Ancient Monuments Laboratory
Report 38/2000

ASSESSMENT OF METAL WORKING DEBRIS FROM WIGMORE CASTLE HEREFORD AND WORCESTER

D Dungworth

Ancient Monuments Laboratory Report 38/2000

ASSESSMENT OF METAL WORKING DEBRIS FROM WIGMORE CASTLE HEREFORD AND WORCESTER

D Dungworth

Summary

Excavation at a medieval castle produced 13 kg of slag. The types of slag recovered were all characteristic of iron smithing. Slags were recovered from most phases of occupation but may have been residual in the later phases. The only phase to produce a wide range of slag types pre-dated the construction of the castle. The 1.2 kg of lead waste was produced during the melting of lead; this may be associated with the manufacture of fittings, their fitting or recovery during demolition.

Author's address :-

D Dungworth
ENGLISH HERITAGE
Centre For Archaeology Fort Cumberland
Fort Cumberland Road Eastney
Portsmouth
HANTS
UK
PO4 9LD

Assessment of Metalworking Debris from Wigmore Castle, Hereford and Worcester

David Dungworth

Introduction

Wigmore Castle, Hereford and Worcester is a well preserved Marcher castle. The site is a Scheduled Ancient Monument and a Guardianship site which has not previously been subjected to major excavation and only limited demolition or robbing of masonry. Recent excavations by Marches Archaeology were carried out as part of a programme of assessment ahead of consolidation and repair of the masonry. This report covers the 13 kg of iron working slag, 1 kg of vitrified building debris and 1.2 kg of lead working waste recovered during the excavations of area A (adjoining the south perimeter wall of the inner bailey).

Projects Aims

The project aims include, 'How did the castle and its community function in relation to the surrounding territory and population'. The study of the metal working wastes addresses this aim in showing how important metalworking was to the castle and its community.

Phasing

Preliminary phasing (table 1) is based on stratigraphy and pottery spot dating (Stone & Appleton-Fox 1998). During excavation and the first stages of post-excavation analysis (Stone & Appleton-Fox 1998) metal working debris was identified as significantly present during a number of period/phases of activity. Period 4 phase iii consisted of 'a series of deposits associated with burning. Within some of these were substantial amounts of slag, indicating some industrial process (provisionally identified as iron working) in the vicinity'. In period 6 'the southern part of the site was an industrial complex of lead working activity . . . The extensive amount of trimmings found suggests that lead working included manufacture to the finished product and was not concerned primarily with the reclamation of lead from an earlier phase'. Period 9 phase iii consisted of layers containing much 'animal bone, metalwork and slag, as well as large amounts of ceramics, including tile'.

Period	Date	Activity
1	Later 11th century	Pre-castle
2	12th century	Construction of timber castle
3	12th century	Destruction of timber building, clearance, pits, capping of pits
4	13th century	Resurfacing, industrial use (possible iron working)
5	13th century	Construction of curtain wall of inner bailey
6	13th–14th century	Building construction and use; lead working
7	14th century	Decay and disuse
8	14th–15th century	Construction of upper part of curtain wall of inner bailey
9	14th–16th century	Occupation, disuse, re-occupation, iron working nearby
10	16th–18th century	Gradual decay

Table 1. Wigmore Castle Area A. Preliminary phasing

Assessment of the iron working slags

A total 13 kg of iron working slag was visually examined, classified and quantified (see table 2). Visual examination of the slag allowed the material to be categorised on criteria of morphology, density, colour and vesicularity. It should be stressed that many "classes" of slag form part of a compositional and morphological continuum. Only certain classes of material are strictly diagnostic, and can be unambiguously assigned to a single metalworking process. Others may derive from a restricted range of processes but, when found in association with the diagnostic types, may provide support for the identification of these activities. Some forms of debris may originate from a very wide range of high temperature processes and are of no help in identifying crafts or industries. A number of samples were analysed qualitatively using energy dispersive x-ray fluorescence (EDXRF) in order to test for the presence of non-ferrous metals, but none were detected.

