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Assessment of archaeometallurgical residues from Rathnadrinna (12E157)

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Abstract

The submitted material comprised 182 samples from 134 contexts, with a total weight 2763g. Most of the samples taken from processed bulk samples contained no metallurgical residues. There were 30 productive samples from 18 contexts. Macroscopic material included 14 pieces, from 7 different contexts, with a total weight of 1099g. There were just 5 pieces (possibly 6) of flake hammerscale.

The assemblage of archaeometallurgical residues is thus very restricted, almost certainly suggesting that no metalworking took place within the excavated area. Most of the materials are identifiable as being certainly, or possibly, from iron working (smithing). No pieces were certainly from non-ferrous processes or from iron smelting.

One piece of smithing hearth cake contained clasts of foliated shale and was probably at least partially coal-fuelled. This piece (from context (225)) is very likely to be post-medieval/modern in age.

Earlier macroscopic smithing residues derived from just four cut features: [124] (593g), [1441] (94g), [1706] (54g) and [1866] (186g). This distribution suggests that this iron working activity was Iron Age in date and pre-dates the metalled surface. Of these, only one context ((1401) in cut [124]) also yielded hammerscale, but only two fragments. The lack of hammerscale (assuming the bulk samples were sampled with a suitably fine mesh) suggests that the smithing took place elsewhere.

The single complete smithing hearth cake was of moderate weight (506g) for an Iron Age example, which raises the possibility it was from bloomsmithing rather than blacksmithing.

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Methods

All materials were examined visually, using a low-powered binocular microscope where required. As an assessment, the materials were not subjected to any high-magnification optical inspection, not to any form of instrumental analysis.

The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

The submitted material comprised 182 samples from 134 contexts, with a total weight 2763g. The full catalogue of examined material is presented in Table 1.

Most of the samples taken from processed bulk samples contained no metallurgical residues. There were 30 productive samples from 18 contexts (Table 2). Macroscopic material included 14 pieces from 7 different contexts with a total weight of 1099g. There were just 5 pieces (possibly 6) of flake hammerscale.

This assessment was conducted in November 2017, and was commissioned by Richard O'Brien.

Results

General description of the assemblage

There were 30 productive samples from 18 contexts. Macroscopic material included 14 pieces, from 7 different contexts, with a total weight of 1099g (Table 2). There were just 5 pieces (possibly 6) of flake hammerscale. The assemblage of archaeometallurgical residues is thus very restricted, almost certainly suggesting that no metalworking took place within the excavated area. Most of the materials are identifiable as being certainly, or possibly, from iron working (smithing). No pieces were certainly from non-ferrous processes or from iron smelting.

The natural materials contained in the samples contained much that was magnetic, and therefore possibly heat-affected. A wide variety of rock types were present, with larger pieces including chert and fossiliferous limestones. The small debris was rich in highly polished iron oxide grains and also in fragments derived from sulphidic mineral veins.

Ironworking residues

Smithing hearth cakes

A complexly-lobed slag with a slightly tan surface and basal pendent lobes was retrieved from context (225). Although the upper surface bore the probable impression of a charcoal fragment, the pale colour of the upper slag, together with its dull lustre (the appearance and lustre of melted plastic) and clasts of shale, strongly suggest the involvement of coal fuel. This piece appears to represent a large part of a smithing hearth cake (SHC) and, if coal-fuelled, is very likely to be post-medieval/modern in age.

Earlier macroscopic smithing residues include slag identifiable as from SHCs from contexts (1401) and (1443). That from (1401) includes a complete example of an SHC weighing 506g. It was plano-convex in form and transverse in plan. It measured 80x95x60mm and had a base which was dimpled, with charcoal impressions, and glassy top with lining slag clots and pebbles. The upper lining-influenced layer was almost rectangular in plan and 15-20mm in thickness. On what is probably the proximal side of the piece there is a protruding zone of accretion, probably covering an iron inclusion. The piece is coated with secondary iron oxides which preclude detailed observations of the surface.

Context (1443) produced a small fragment of SHC, weighing 49.4g.

Related slags also occurred in context (568) and (1706). The piece from (568) was a fragment of slag with an amalgamation of dense prills bound by more vesicular material, weighing 14g. That from (1706) was a small pad of slag weighing 54g, that could be a complete incipient SHC (proto-SHC) or might have been a fragment from a larger mass.

Hearth/furnace lining

Oxidised-fired and vitrified hearth lining was represented only by a small (13g) fragment from context (1401).

