Ancient Monuments Laboratory
Report 4/93

THE EXAMINATION OF THE SLAGS AND RESIDUES FROM MUCKING, ESSEX

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Summary

Nearly 400kg of slags and residues were recovered from excavations at Mucking, Essex. Only 60% of the slag was stratified. However, there was evidence for iron smithing in the Iron Age, Roman and Saxon periods. There was evidence, in the form of Slag Blocks, for iron smelting during the Saxon period.

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The Examination of the Slags and Residues from Mucking, Essex.

Dr Gerry McDonnell

1 Introduction

A total of 390kg of slags and residues were recovered from the Mucking Excavations. The classification was based on morphological criteria, and the weight of each slag type from each area/context was recorded. The slags and residues are divided into diagnostic and non-diagnostic groups. The former are slags that are products of an iron working process. The latter group may have derived from any high temperature activity. In some instances they can be assumed to have derived from an ironworking process, by association with diagnostic residues.

The total weight of each slag type is given in Table 1, and the diagnostic slags are grouped according to process. The shorthand nomenclature for each slag or residue type is also given. In this table and throughout the report the Dense Iron Silicate Slag (DIS) has been identified as a smelting slag. The absence of well dated large deposits of this slag means that it does not figure significantly in this report. The material classed as "Other" included charcoal and coal fragments etc.

Table 1 also gives the weight (Conc Weight) of each slag type included in the large slag concentrations (Section 2.2), and the isolated single large deposits (Section 2.3) which are discussed in this report. This weight is also calculated as a percentage of the total weight of each slag type. The concentrations were determined by examination of quantities greater than 1kg, the area around such points (in terms of Northing and Eastings) were examined for slag, and the area extended to include surrounding slag deposits. Table 1.1.1 demonstrates that less than half the smelting tap slag and the dense iron silicate slag was present in the identified concentrations. In particular, over 4kg of the DIS was from isolated finds spots (Section 2.3). The slag blocks were well represented (73%) in identified contexts, but this is because it occurs in large lumps, thus causing the deposits to readily exceed the minimum quantity for analysis. About 60% of all types of smithing slag were present in the identified concentrations. The hearth or furnace lining was also well represented but less than 40% of the two other non-diagnostic slags were in the identified concentrations.

The spatial analysis is therefore based on a significant percentage of the total weight of slags recovered from the excavations. Slags tend to be dumped into pits or one length of ditch, rather than thinly spread across a site. The distribution can be radically altered either by later disturbance or the use of slags for cobbling or

hard-core. At Mucking the location of the slag concentrations is thought to reflect the spatial and temporal distribution of ironworking activity on the site.

TABLE 1 Total Weight of Each Slag Type

Diagnostic Slags	Total Weight (kg)	Conc Weight (kg)	%
Smelting Slags			
Tap Slag (TSL)	13.100	5.424	41
Slag Block (SLB)	117.685	86.045	73
Dense Iron Silicate Slag (DIS)	23.368	7.603	32
Smithing Slags			
Hearth Bottom (HBM)	69.003	40.103	58
Smithing Slag Lumps (SSL)	115.443	70.532	61
Hammer Scale (Present?)	0.012		
Cinder (CKR)	13.304	7.682	58
Non-Diagnostic Slags			
Hearth/Furnace Lining (HL)	22.271	13.462	60
Fuel Ash Slag (FAS)	14.984	5.626	37
Other	4.585	1.410	31
Total	393.755		

Total Weight Total weight of each slag type
Conc Weight Weight present in identified concentrations
% The concentration weight as a percentage of the total weight.

2 Spatial Distribution of the Slags

2.1 Determination of Groups

In general slag concentrations occurred in large features eg ditches etc,the absence of 'floor levels' and 'working surfaces' prevented the identification of working areas.

2.2 Distributions

The areas are given as spreads, ie readings North1, North2 by East1 and East2. Negative values indicate southings and westings. A full listing is given in Table 2.2.0. There were also a number of large individual slag pieces, mostly examples of SLB, which gave "apparent" high slag concentrations, these are examined separately (Section 2.3)

TABLE 2.2.0 CONCENTRATIONS OF SLAGS

Area	North1	North2	East1	East2	Total Weight (kg)
1	-228	-230	345	356	3.9
2	160	188	135	155	12.2
3	190	200	80	100	16.4
4	230	242	-75	-81	5.2
5	297	303	271	265	2.8
6	353	353	447	447	3.0
7	375	382	715	725	5.2
8	393	410	145	155	1.9
9	449	449	575	575	2.3
10	725	726	110	115 (GH42)	1.9
11	755	770	90	110 (GH44/45)	26.8
12	840	910	140	210	50.8
13	903	907	219	219	8.4
14	930	942	165	169	2.9
15	1041	1053	622	642	13.0
16	1898	1903	968	979 (GH129)	6.7
17	2095	2106	635	775 (GH173)	9.9
18	2140	2148	780	786 (GHI79)	10.2
19	2445	2455	915	922 (GH196)	12.8
20	2490	2500	960	980 (GH202)	21.8

GH - Grubenhaus

2.2.1 Area 1 (Northing)-228 to -230 (Easting)345 to 356.

Most of the slag was recovered during initial cleaning of the area. It was associated with Romano-British pottery and a single sherd of medieval ware. Slag and pottery (all of 1st century AD date) were recovered from a large (?)pit (Cut 2023, FAS and DIS), and a ditch (Cut 2049, the remainder of the slag). The quantity of the slag is insufficient to indicate that smithing was carried out in the area. It might have been a single dump of smithy material, since a small amount of hearth lining was present.

