

DUNADD ARCHIVE

SECTION 3: ANALYSIS AND SPECIALIST REPORTS

3.1 *Report on the ironworking slags and other residues*

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Introduction

The material classed as slags and other residues was grouped into six types, of which two were diagnostic, i.e. derived from the ironworking process. The manufacture of iron artefacts is a two stage process, firstly the extraction of the metal from the ore, the smelting process, and secondly the working of the metal into artefacts, the smithing process. Both processes generate slags as waste by-products which in many cases are easily distinguishable, but some smelting slags, particularly those produced by technologies that were used in the 'pre-' and 'post-Roman' periods, are difficult to distinguish from smithing slags.

The Classification of the Dunadd residues

The six groups are:

The Diagnostic Slags

- i] Smithing Slags: randomly shaped pieces of slag generated by the smithing process.
- ii] Hearth Bottoms: plano-convex accumulations of smithing slag that developed in front of the tuyeres.

The mean dimensions of the Dunadd hearth bottoms are:

	Mean	S.D.
Weight (kg)	0.310	0.215
Major Diameter (mm)	85	20
Minor Diameter (mm)	70	20
Depth (mm)	35	10

The Non-Diagnostic Slags

- iii] Fuel Ash Slag: a high temperature product of reaction between siliceous material (including soil) and the ash content of the fuel. It is a non-diagnostic slag, since it could have been generated by any high temperature process, including the domestic hearth.
- iv] Furnace-hearth Lining: the vitrified clay lining of a hearth, kiln or furnace. Usually vitrification only occurs in the tuyere region, which is the zone of highest hot-face temperature. It is a non-diagnostic residue, since it could be derived from any hearth, furnace or kiln.
- v] Ore: the material classed as ore was ferruginous stone etc. The term does not imply that the material was smelted.
- vi] (Ferruginous) Concretion: this material was a 'soft' earthy ferruginous concretion. Both the ore and the 'concretion' can be considered as variations of the same material, the hydrous ferrous oxide mineral limonite. They are forms of 'bog ore' or 'iron panning', i.e. the result of precipitation of iron compounds from solution. The cause of the precipitation is not known, but could be due to changes in oxygen potential, P.H., or the presence of impervious layers with sand grains or other small particles acting as nuclei for precipitation. Samples of the concretion were analysed by X-ray Diffraction and the Scanning Electron Microscope with an attached energy dispersive analyser. The X.R.D. results were inconclusive, only showing the

presence of a weak silica pattern. This indicates that the material is amorphous, lacking a distinct structure. The S.E.M. analyses show the major elements as iron with a significant phosphorus content. Other elements present were silica, alumina, potash and lime. Similar material has been noted on other 'upland' sites, e.g. Clatchard Craig (Close-Brooks 1987, 178).

Distribution of the Residues

A listing by Site and Context Number is given in Table 1.

Site 1

A total of 0.795 kg of smithing debris was recovered from the site. This is a background level, i.e. a quantity that is to be expected from any occupied site, it does not provide evidence for iron smithing in the context, area, or phase in which it was recovered. The associated finds were domestic, i.e. occupation debris, providing further evidence that it formed part of the general refuse of the occupation of the site. A significant quantity of hearth lining was recovered (0.190 kg). It occurred in small quantities in 9 contexts, and was not strongly associated with the iron slag. It is therefore probable that the majority of the hearth lining derived from processes other than smithing. Small quantities of 'concretion', 'ore' and fuel ash slag were recovered.

Site 2

A total of 1.085 kg of smithing debris was recovered from 4 contexts. This probably represents background levels of slag. Also small amounts of 'concretion' and hearth lining were recorded.

Site 3

Site 3 produced the largest quantities of all residue types. The total of smithing debris was 10.108 kg. The largest deposits occurred in contexts interpreted as midden material (Phase IIIc). This again indicates that the slag is one component of the general refuse of the site, although other metal-working debris is present, e.g. crucibles. Large quantities of 'concretion' (17.158 kg) and 'ore' (8.590 kg) were present on the site. In general the large deposits reflected the distribution outlined above though Phase IIIA and B deposits had substantial amounts. The distribution of the hearth lining (0.482 kg) was also widespread, and was not strongly associated with the iron smithing debris though the largest amount again came from Phase IIIc. Only a small amount of fuel ash slag was recovered.

Site 4

Only very small amounts of smithing slag (0.010 kg) and fuel ash slag (0.005) were recovered.