Other slags

Dense slags of indeterminate origin were retrieved from up to nine contexts. In many of these ((1257), (1401), (1443), (1571), and (183)/(1881), and, less certainly from (1416) and (1662)) the recorded material was very small in size, precluding the existence of any diagnostic features.

For two pieces (from contexts (1867) and (1882)) an origin could not be determined, although both were probably iron slags. That from context (1867) was a slab of slag forming an attachment with the hearth wall. The piece showed a proper burr (a zone in which hot reaction has occurred between the slag and wall ceramic) in the upper part of its contact with the hearth wall, but a non-wetted texture below. The internal surface shows charcoal ranging up to about 25mm in size. The slab was thin (a maximum of 30mmn but mostly less) and covered a moderately large area of wall (105 x 80mm). The piece was not classifiable as an SHC, and an origin in either iron smelting or smithing would be technically possible, although the small scale of the piece would very strongly suggest the latter.

Low-density slags (typically derived from melting of hearth lining under the influence of the fuel ash) were recovered from four contexts ((1257), (1401), (1416) and ((1571)) in mostly very small pieces. The largest piece (from context (1401)) weighed just 8g. Such materials are not diagnostic of metallurgical process and may result from both ferrous and non-ferrous metalworking.

Micro-residues

The magnetic separates contained a very few small fragments of flake hammerscale. There is a significant quantity of material in many retents that resembles flake hammerscale and is magnetic, but flexible, with one striated surface and one slightly rusty surface. It is likely this material is a damaged protective (plastic or other polymer) coating spalled from the surface of the sieving equipment.

Coke

Two contexts ((10), (225)) produced small pieces of coked organic matter. Although interpreting the original

nature of coked organic matter can be problematic, one of these pieces occurred in the same context as the potential coal-fuelled SHC (225) and is likely to be true coke (the organic residue from incompletely combusted coal).

Other material

Besides the natural materials mentioned above, the submitted materials included a slab of indurated clay from below a fire-spot (from context (53)). The induration may have been either a simple effect of heat or perhaps cementation by lime released from the fuel ash. There was no evidence to necessarily link this burning to metallurgical activity.

A sample from context (14) comprised some weathering products from weathering of copper alloy. The material is too degraded for detailed interpretation, but there is no particular reason to interpret the fragment necessarily as being a metallurgical residue rather than a fragment from an artefact.

Distribution of the assemblage

The distribution of residues by context is summarised in Table 3.

Context (225) produced one piece of a smithing hearth cake, containing clasts of foliated shale and which was therefore probably at least partially coal-fuelled. This piece (from context (225)) is very likely to be post-medieval/modern in age. Context (225) also yielded a piece of coke, potentially also deriving from the smithing. A piece of coke was also retrieved from context (14).

Earlier macroscopic smithing residues derived from just four cut features: [124] (593g), [1441] (94g), (1706) (54g) and [1866] (186g). This distribution suggests that this iron working activity was Iron Age in date. Of these, only one context ((1401) in cut [124]) also yielded hammerscale (but only two fragments).

Three other contexts also yielded flake hammerscale ((grey sod (1), (1762), (2146)), but only a single flake from each. Such small quantities might be residual or even intrusive, and shed little light on the location or phasing of the metalworking.

Five further contexts produced very small quantities of macroscopic slag debris ((1257), (1416), (1571), (1863)/(1881) and (1882)). These materials were less diagnostic than those described previously, but are less likely to be intrusive than the hammerscale and, as probable iron-working residues, would be suggestive of an Iron Age or later date for the enclosing contexts.

Interpretation

The assemblage comprises metallurgical residues that can be interpreted either as either being, or probably being, from ironworking. There were no certain residues from the working of non-ferrous metals, although the fragment of weathered copper alloy and the low-density lining slags could, in theory, have been produced during the handling of non-ferrous materials. The collection included no finds, such as moulds or crucibles that would normally be expected to form a part of a non-ferrous metalworking assemblage.