Those classes of iron working slag from Wigmore Castle which can be assigned to a particular activity all indicate that iron smithing was carried out. None of the slags found are of types associated with iron smelting. The recovery of smithing hearth bottoms, vitrified hearth lining, and cinder from period 1 contexts suggests that iron smithing took place within Area A or nearby at this time (see table 2). Vitrified hearth lining in particular is unlikely to have been transported far from the smithing area. In addition, a high proportion of the smithing hearth bottoms from period 1 contexts are whole (later contexts tend to have higher proportions of smithing hearth bottom fragments).

Period	1	2	3	4	5	6	7	8	9	10	Total
Smithing hearth base	3316	0	0	1002	1164	0	0	0	4720	143	10345
Vitrified hearth lining	80	0	0	0	0	0	0	0	0	0	80
Cinder	310	6	0	0	3	0	0	12	0	27	358
Fuel ash slag	1	0	0	86	0	41	0	0	39	0	167
Undiagnostic iron working slag	550	49	0	517	68	4	0	0	911	86	2185
Total iron working slag	4257	55	0	1605	1235	45	0	12	5670	256	13135
Lead waste	0	0	0	0	0	42	1181	0	0	0	1223
Vitrified building debris	0	0	128	153	493	46	0	0	109	30	959
TOTAL	4257	55	128	1758	1728	133	1181	12	5779	286	15317

Table 2. Wigmore Castle Area A. Slag weight by phase (g)

Although period 4 phase iii was identified as having 'substantial' evidence for iron working, relatively modest quantities of slag have been identified from period 4 contexts. No vitrified hearth lining fragments were among the period 4 slag and all of the smithing hearth bottom pieces were fragmented. It is likely that the period 4 slag was not produced in the immediate vicinity of the Area A excavation. Alternatively, the period 4 slag may all be residual from period 1. None of the slag from period 4 is diagnostically different to that from period 1.

The slag from period 9 phase iii deposits is also lacking in vitrified hearth lining but does include some whole smithing hearth bottoms. It is likely that the period 9 slag was produced some distance from Area A or is residual.

Finds of hammerscale provide good evidence for the location of iron smithing activity. Unfortunately no soil samples were taken from Area A specifically for this purpose. The environmental samples, however, could still provide samples of hammerscale. This could help in determining whether the iron working slags were produced in Area A.

Explanation of terms used in classification

Examination of the debris from Wigmore Castle revealed a typical iron working assemblage which has been classified using categories of debris used at the Centre for Archaeology. Qualitative surface EDXRF analysis of several slag samples was undertaken and indicated a typical, predominantly fayalitic ($2FeO.SiO_2$), composition.

Evidence for iron smithing may be recognised in two forms, as bulk slag and as micro

slags. Of the bulk slags produced during smithing only the **smithing hearth bottoms** are unlikely to be confused with the waste products of smelting and are therefore considered to be diagnostic of smithing. Hearth bottoms are recognisable by their characteristic plano-convex form, typically having a rough convex base and a smoother, vitrified upper surface which is flat, or even slightly hollowed as a result of the downwards pressure of the air blast from the tuyère. Compositionally, smithing hearth bottoms are predominantly fayalitic (iron silicate) and form as a result of high temperature reactions between the iron, iron-scale and silica from either the clay furnace lining or sand used as a flux by the smith.

In addition to bulk slags, iron smithing also produces micro-slags of two types. **Flake hammerscale** consists of fish-scale like fragments of the oxide/silicate skin of the iron dislodged during working. **Spheroidal hammerscale** results from the solidification of small droplets of liquid slag expelled during working, particularly when two components are being fire welded together or when a slag-rich bloom of iron is first worked into a billet or bar.

Vitrified hearth lining is produced by a high temperature reaction between the clay lining of a hearth, and the alkaline fuel ashes or fayalitic slag. It can be formed during iron smelting, iron smithing, non-ferrous metal working or other pyrotechnical processes. This material usually shows a compositional gradient from un-modified clay on one side to a glazed surface or irregular cindery material on the other.

Much smaller amounts of material were classified as **fuel ash slag**, a very lightweight, light coloured (grey-brown), highly porous material which results from the reaction between alkaline fuel ash and silicates from soil, sand or clay at elevated temperatures. The reaction is shared by many pyrotechnological processes and the slag is not diagnostic. EDXRF analysis shows the presence of silicon and alkalis such as calcium, potassium and sodium with little or no iron.

