag fused with undiagnostic slag. Tap slag has ropey upper surface, and a few vesicles on exposed interior surface. Undiagnostic material is vesicular, grainy with some vitrification and oxidisation on surfaces.	Not known	25
001		WR	Tr 3		1	60	55	38	20	Tap slag	Grey matt tap slag. Ropey upper surface, accretions on lower surface. Some vesicles on exposed interior surfaces.	Not known	26
001		WR	Tr 3		1	88	53	53	37	Tap slag	Grey matt upper surface with folded appearance. Porous exposed surfaces of fuse material.	Not known	27
001		WR	Tr 3		1	28	54	36	26	Tap slag	Matt grey/brown vesicular material. Some oxidisation of exposed surfaces. Some very large vesicles on exposed interior surfaces.	Not known	28

SF	Sample	Area codes	Trench	Context	No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Type	Description	Context description	Catalogue Reference
001		WR	Tr 3		2	10	38	34	11	Tap slag	Flat grey tap slag with accretions on lower surface. Vesicles on all surfaces	Not known	29
001		WR	Tr 3		2	44	35	27	28	Tap slag	Dense vesicular slag of grey matt colour. Upper surface has a folded appearance; lower surface is amorphous.	Not known	30
001		WR	Tr 3		1	16	35	28	18	Tap slag	Fairly dense vesicular material. Colour ranges from black, to grey to orange/pink. Some oxidisation and accretions on all surfaces	Not known	31
001		WR	Tr 3		1	16	34	24	14	Tap slag	Dense vesicular slag. One flat surface, opposite surface is very porous. Some accretions and oxidisation	Not known	32
003		WR	Tr 3		1	1496	183	119	34	Tap slag	Fairly dense, grey matt tap slag. Ropey upper surface, accretions on lower surface. Vesicles and some oxidisation on exposed surfaces	Not known	34
002		WR	Tr 3		1	818	119	115	55	Tap slag	Dense, vesicular slag, matt grey colour. Upper surface is fairly flat, and has a pretusion that apears almost moulded to the surface. Accretions of stone on lower surface. Some oxidisation on all exposed surfaces.	Not known	35
007		WR	Tr 3		1	24	62	34	8	Tap slag	Dense, dark grey slag. Shaped like part of a plate base. Oxidisation and some vitrification on exposed upper surface. Accretions on lower surface	Not known	39
	2	WR		3005	20	0.5				Spheroidal hammerscale	Spheroidal hammerscale	Bloomery mound with CV rich silt deposit.	43
	3	WR		4004	12	0.2				Spheroidal hammerscale	Spheroidal hammerscale	Bloomery mound with CV rich silt deposit.	45

SF	Sample	Area codes	Trench	Context	No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Type	Description	Context description	Catalogue Reference
	3	WR		4004	2	12				Slag prill(s)	Slag prills	Bloomery mound with CV rich silt deposit.	46
	1	WR		3003	1	6.9				Slag prill(s)	Slag prills	Bloomery mound with CV rich silt deposit.	47
	1	WR		3003	10	0.1				Spheroidal hammerscale	Spheroidal hammerscale	Bloomery mound with CV rich silt deposit.	48
	1	WR		3003		679				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Bloomery mound with CV rich silt deposit.	
	2	WR		3005		228				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Bloomery mound with CV rich silt deposit.	
	3	WR		4004		795				Tap slag and undiagnostic		Bloomery mound with CV rich silt deposit.	
	4	WR		4006		1626				Tap slag and undiagnostic	Mix of small pieces of tap slag and undiagnostic slag	Bloomery mound with CV rich silt deposit.	

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