One of the slag pieces differs from the remainder of the collection. This piece (from context (225)) is interpreted as probably being a coal-fuelled smithing slag. A piece of coke was also retrieved from the same context, circumstantially supporting the case for coal-fuelling of the smithing activity. Current evidence suggests that the introduction of the use of coal as a fuel during blacksmithing occurred first on the east coast, under Anglo-Norman influence, probably in approximately the 13th century, and initially employing coal imported from Britain. Coal use developed during the medieval period in the areas of the coalfields, such as in Co. Kilkenny. Coal was listed amongst taxable items at Fethard in 1292 (Cosgrove 1987, 238; although this is unclear whether the coal was being imported or exported and in 1322-3 a ship carrying coal was detained in Dublin (O'Neill, 1987). The sources at Coalisland, Co. Tyrone, were being exploited by the mid-17th century (Bardon, 1991, p. 203). Coal has been noted from archaeometallurgical assemblages from Carrickmines Castle, Co. Dublin (Young 2006; Young & Kearns 2010; Young 2011a), Greencastle, Co. Down (Young 2010), Gorteens Castle, Co. Kilkenny (Dabal & Young 2011) and Portumna Castle, Co Galway (Young 2017), all probably from between the 16th and mid-18th centuries. Closer to the present site, a post-medieval smithy from Cuffsbrough, Co. Laois, was also coal fuelled (Young 2009b). An 18th-19th century assemblage from Mucklagh, Co. Offaly (Young 2008b), was also rather similar to the present material. It would appear likely that in areas remote from the coalfields, such as Co. Offaly, the introduction of coal as fuel did not occur until after the advent of the canal system at the end of the 18th century.

The earlier iron-working residues include a complete SHC, together with other fragmentary slags. What is understood of the stratigraphic context of these pieces would suggest that they are probably Iron Age in date. The lack of any rich assemblages of hammerscale and the fragmentary nature of much of the macroscopic material argues against the ironworking having been undertaken within the excavated area (compare, for instance the abundant microresidues at a smithy such as Coolamurry, Young 2008c). The lack of associated macroresidues is commonly an indicator of transport. Examples of macroscopic slag assemblages occurring, for instance, in the ditches of ringforts and enclosed settlements (presumably either carried or thrown) are common (e.g. Killeany, Young 2008d, and Parknahown, Young 2009c, with a particularly good example at the ringfort of Rochfort Demesne, Young 2008a). Disposal of macroscopic slag pieces thus commonly occurs at considerable distance from the smithy itself, whereas hammerscale and fine grained ashy material is commonly disposed-of more locally.

Iron Age smithing assemblages are remarkably rare in Ireland, particularly so in view of the large number of iron smelting sites recorded in recent road schemes. Some of these smelting sites have produced a small number of SHCs, probably deriving from the bloomsmithing process. A probable iron smelting site at Derrygarriff, Co. Galway, that might be Iron Age in date, produced SHCs (262g and 400g; Young 2009f). An Iron Age smelting site at Ballinamona, Co. Cork, also yielded a few SHCs (138g, 184g, 200g, 342g; Young 2009e). A smelting site at Milltown, Co. Kilkenny, yielded a single SHC (260g; Young 2009d). A somewhat problematic site at Cuffsborough, Co Laois, produced several SHC fragments probably from examples in the 300-600g range and which may be of Iron Age date (Young 2009a).

The end use of iron (blacksmithing) is much less well understood, and the few indications have been at major regional centres. At the Iron Age site of Ballydavis (Young 2005, 2), for instance, minor cut features commonly contained hammerscale and other microresidues, locally in rich assemblages, as well as slag, whereas an enclosing ditch produced isolated larger pieces of macroscopic slag. Limited evidence for smithing was also obtained at Tara (Crew & Rehren 2002).

The 506g weight of the SHC from Rathnadrinna falls into a weight range, which if early medieval or later would be interpreted as deriving from blacksmithing. However, the weight is within the range of those recorded from various Iron Age iron smelting sites listed above. Although the Irish Iron Age currently lacks any large, well-characterised smithing residue assemblages, it certainly appears likely that a 500g SHC might be a residue from bloomsmithing.

Further work

The limited assemblage and the lack of association with any metallurgical features, means that the research potential for the assemblage is reduced. The key issue that could be addressed through additional laboratory analysis would be to attempt to determine whether the Iron Age SHC from the site is from blacksmithing or bloomsmithing.

Irrespective of the commissioning of any further investigation, the assemblage is of significance because of its apparent age, despite its small size, and should be deposited with the site archive in an appropriate receiving institution.

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Table 1: summary catalogue. SHC = smithing hearth cake, FHS = flake hammerscale, ph = posthole, sh = stakehole, assm = uncounted assemblage. Weights in grams.