Cinder is also produced by fuel ash or slag attack of the clay lining of a hearth or furnace. It resembles the more heavily reacted surface of a hearth/ furnace lining. Fresh fractures show the slag is black and EDXRF analysis shows the presence of significant amounts of iron.

The debris classified as **undiagnostic iron working slag** is also of fayalitic composition and can be formed during iron smelting or iron smithing. However, in the absence of any clear evidence for the former it is probable that the undiagnostic slag also derives from iron smithing.

Assessment of the lead working waste

A total of 1223 g of lead working waste was included in the slag submitted for assessment. Some of the lead was recovered as small finds and some was recovered from environmental sampling (sample number 7 from context 104, and sample number 12 from context 135). The lead assemblage included fragments of at least two plano-convex shaped pieces (both approximately 20 cm in diameter and up to 5 cm thick) as well as numerous smaller and generally amorphous pieces. The waste consisted primarily of metallic lead with oxidised surfaces, although some of the smaller pieces are more extensively oxidised. This material is likely to have formed in and around hearths used to melt lead. Lead working may have been carried out for a number of

different purposes: production of lead artefacts, installation of lead (window cames or lead roofing) or iron fittings held into masonry with lead, or during the demolition and recovery of constructional lead fittings. The large number of off-cuts of lead does not necessarily indicate the production of artefacts rather than the recovery of structural lead (Stone & Appleton-Fox 1998). Lead would tend to be cut up during its recovery prior to be melted down. Most of the lead (by weight) derives from period 7 contexts. It could relate to a refurbishment in this period or may be residual from period 6 activity.

Vitrified Building Debris

Twenty-eight samples (959 g) of material submitted for assessment were particularly vesicular, had glazed or vitrified surfaces and were generally green in colour (compared to the black of the iron working slags). Close examination of this material showed it was variously ceramic or stone fragments which had been subjected to high temperatures and had partially vitrified. This is interpreted as fragments of building material which were exposed to high temperatures during a fire: either accidentally or deliberately during demolition. The vitrified building debris is found in contexts of many different periods and cannot on contextual evidence be related to a single period of destruction.

Conclusions

The iron working slag and other materials submitted for assessment indicate that iron smithing took place in the immediate vicinity of Area A in the period before the castle was constructed. While some iron smithing slag was recovered from later contexts it is likely that this is residual or derived from another working area some distance from Area A. On the basis of the evidence from Area A iron smithing was not a significant part of the economy of the castle. The evidence of lead working indicates that lead was being melted. The reason for this (manufacture of lead artefacts or structural lead, or the recovery of structural lead) is uncertain.

Potential for further work

The iron working slags and lead waste do not warrant further examination.

References

Stone, R. & Appleton-Fox 1998. Wigmore Castle Excavation of Area A, 1996. Archive Report. Marches Archaeology Service Series 009A.

Appendix

Context	Period/ phase	Description	Weight (g)	Dimensions
4	10	Vitrified Building Debris	21	
4	10	Vitrified Building Debris	9	