Overall Interpretation

Examination of the slags and residues recovered from the excavation at Dunadd show that iron smithing was practiced on the site. The smithing debris was widely distributed and the largest deposits were either disturbed/unstratified layers or contexts that contained large numbers of other finds. It is therefore probable that the slag was generated elsewhere on the site and disposed of with other domestic and industrial waste. There was no evidence of iron smelting. The unusual residue from Dunadd was the ferruginous 'concretion and ore'. Although they have been recorded from other sites, the quantity here is very high. Their widespread distribution, and the absence of very large deposits (as for example at the Howe of Howe, Orkney (Smith 1994, 228-34)), excludes the probability that they represent the remains of an ore heap. That is not to say that they could not have been exploited as an ore source in some other part of the site, though the absence of smelting slag argues against this. The hearth lining probably derived from iron smithing and other processes. The quantity of fuel ash slag was not significant.

Conclusions

Iron smithing was carried out at Dunadd, but not in the areas excavated. The material classed as ferruginous 'concretion' or 'ore' was a natural deposit, brought to the site but there is no evidence that it was actually smelted.

TABLE 1**Dunadd Slag listing, by site and context (weight in grams)**

CONTEXT	Context Number
SMITH	Weight of Smithing Slag
HB	Weight of Hearth Bottoms
CONC	Weight of Ferruginous Concretion
ORE	Weight of Ferruginous ore
FAS	Weight of Fuel Ash Slag
HL	Weight of Heath Lining

Site 1

CONTEXT	SMITH	HB	CONC	ORE	FAS	HL
1	0	0	30	25	5	0
2	0	0	0	0	10	0
4	0	0	0	0	10	0
5	0	0	80	0	0	30
8	30	260	0	0	0	0
10	50	0	0	0	0	0
17	0	0	30	0	5	0
20	0	0	1	0	0	0
24	0	0	0	0	0	65
25	5	0	45	0	0	0
28	0	0	1	0	0	30
31	0	0	10	0	0	0
36	60	0	0	0	5	0
37	175	0	0	0	0	5
41	15	0	0	0	0	0
43	10	19	0	0	0	0
45	0	0	0	0	0	5
46	0	0	30	0	0	0
53	0	0	0	0	0	5
55	0	0	0	0	0	10
60	0	0	0	0	0	20
63	0	0	10	0	0	0
70	0	0	0	0	0	20
Subtotal	345	450	237	25	35	190

Site 2

CONTEXT	SMITH	HB	CONC	ORE	FAS	HL
1	0	185	0	0	0	0
8	350	90	0	0	0	0
13	0	320	140	0	0	25
14	0	90	0	0	0	0
Subtotal	350	685	140	0	0	25

Site 3

CONTEXT	SMITH	HB	CONC	ORE	FAS	HL
31	685	1670	1855	0	0	45
32	0	625	655	0	0	0
33	330	0	0	0	0	0
34	0	0	20	0	0	0
36	0	315	35	0	0	0
38	115	1260	1945	0	0	25
39	0	0	765	0	0	0
40	0	0	35	0	0	5
43	360	0	0	0	0	10

44	0	0	1250	0	0	120
45	0	0	185	0	0	0
48	245	0	435	0	0	0
49	5	105	45	0	0	0
50	60	0	895	30	10	20
51	15	0	25	0	0	0
52	0	0	0	0	10	0
55	0	0	0	0	0	0
61	255	0	95	775	0	0
62	60	530	155	1105	5	5
79	0	0	330	0	0	0
81	5	0	305	0	0	6
82	40	285	355	170	0	0
83	0	0	10	0	0	0
84	15	0	150	305	0	0
85	0	0	20	0	0	0
86	0	0	400	0	0	0
87	25	0	35	0	0	0
88	0	0	30	0	0	0
90	50	0	370	0	0	15
92	301	950	1385	800	5	42
93	0	85	80	0	0	0
94	0	0	70	0	0	5
95	240	0	300	0	0	25
96	1	0	90	375	5	0
97	0	0	1125	0	0	0
98	0	0	50	0	0	5
100	0	0	10	0	0	0
101	35	0	120	0	0	10
102	21	0	0	0	0	0
104	0	0	225	0	0	0
105	0	0	195	0	0	26
106	5	0	355	0	15	20
107	0	0	0	0	1	0
111	0	0	0	5	0	2
113	0	90	0	0	0	0
U.S.	20	0	65	0	20	5
Subtotal	3148	6960	17158	8590	86	482
Site 4						
CONTEXT	SMITH	HB	CONC	ORE	FAS	HL
13	10	0	0	0	5	0
Subtotal	10	0	0	0	5	0
TOTAL	3953	8085	1753	8615	126	697