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
C1A							
8	37	5		early medieval kiln 37	0.61	assm	stone
51	50	8	3	fort itch 50	0.03	26	stones
68		12		magnetic early medieval kiln	0.01	3	stone
115	114	60		magnetic pit 114	0.08	1	stone (just possibly hard-fired clay)
161	160	38		magnetic ph 160	0.09	6	stones
313	314	97		sh 314	0.01	7	stone
374	375	116		non-magnetic ph 375	0.3	4	polished dark grains
578	577	170		sh 577	0.02	4	stone
Cutting 1B Bank 3 of fort							
32	40	33/39		magnetic ph 40 bank 3	0.75	40	stone
619		172		magnetic fort bank material	0.61	1	stone
Cutting 1B Bank 1							
10		260	area 1	bank 1	234	1	rounded pebble of ?manganese ore
10		158		bank 4	13.1	6	possible single broken piece of coke, now 6 pieces and dust

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
225		159		bank 1	172	1	complexly-lobed slag with slightly tan surface basal pendent lobes, upper parts of 'plasticy' appearance with foliated clasts of shale, a probable imprint of charcoal on the upper face; most likely a substantial smithing slag
478		325		magnetic bank 1	0.16	6	stones
587		191		magnetic bank 1	0.89	4	stones
600	599	179		magnetic sh 599	1.33	47	stones
604	603	187		magnetic under bank 1	0.01	2	stone
cutting 1c							
24		602		non-magnetic slot 1	1.11	1	dark polished iron oxide grain
95	94	30		magnetic ph 94	0.25	1	dark polished iron oxide grain
167	166	59		non-magnetic ph 166	0.16	1	small dark shiny grain
171	170	52		magnetic ph 170	0.14	9	stone
235	236	121		non-magnetic ph 236	0.09	1	dark shiny grain of iron oxide
264	263	110		magnetic ph [263]	0.01	1	small dark shiny grain
304	301	88		magetic sh 301	0.01	1	stone
316	315	106		magnetic sh 315	0.01	1	stone
346	345	129		non-magnetic ph 345	0.23	1	polished iron oxide grain
348	347	109		non-magnetic ph 347	0.38	4	stones, including large polished iron oxide grain

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
449	124	147		non-magnetic pre-fort ditch 124	7.3	6	2 large polished grains, others are other natural lithologies
806	805	399		wall slot 805	0.22	1	dark polished iron oxide grain
1260	1259	344		non-magnetic sh 1259	0.28	2	dark shiny grains
1306		359		magnetic	0.38	assm	stones
1308	1307	360		magnetic ph 1307	0.28	9	stone
1489	1488	423		magnetic sh 1488	0.01	1	small dark shiny grain
1581	1580	441		magnetic ph 1580	0.22	4	stone
1662	1661	367		magnetic sh 1661	0.6	assm	stones plus 1 piece of possible slag and 1 possible FHS
1701	1700	473		magnetic sh 1700	0.09	15	stones
1708	1707	475		magnetic sh 1707	0.02	asm	stone
1733	1732	478		magnetic pit 1732	0.01	4	tiny ferruginous stones
1810	1809	495		magnetic ph 1809	0.01	4	stones
1888	1887	532		magnetic	0.02	1	small dark shiny grain
1890	1889	53		magnetic wall slot 1889	0.17	1	ferruginous rock - weathering crust
1894	1893	536		magnetic wall slot 1893	0.13	9	stone
1896	1895	540		magnetic wall slot 1895	0.08	6	stone
1902	1901	515		magnetic wall slot 1901	0.01	1	stone

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1917	1916	542		magnetic wall slot 1916	0.01	1	small stone with dark material adhering
2143	2142	225		magnetic pre-fort ditch 2142	0.05	7	stone
2145	2144	227		magnetic 2144 pre-fort ditch	0.08	11	stone
Bank 2							
22		330		magnetic bank 2	0.23	1	dark polished iron oxide grain
Under bank 4							
grey sod (1)		220		magnetic	0.09	6	5 stones, 1 piece FHS
grey sod (2)		221		magnetic bank 4	0.23	assm	stone
deposit under 23		242		non-magnetic	17.1	1	dark polished iron oxide grain
463	462	195		magnetic ph 462	0.64	49	stones
945	944	219		magnetic sh 944	0.01	3	dark polished grains
1264	1263	346		magnetic ph 1263	2	assm	stones
1296	1295	355		magnetic pit 1295	0.08	2	stone
1312		361		spread 1312 under bank 4	0.41	26	stones
1322	1321	365		magnetic sh 1321	0.08	8	stones
1338	1337	373		magnetic sh 1337	0.01	1	dark polished iron oxide grain
1383	1382	398		magnetic sh 1382	0.01	1	dark polished iron oxide grain