5	10	Mortar, fossil, flint & glass		
11	10	Undiagnostic	24	
12	10	Iron object	139	
23	10	Smithing Hearth Bottom	143	7x5x3 cm
23	10	Undiagnostic	25	
23	10	Undiagnostic	19	
25	9.iii	Fuel Ash Slag	39	
25	9.iii	Smithing Hearth Bottom fragment	276	
25	9.iii	Smithing Hearth Bottom fragment	649	
25	9.iii	Smithing Hearth Bottom fragment	533	
25	9.iii	Smithing Hearth Bottom fragment	350	
25	9.iii	Smithing Hearth Bottom fragment	527	
25	9.iii	Smithing Hearth Bottom fragment	229	
25	9.iii	Smithing Hearth Bottom fragment	132	
25	9.iii	Smithing Hearth Bottom fragment	100	
25	9.iii	Undiagnostic	143	
25	9.iii	Undiagnostic	13	
25	9.iii	Undiagnostic	12	
25	9.iii	Undiagnostic	6	
25	9.iii	Undiagnostic	5	
25	9.iii	Undiagnostic	93	
25	9.iii	Undiagnostic	73	
25	9.iii	Undiagnostic	61	
25	9.iii	Undiagnostic	80	
25	9.iii	Undiagnostic	48	
25	9.iii	Undiagnostic	42	
25	9.iii	Undiagnostic	39	
25	9.iii	Undiagnostic	46	
25	9.iii	Undiagnostic	34	
25	9.iii	Undiagnostic	10	
25	9.iii	Undiagnostic	22	
30	10	Cinder	2	
30	10	Cinder	16	
30	10	Cinder	9	
30	10	Undiagnostic	17	
30	10	Undiagnostic	1	
35	9.iii	Daub	6	
35	9.iii	Iron object	85	
35	9.iii	Smithing Hearth Bottom	176	7x6x3 cm
35	9.iii	Smithing Hearth Bottom	171	8x7x4 cm
Context	**Period/ phase**	**Description**	**Weight (g)**	**Dimensions**
35	9.iii	Smithing Hearth Bottom	536	12x10x4 cm
35	9.iii	Smithing Hearth Bottom	205	10x6x3 cm
35	9.iii	Smithing Hearth Bottom	596	10x8x5 cm
35	9.iii	Smithing Hearth Bottom	134	8x7x2 cm
35	9.iii	Smithing Hearth Bottom fragment	106	

35	9.iii	Undiagnostic	64	
35	9.iii	Undiagnostic	55	
35	9.iii	Undiagnostic	52	
35	9.iii	Undiagnostic	6	
35	9.iii	Undiagnostic	2	
35	9.iii	Undiagnostic	3	
35	9.iii	Undiagnostic	1	
35	9.iii	Undiagnostic	1	
35	9.iii	Vitrified Building Debris	18	
42	9.ii	Vitrified Building Debris	80	
45	9.ii	Vitrified Building Debris	6	
50	9.ii	Vitrified Building Debris	5	
61	8	Smithing Hearth Bottom fragment	1344	
76	8	Stone	37	
82	8	Cinder	12	
82	8	Stone	26	
92	7	Smithing Hearth Bottom fragment	584	
93	7	Lead waste	82	
93	7	Lead waste (hearth bottom-shaped)	434	
96	7	Lead waste (hearth bottom-shaped)	637	
104	7	Lead waste	28	
112	6	Lead waste	5	
112	6	Lead waste	9	
112	6	Lead waste	3	
112	6	Lead waste	2	
112	6	Lead waste	2	
112	6	Lead waste	2	
112	6	Lead waste	2	
112	6	Lead waste	1	
112	6	Lead waste	1	
112	6	Lead waste	2	
112	6	Lead waste	2	
112	6	Lead waste	2	
112	6	Lead waste	1	
112	6	Lead waste	8	
115	6	Undiagnostic	1	
115	6	Undiagnostic	2	
140	6	Vitrified Building Debris	2	
147	6	Fuel Ash Slag	32	

Context	Period/ phase	Description	Weight (g)	Dimensions
147	6	Fuel Ash Slag	5	
147	6	Fuel Ash Slag	3	
147	6	Fuel Ash Slag	1	
151	6	Undiagnostic	1	
151	6	Vitrified Building Debris	44	
177	4.ii	Smithing Hearth Bottom fragment	112	
177	4.ii	Smithing Hearth Bottom fragment	105	

