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REPORT

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SERIES/No CONSULTANT

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TITLE Examination of slags and furnace material from Wanborough, Wilts

Examination of slags and furnace material from Wanborough, Wilts.

Ex Mike Stone, Swindon Museum.

This is the second report on material from this site. The first embraced the iron work which is now considered to be both Roman and ~~Medieval~~ later. The slag, which is the subject of this report is all Roman and falls into three periods; I, AD 50-80; II, AD 80-230; and III, AD 230-400+.

The material examined came from nine boxes (A-J, Tables 1 and 2) which had been previously examined and weighed by M.S. After weighing the various categories, typical pieces had been put to one side for my examination from which I removed three pieces for electron probe analysis.

Identification.

The list of specimens examined and the results are given in Table 3.

The majority of the material was furnace bottoms from smithing. Some of these were very nicely shaped, plano-convex, 9 cm dia x 3 cm thick. Much of the rest was pieces of these. Material which could have been from smelting was in very short supply.

The furnace lining was clean and had no slag accretion which suggests that it was from clay-lined smithing furnaces. There was one tuyere fragment which indicated a bore of 2.5 cm or so.

Results of Electron probe analysis (EMPA).

The results on the three pieces selected are given in Table 4. These give raster analyses on areas about 200 µm square, and spot analyses on discrete phases. Normally slags contain fayalite-type crystalline phases (high iron olivines) and glasses which usually contain the alkalis alumina and lime as well as some of the silica. These are often referred to as anorthite. It would

seem that most of the CaO in specimen 1 was contained in another crystalline phase - perhaps a lower-iron olivine. This phase showed the presence of copper and it suggests that the smithing hearth was occasionally used for copper-base metals. This SFB had been made from iron with a low phosphorus content. This piece of slag was quite badly corroded and consistent readings would not be expected. The FeO readings in three raster analyses were 64%, 72% and 59.7%, reflecting attack and/or deposition.

In contrast, specimen 2 was a very dense piece of (?) tap slag with a consistently high FeO content confirming the existence of wüstite as a separate phase.

Again the phosphorus content is low which suggests that even the wood ash had a low phosphorus content, i.e. was debarked before coaling.

Specimen 3 was a better SFB, dense and uncorroded. The three raster analyses show good agreement. We have enough CaO and Al_2O_3 to form anorthite and the iron content is low enough to inhibit the formation of wüstite. But the P_2O_5 content is different from specimen 1 and either the iron came from a different source (ore with 2.0% P_2O_5), or a different charcoal with more bark was used. We do not yet have much information on the relative contribution of smelting slag and other inputs in smithing but one would expect a dilution of the P_2O_5 by 50% unless some entered from the charcoal.

Conclusions.

This material was mostly the product of smithing operations. The possible smelting slag came from low phosphorus ores. The metal smithed was probably also from low phosphorus ores and all work was carried out with charcoal as fuel.

The size of the SFB s suggests relatively small furnaces or frequent removal of the slag accumulations in the bottom.

April 1985. R.F. Tylecote.

Table 1

Wanborough - Weights of Slag from Boxes A to J.(kg)

	I 50-80 AD	II 80-230	III 230-400 +
A	-	-	Slag 3.0
B	-	-	Slag 1.05
C	-	-	slag 2.62 F.L. 0.01
D	-	-	Slag 6.03 F.L. 0.02
E	-	-	Slag 8.68
F	-	-	Slag 6.68 F.L. 0.07
G		Slag 0.02	Slag 1.00 F.L. 0.02
H	Slag 0.25	Slag 2,50	Slag 1.56 F.L. 0.04
J	Slag 0.11	Slag 0.10	Slag 0.47
Total	Slag 0.36	Slag 2.62	Slag 31.09 F.L. 0.14

Table 2.

Total slag weights - kg.

Wanborough - 1966-1970

		Periods I and II 50- 230 AD	Period III 230- 400 AD
1966-68	Slag	-	4.01
(E.Greenfield)	F. Lining	-	1.34
1969-70	Slag	3.60	34.63
(J.Wacher)	F.Lining	-	0.20
Total	Slag	3.60	38.64
	F.Lining	nil	1.54

Table 3.