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1388	1387	395		non-magnetic ph 1387	0.13	1	dark polished iron oxide grain
1451	1450	420		magnetic ph 1450	0.01	1	dark polished iron oxide grain
1513	1512	431		magnetic ph 1512	0.01	1	rock
1547	1596	445		magnetic posthole 1596	0.04	2	dark polished grins
1591	1590	444		magnetic ph 1590 under bank 4	0.01	3	dark polished grains
c2							
151	150	566	2	magnetic ph 150	0.13	12	stones
178	177	546	2	magnetic ph 177	0.41	5	stones
178	177	493	2	magnetic ph 177	0.14	4	stones
178	177	492	2	magnetic ph 177	0.03	1	dark polished stone
212	150	48	2	magnetic ph 150	0.09	6	stones
486	485	163	2	magnetic sh 485	0.3	9	stones
514	513	37	2	magnetic ph 513	0.13	1	stone
643	642	612	2	magnetic ditch 642	0.01	3	stone
653	652	203	2	magnetic ph 652	0.22	19	stones
750	749	202	2	magnetic ph 749	0.14	1	polished dark stone
1855	1854	510	2	magnetic ph 1854 in base ph 177	0.3	2	stones

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1855	1854	520	2	magnetic ph 1854 in base ph 177	0.01	1	dark polished stone
1857	1856	511	2	magnetic ph 1856 in base ph 177	0.11	1	dark polished stone
1857	1856	519	2	magnetic ph 1856	0.09	1	stone
C3							
14	15	233		Cu-alloy Ditch B	0.53	assm	Cu-alloy weathering products in soil
53	1256	272	3	oxidised clay	760	2	large blocks of well-cemented gravelly silt; reddened patches are associated with charcoal but no indications of metallurgical activity; it is possible that the cementation of these pieces have been influenced by the calcareous ash; firespot
98	15	18		lower fill Ditch B	0.22	1	polished iron oxide grain
225		167			3.66	3	coked organic matter - probably coke
246	15	68		basal fill Ditch B	0.01	10	dark sheet-like grains, not hammerscale
387	124	125		from retent	0.64	1	ferruginous rocks
568	124	549			14	1	highly-weathered piece of prilly iron slag, denser prills bound by more vesicular material
645	644	340	2	ditch 644	1.88	33	stone
737	736	198		bank 4	0.63	2	polished ferruginous gravel grains
943	942	403		bank 4	3.73	31	various ferruginous stones, other lithologies and small pieces of Fe-Mn concretionary material
1257	1256	467	3/3a	magnetic pit 1256	0.13	3	problematic stones probably, one laminated possible magnetite, 2 other pieces might possibly be slag

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1257	1256	421	3/3a	magnetic pit 1256	3.34	assm	single flexible piece, 0.13g grain of vesicular iron slag, and a slightly smaller grain of sandy lining slag, remainder stones
1303	1302	385	3	magnetic pit 1302	3.84	1	polished Fe oxide grain
1332	1331	381	3	magnetic pit 1331	0.13	1	polished dark stone
1358	1357	386	3	magnetic pit 1357	2.25	assm	stones
1386	1385	393			0.01	2	rock grains
1401	1620	450	3		506	1	95x80x60mm SHC; base dimpled; top glassy with lining slag clots and pebbles; very slightly two-layer; accretion covers details
1401		496	3		54	1	fragment of SHC; deeply dimpled glassy top with charcoal; base shows reaction with wall and includes some gravel; possible burr of small attachment?
1401	124	257	3		7.42	1	chert
1401	124	261	3	ditch 124	5.45	1	vitrified oxidised fired lining, ceramic sandy or finely gravelly
1401	124	464	3	magnetic	2.08	assm	stone
1401	124	404	3		3.37	2	1.81 g FAS attached to small pebble, 1.56g small concretion or slag fragment with abundant charcoal
1401	124	491	3	magnetic pre-fort ditch 124	6	assm	pieces flexible striated, 2 pieces FHS, two pieces possible FHS or iron-rich crust, 1 piece lining slag, 2 possible slag pieces, 1 piece of bornite-like fragile material
1401	124	268			5.01	1	highly weathered vesicular sandy lining slag, slightly lobate surface