178	5	Undiagnostic	53	
178	5	Undiagnostic	14	
183	5	Vitrified Building Debris	175	
187	5	Vitrified Building Debris	31	
194	5	Undiagnostic	1	
195	5	Cinder	3	
195	5	Smithing Hearth Bottom	390	9x8x5 cm
199	4.iii	Smithing Hearth Bottom fragment	268	
199	4.iii	Smithing Hearth Bottom fragment	89	
203	5	Smithing Hearth Bottom fragment	64	
203	5	Vitrified Building Debris	39	
203	5	Vitrified Building Debris	144	
203	5	Vitrified Building Debris	19	
203	5	Vitrified Building Debris	17	
203	5	Vitrified Building Debris	41	
203	5	Vitrified Building Debris	27	
207	4.iii	Smithing Hearth Bottom fragment	350	
207	4.iii	Smithing Hearth Bottom fragment	78	
207	4.iii	Undiagnostic	36	
210	4.ii	Undiagnostic	2	
210	4.ii	Undiagnostic	208	
210	4.ii	Undiagnostic	73	
210	4.ii	Undiagnostic	20	
210	4.ii	Undiagnostic	59	
210	4.ii	Undiagnostic	35	
210	4.ii	Undiagnostic	39	
210	4.ii	Undiagnostic	25	
210	4.ii	Undiagnostic	14	
210	4.ii	Undiagnostic	6	
210	4.ii	Vitrified Building Debris	20	
210	4.ii	Vitrified Building Debris	37	
219	4.ii	Vitrified Building Debris	7	
233	4.i	Vitrified Building Debris	12	
233	4.i	Vitrified Building Debris	22	
233	4.i	Vitrified Building Debris	18	
238	4.i	Vitrified Building Debris	37	
244	4.i	Fuel Ash Slag	84	
Context	**Period/ phase**	**Description**	**Weight (g)**	**Dimensions**
252	4.ii	Fuel Ash Slag	2	
263	5	Smithing Hearth Bottom fragment	308	
263	5	Smithing Hearth Bottom fragment	77	
266	5	Iron object	91	
267	5	Smithing Hearth Bottom	325	9x9x3 cm
270	3.ii	Vitrified Building Debris	50	
270	3.ii	Vitrified Building Debris	58	
270	3.ii	Vitrified Building Debris	2	
270	3.ii	Vitrified Building Debris	1	

286	3.i	Vitrified Building Debris	17	
369	1	Vitrified Hearth Lining	4	
369	1	Vitrified Hearth Lining	4	
371	1	Cinder	30	
371	1	Cinder	8	
371	1	Cinder	6	
371	1	Fuel Ash Slag	1	
371	1	Vitrified Hearth Lining	3	
373	2	Cinder	6	
373	2	Undiagnostic	49	
374	1	Cinder	16	
374	1	Cinder	51	
374	1	Cinder	32	
374	1	Cinder	31	
374	1	Cinder	39	
374	1	Cinder	17	
374	1	Cinder	21	
374	1	Cinder	4	
374	1	Cinder	4	
374	1	Cinder	12	
374	1	Cinder	2	
374	1	Cinder	3	
374	1	Cinder	7	
374	1	Cinder	11	
374	1	Cinder	7	
374	1	Cinder	4	
374	1	Cinder	4	
374	1	Cinder	1	
374	1	Iron object	9	
374	1	Smithing Hearth Bottom	591	12x12x4 cm
374	1	Smithing Hearth Bottom	743	13x12x5 cm
374	1	Smithing Hearth Bottom	156	7x7x3 cm
374	1	Smithing Hearth Bottom	105	7x5x2 cm
374	1	Smithing Hearth Bottom	129	7x5x3 cm
Context	**Period/ phase**	**Description**	**Weight (g)**	**Dimensions**
374	1	Smithing Hearth Bottom (with hearth lining attached)	741	14x8x7 cm
374	1	Smithing Hearth Bottom fragment	107	
374	1	Smithing Hearth Bottom fragment	139	
374	1	Smithing Hearth Bottom fragment	158	
374	1	Undiagnostic	76	
374	1	Undiagnostic	37	
374	1	Undiagnostic	22	
374	1	Undiagnostic	24	
374	1	Undiagnostic	80	

374	1	Undiagnostic	48
374	1	Undiagnostic	23
374	1	Undiagnostic	37
374	1	Undiagnostic	20
374	1	Undiagnostic	4
374	1	Undiagnostic	49
374	1	Undiagnostic	53
374	1	Undiagnostic	40
374	1	Undiagnostic	23
374	1	Undiagnostic	7
374	1	Undiagnostic	7
374	1	Vitrified Hearth Lining	37
374	1	Vitrified Hearth Lining	13
374	1	Vitrified Hearth Lining	5
374	1	Vitrified Hearth Lining	8
374	1	Vitrified Hearth Lining	4
374	1	Vitrified Hearth Lining	2
392	1	Smithing Hearth Bottom fragment	447