Box 1	Wan 68		
	1355	SL10	Hard grey floor or furnace lining.
	193	Wan 393. SL5	Heavy vitrified furnace lining and slag.
	191	Wan 391. SL3	Large tuyere fragment, 2.5cm dia.
	192	Wan 392. SL4	Rather large flat pieces of furnace lining, well vitrified with no accretion.
	194	Wan 395 SL6	Thin, dark grey piece of furn.lining
	190	Wan 390 SL2	A slaggy hollow ball with a hole.
Box 2	Wan 69. JSW		
	D VII (1)		Two pieces of smithing furnace bottom (SFB).
	D VII (1)		One very heavy piece of SFB (high iron cont.
	D IV (1)		One SFB.
	D IV (13)		An amorphous lump of slag; could be a SFB, if so a very large one. Another small piece of the same.
Box 3	Wan 69		
	C VII (1)		Two pieces of and one almost complete SFB well glazed on the top surface.
	C XIII (1)		One piece of slag.
	B IV (1)		One dribble of slag
	B VIII (3)		One piece of unidentifiable slag.
	C VIII (1)		Furnace lining
	B II (5)		Slag
	C XIII (1)		A small piece of slag
	C XIII (1)		Fired black clay
	A IX (1)		A small piece of slag
Box 4	Wan 70		
	J VII (3)		SFB
	F I (4)		Amorphous slag mostly SFB's
Box 5	Wan 70		
	H VI (1)		SFB
	F I (4)		More amorphous lumps of slag with some charcoal.
	H VI (11)		SFB
	H I (1)		Flat plate of slag could be from smelting.
	F I (4)		a heavy dribble; could be tap-slag.
	G VII (11)		A nicely shaped SFB.

Table 3 (cont.)

Box 6	1967. 814. 5851. SL 14. SFB
	1966 B 130/2 SL 5 A piece of slag.
	1967. 828. 5851 SL 15 (828) Heavy tap slag with white clay attached. Anal. T.2.
	1966. B96/2 SL 4. A small SFB
	1966. B51/2 SL 1. Rough? furnace slag.
	1967. Wan 338 Bag 156. SL 6. Probably part of SFB.
Box 7	Wan 3457 (597) SL 10. Two very nice SFBs.
	Wan 70 F.1. (5),(6). A nice SFB. Anal.T.2.(9 cm dia x3 thi
	1967. 808 Wan 5779 SL 13. An amorphous piece of slag.
	Wan 70 G II (5) Vitrified furnace lining.
	Wan 70 F I (3) A large amorphous slag lump.
Box 8	Wan 69 E I/III (2) An amorphous slag lump, could be tap slag.
	Wan 69 E VIII (2) " "
	Wan 69 E IV (2) (201) Probably a piece of a large SFB.
	Wan 69 B VIII (1) Run slag.
	Wan 69 E X XX (2) Probably a piece of a large SFB.
	Wan 69 CXII (1) An amorphous piece of slag.
	Wan 69 DI (6). A nice piece of hard charcoal (kept).
	Wan 69 EX (2) Two small pieces of run slag.
	Wan 69 AI (3) SFB
	Wan 69 AIII (2) An SFB (22 cm diam and 5cm deep. Anal.T.2. (in pieces - unusually large for a smithing hearth bottom)
Box 9	Wan 70 GII An SFB and an amorphous piece of slag.
	Wan 70 HV (1) Two amorphous pieces of slag; one large.

Table 4. EMPA of Wanborough slags.

Spec.	1			2		3		
%	Corroded SFB(?) 1969. A III 2 AD 230-400+			Dense tap slag 1967. SLI5		Dense SFB 1970, FI (5) (6)		
	Rast*	Glass	Xstal	Rast.	Glass	Rast.	Rast.	Rast.
FeO	64.4	12.3	48.2	76.2	41.4	57.1	53.0	51.3
SiO_2	23.6	46.9	30.2	13.1	35.5	24.6	27.7	28.0
CaO	6.0	1.8	18.2	2.2	9.4	8.6	8.1	9.0
Al_2O_3	2.0	18.3	nd	2.9	6.8	8.2	7.5	8.3
MnO	nd	nd	nd	nd	nd	nd	nd	nd
MgO	1.0	nd	0.4	nd	nd	0.6	0.5	0.4
K_2O	1.2	15.3	nd	1.2	4.8	1.7	1.6	1.8
Na_2O	nd	0.7	nd	nd	nd	nd	nd	nd
SO_2	nd	nd	nd	nd	nd	0.2	0.2	0.2
P_2O_5	nd	nd	0.5	nd	0.3	1.0	0.9	1.0
Cu	-	-	0.3	-	-	-	-	-
Total	98.2	95.3	97.8	95.6	98.2	102.0	99.5	100.0

nd = not detected

\- = not sought

* Rast = Raster, 200 μm