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1401	124	262			7.55	1	gravelly lining, oxidised, but reduced near surface, sandy lining slag has development of lobes
1401	124	256			1.19	1	abraded fragment of vesicular lining slag
1416	1256	511			1.14	1	micaceous sandstone
1416	1256	417		hand-picked from 417 retent	3.66	1	possible weathered vesicular slag fragment, only secondary minerals, so origin uncertain
1416	1256	269		pit 1256	0.11	1	small fragment of lining slag with green glass
1416	1256	258	3	pit 1256	22.9	1	chert
1430	1429	408		from retent	0.22	1	ferruginous rock - probable oxidised sulphide
1442	1441	413	3	magnetic pit 1441	0.3	17	stones
1443	1441	422	3	hammerscale pit 1441	36	assm	lots of black flexible sheet, often iron stained on one side; mostly stone, but some small irregular rounded iron concretions that could just possibly be weathered slag droplets
1443	1441	494	3	magnetic pit 1441	72	assm	6g general magnetic, includes 1.37g slag piece; 66g magnetic from N end of pit (includes 5g of fines, mostly stone but some slag, 1.7g sandy vitrified lining piece and 49.4g piece of SHC)
1443		259			6.61	1	slightly cracked small ferruginous concretion
1443	1441	264		pit 1441	0.58	1	sandstone
1443	1441	270		pit 1441 retent	1.6	1	polished iron oxide
1449	1448	415			0.34	3	variably polished Fe oxide rich grains

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1472	1471	426	3	magnetic pit 1471	0.13	1	polished dark grain
1516	1441	578	3	magnetic from IA pit 1441	1.36	assm	stone
1516	1441	512	3	IA pit 1441	28	assm	stones, some charcoal
1516	1441	486	3	magnetic pit 1441	0.93	assm	stones
1516	1441	267			2.44	1	chert
1516	1441	517			5.28	1	charcoal-rich ferruginous concretion
1549	124	271		ditch 124	1.96	9	8 natural stones and a small concretion
1571	1570	437	3	magnetic pit 1570	0.04	1	polished dark stone
1571	1570	500	3	magnetic	3.29	assm	fragment of sandy lining slag and 4 other small slag fragments and a droplet, remainder stone
1573	1572	436	3	magnetic pit 1572	2.21	assm	stones
1600	1256	490	3a	magnetic pit 1256	0.66	assm	stones
1643	1642	455		sh 1643	0.47	6	five tubular concretion fragments and one small elongate ferruginous concretion on charcoal
1652	1651	460	3	magnetic	0.39	13	stones
1706		528	3	magnetic stone surface 1706	1.05	assm	stones, with two slag grains, both dark and very weathered
1706		557	3		74	1	silicified rock
1706		556	3		2.1	1	small fragment of goethitic vein
1706		266			0.38	1	stone

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1706		544	grid3c	hammerscale	0.1	assm	ferruginous rock fragments
1706		554	3	Clean back after removal of metalling	0.09	assm	some strongly magnetic particles, but no scale
1706		265	3		54	1	small piece of very weathered slag, deeply dimpled on one side and flat on the other- so somewhat resembling a tongue; unclear if this is a 'proto-SHC' or a small piece of a larger cake
1720	1719	476	3	magnetic cut 1719	0.04	6	stones
1720	1620?	477	3	magnetic 1620?	12.4	assm	stones (plus a little charcoal)
1721	1620	508	3	magnetic pit? 1620	6.78	assm	stone, including a piece of slate
					0.63	assm	picked as FHS, but rather appears to include both slate and black polythene?, weight mostly matrix
1721	1620	508	3	hammerscale baulk 2	0.4	assm	magnetic material including various secondary oxides and several pieces of shiny grey flake, but these appear to be slate fragments and not hammerscale
1721	1620	509	3	bank 2	0.33	1	ferruginous rock (weathering crust?)
1722	1811	514	3		42	1	decalcified limestone
1722		231			0.44	1	ferruginous rock, weathering crust
1722	1811	503	3	magnetic pit 1811	6.5	assm	stones
1722	1811	505	3		31.4	1	hydrated iron oxides, brown and green grains (large - after sulphides) in much blacker matrix
1722	1811	506	3	upper layer of pit 1811	23.7	1	partially silicified and decalcified limestone
1723	124	498	3	magnetic pre-fort ditch	5.39	assm	1 striated flexible fragment, rest stones

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1762	deposit	497	3	hand-picked from retent	0.54	assm	stones, with one piece of FHS
1776	1775	487		ph 1775	3.08	13	ferruginous stones
1807	1808	499	3	magnetic pit 1808	1.16	assm	stones
1863	1265	524	3		49	1	chert
1863	1256	513	3	magnetic pit 1256	14	assm	stone, some charcoal
1863/1881	1256	524	3a	magnetic pit 1256	0.91	assm	one 0.04 slag fragment with oxidised surface skin cf tapslag, rest stone
1867	1866	263	3		186	1	slab of wall attachment slag, proper burr above but more non-wetted below; internal surface shows charcoal to about 25mm; a thin slab (maximum 30mm mostly less) from a large area of wall (105 x 80mm); not a proper SHC but could be either smelting or smithing
1881	1256	530	3a	non-magnetic pit 1256	3.84	assm	stone
1882	1441	451			42.7	1	highly weathered, deeply dimpled/prilly parallel side slag sheet; dense, accretion obscures detail
1882	1441	451	3	magnetic pit 1441	3.07	assm	stone, one 0.02g grain is dubious slag
1882	1441	526	3	magnetic pit 1441	6.4	assm	stones
1886	1885	583	3	magnetic pit 1885	5.39	assm	stones plus one small shale fragment, plus a fragile grain with a bright coloured sheen (probably ore, just possibly coke)
1962	1961	552	3	magnetic ph 1961	0.13	2	stones
1981	124	561	3	magnetic pre-fort ditch 124	0.19	9	stones

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1982	1256	571		pit 1256 retent	0.09	1	ferruginous rock
1982	1256	558	3/3a	magnetic pit 1256	0.01	2	stone
1982	1256	571	3a	magnetic pit 1256	0.02	18	stone
1996	1995	576	3	magnetic pit 1995	0.01	3	stones
2065	2064	584	3	magnetic slag ph 2064	43.5	2	chert
2086	2085	588	3	magnetic 2085	0.03	7	5 stones plus two grains of secondary iron oxides that might be weathered slag
2090	2089	590	3	magnetic 2089	0.01	2	stone, charcoal
2130	2129	595	3	magnetic	0.01	4	stones
2136	2135	608	3	magnetic pit 2135	2.8	12	stones
2136	2135	609	3	magnetic	0.14	1	polished dark grain
2146	1256	606/607/613	3/3a	magnetic pit 1256	30	assm	stones, single piece of FHS
2146	1256	613	3/3a	pit 1256	14.4	1	chert
2147	124/568 interface	610	3	magnetic on interface	0.34	assm	stones
2164	1256	615	3/3a	magnetic pit 1256	4.54	assm	stones
2165	1256	614	3	magnetic pit 1256	43	assm	stone with many pellets of ashy/cemented/burnt clay
C5							
24		228		magnetic surface deposit 24	0.09	12	stones

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1884	1883	545		magnetic pit 1883	0.17	18	stones
1998	1997	619		non-magnetic wall slot 1997	0.31	1	dark polished iron oxide grain
2155	2154	611		magnetic wall slot 2154	0.14	11	stones
2161	2160	223		magnetic pit 2160	0.22	12	stones

Table 2: *summary catalogue pf productive contexts/samples alone. SHC = smithing hearth cake, FHS = flake hammerscale, ph = posthole, sh = stakehole, assm = uncounted assemblage. Weights in grams.*

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
Cutting 1B Bank 1							
10		158		bank 4	13.14	6	possible single broken piece of coke, now 6 pieces and dust
225		159		bank 1	172	1	complexly lobed slag with slightly tan surface; basal pendent lobes; upper parts of plasticy appearance with foliate clasts of shale; a probable imprint of charcoal on the upper face; most likely a substantial smithing slag
cutting 1c							
1662	1661	367		magnetic sh 1661	0.6	assm	stones plus 1 piece possible slag and 1 possible FHS
Under bank 4							
grey sod (1)		220		magnetic	0.09	6	5 stones, 1 piece FHS
C3							
14	15	233		Cu alloy Ditch B	0.53	assm	Cu-alloy weathering products in soil
53	1256	272	3	oxidised clay	760	2	large blocks of well-cemented gravelly silt; reddened patches are associated with charcoal but no indications of metallurgical activity; it is possible that the cementation of these pieces have been influenced by the calcareous ash. Fire-spot
225		167			3.66	3	coked organic matter - probably coke
568	124	549			14.03	1	highly weathered piece of prilly iron slag, denser prills bound by more vesicular material

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1257	1256	467	3/3a	magnetic pit 1256	0.13	3	problematic stones probably, one laminated possible magnetite, 2 other pieces might possibly be slag
1257	1256	421	3/3a	magnetic pit 1256	3.34	assm	single flexible piece, 0.13g grain of vesicular iron slag, and a slightly smaller grain of sandy lining slag, remainder stones
1401		450	3		506	1	95x80x60mm SHC; base dimpled; top glassy with lining slag clots and pebbles; very slightly two-layer; accretion covers details
1401		496	3		54	1	fragment of SHC; deeply dimpled glassy top with charcoal; base shows reaction with wall and includes some gravel; possible burr of small attachment?
1401	124	261	3	ditch 124	5.45	1	vitrified oxidised fired lining, ceramic sandy or finely gravelly
1401	124	404	3		3.37	2	1.81 g FAS attached to small pebble, 1.56g small concretion or slag fragment with abundant charcoal
1401	124	491	3	magnetic pre-fort ditch 124	6	assm	pieces flexible striated, 2 pieces FHS, two pieces possible FHS or iron-rich crust, 1 piece lining slag, 2 possible slag pieces, 1 piece of bornite-like fragile material
1401	124	268			5.01	1	highly weathered vesicular sandy lining slag, slightly lobate surface
1401	124	262			7.55	1	gravelly lining, oxidised, but reduced near surface, sandy lining slag has development of lobes
1401	124	256			1.19	1	abraded fragment of vesicular lining slag
1416	1256	417		hand-picked from 417 retent	3.66	1	possible weathered vesicular slag fragment, only secondary minerals, so origin uncertain
1416	1256	269		pit 1256	0.11	1	small fragment of lining slag with green glass
1443	1441	422	3	hammerscale pit 1441	36	assm	lots of black flexible sheet, often iron stained on one side, mostly stone, but some small irregular rounded iron concretions that could just possibly be weathered slag droplets

Context	cut	sample	cutting	sample and locality notes	wt	no	material notes
1443	1441	494	3	magnetic pit 1441	72	assm	6g general magnetic (includes 1.37g slag piece), 66g magnetic from N end of pit (includes 5g of fines, mostly stone but some slag, 1.7g sandy vitrified lining piece and 49.4g piece of SHC)
1571	1570	500	3	magnetic	3.29	assm	fragment of sandy lining slag and 4 other small slag fragments and a droplet, remainder stone
1706	deposit	265	3		54	1	small piece of very weathered slag; deeply dimpled on one side and flat on the other- so somewhat resembling a tongue; unclear if this is a 'proto-SHC' or a small piece of a larger cake
1762	deposit	497	3	hand-picked from retent	0.54	assm	stones, with one piece of FHS
1863/1881	1256	524	3a	magnetic pit 1256	0.91	assm	one 0.04 slag fragment with oxidised surface skin cf tapslag, rest stone
1867	1866	263	3		186	1	slab of wall attachment slag; proper burr above but more non-wetted below; internal surface shows charcoal to about 25mm; a thin slab (max 30mm mostly less) from a large area of wall (105 x 80mm); not a proper SHC but could be ether smelting or smithing
1882	1441	451			42.73	1	highly weathered; deeply dimpled/prilly; parallel sided slag sheet; dense; accretion obscures detail
1882	1441	451	3	magnetic pit 1441	3.07	assm	stone, one 0.02g grain is dubious slag
2146	1256	606/607/613	3/3a	magnetic pit 1256	30	assm	stones, single piece of FHS

Table 3: summary of archaeometallurgical residues (abnd associated material) by class and by context. SHC = smithing heath cake, FHS = flake hammerscale, y = present.

Context	cut	SHC	smithing slag	indet slag	lining slag	lining	FHS	burning	Cu trace	coke	total
grey sod (1)							y				*<*
10										13.1	*13.1*
14	15								y		*<*
53	1256							y			*<*
225		172.0								3.7	*175.7*
568	124		14.0								*14.0*
1257	1256			0.1	0.1						*0.2*
1401	124	560.0		y	8.0	13.0	y				*581.0*
1416	1256			?	0.1						*0.1*
1443	1441	49.4		1.4							*50.8*
1571	1570			y	y						*<*
1662	1661			?			?				*<*
1706			54.0								*54.0*
1762	deposit						y				*<*
1863/1881	1256			0.0							*<*
1867	1866			186.0							*186.0*
1882	1441			42.7							*42.7*
2146	1256						y				*<*
	total	*781.4*	*68.0*	*230.3*	*8.2*	*13.0*	*<*	*<*	*<*	*16.8*	

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