TABLE 2.2.1 Weight of Slag in Area 1

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		
Slag Block		
Dense Iron Silicate Slag		0.125
Smithing Slags	(number)	
Hearth Bottom	8	1.388
Smithing Slag Lumps		1.950
Hammer Scale (Present?)		
Cinder		0.110
Non-Diagnostic Slags		
Hearth/Furnace Lining		0.030
Fuel Ash Slag		0.085
Other		0.175
	Total	3.873

2.2.2 Area 2 (Northing)160 to 188 (Easting)135 to 155.

The total quantity of slag recovered from this area was 12.2kg (Table 2.2.2). Very little of the material was stratified but FAS, HL and CKR were recovered from Grubenhauser 12 and 21. The hearth bottoms and smithing slag were in close proximity, but all the material overlay a Romano-British ditch, which was not excavated. The evidence is therefore inconclusive, except to confirm there was smithing activity (but of uncertain date) in the area.

TABLE 2.2.2 Weight of Slag in Area 2

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		-
Slag Block		-
Dense Iron Silicate Slag		-
Smithing Slags	(number)	
Hearth Bottom	12	2.675
Smithing Slag Lumps		4.730
Hammer Scale (Present?)		?
Cinder		1.495
Non-Diagnostic Slags		
Hearth/Furnace Lining		1.455
Fuel Ash Slag		1.595
Other		0.295
	Total	12.245

2.2.3 Area 3 (Northing)190 to 200 (Easting)80 to 100.

A total of 16.4kg was recovered from this area, the majority from Context 155. When excavated it was described as a "working hollow, possibly a smithy". The slags recovered (Table 2.2.3) are similar to those from Area 2, ie typical of a dump from a smithy. The small piece of DIS was either intrusive or more probably mis-identified. The close proximity of Areas 2 and 3 suggests that they were two separate dumps from the same smithy. The date is uncertain but it is either Late Romano-British or Saxon.

TABLE 2.2.3 Weight of Slag in Area 3

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		-
Slag Block		-
Dense Iron Silicate Slag		0.078
Smithing Slags	(number)	
Hearth Bottom	15	4.180
Smithing Slag Lumps		9.433
Hammer Scale (Present?)		?
Cinder		1.155
Non-Diagnostic Slags		
Hearth/Furnace Lining		1.215
Fuel Ash Slag		0.370
Other		0.010
	Total	16.441

2.2.4 Area 4 (Northing)230 to 242 (Easting)-75 to -81.

The majority of the smithing slags (Table 2.2.4) were recovered from two excavation boxes. In the first (240/-80)a pit (Cut 3945) was recorded as a "slag pit", the box produced 2.27kg of SSL. This can be interpreted as a small dump of smithing waste. In the second box (240/-82) a second pit also produced a small quantity of SSL (1.030 kg) and a fragment of TSL (0.025kg). The dating evidence from both excavation boxes is inconclusive, but the features were cut into a context (Cut 3949) that contained Romano-British pot sherds. The slag is therefore late Romano-British or Saxon. Recovered from the same area were smaller amounts of FAS, TSL and SSL, as well as a single SLB (1.125kg). The evidence is insufficient to form any firm conclusions.

TABLE 2.2.4 Weight of Slag in Area 4

Diagnostic Slags		Weight (kg)
Smelting Slags		
	Tap Slag	0.050
	Slag Block	1.125
	Dense Iron Silicate Slag	-
Smithing Slags	(number)	
	Hearth Bottom	-
	Smithing Slag Lumps	3.310
	Hammer Scale (Present?)	?
	Cinder	-
Non-Diagnostic Slags		
	Hearth/Furnace Lining	-
	Fuel Ash Slag	0.035
	Other	0.640
	Total	5.160

2.2.5 Area 5 (Northing)297 to 303 (Easting)271 to 265.

A SLB (1.8kg), a piece of DIS (0.27kg) and a large HB (0.77kg) were found in a linear feature (Cut 8506) and associated pit (Cut 8498). There was no satisfactory dating evidence, and therefore they must be considered isolated stray finds.

2.2.6 Area 6 (Northing)353 (Easting)447

A single pit (Context 13508) produced smithing debris, including hammer scale and a single piece of DIS (Table 2.2.6). There were no other associated finds, and it therefore must be construed as a single isolated dump of smithing debris. The presence of hammer scale, normally indicates close proximity to the smithing area or a dump of hearth-fill. The absence of stray slag finds from the surrounding area would indicate the latter. The single piece of DIS was probably mis-identified.

TABLE 2.2.6 Weight of Slag in Area 6

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		-
Slag Block		-
Dense Iron Silicate Slag		0.100
Smithing Slags	(number)	
Hearth Bottom	3	2.050
Smithing Slag Lumps		0.600
Hammer Scale (Present?)		0.003
Cinder		0.160
Non-Diagnostic Slags		
Hearth/Furnace Lining		0.090
Fuel Ash Slag		-
Other		-
	Total	3.003

2.2.7 Area 7 (Northing)375 to 382 (Easting)715 to 725.

This area defined the fill of "Grubenhaus 213" and produced a total of 5.185kg of smithing debris, and a single fragment of TSL (Table 2.2.7). Subsequent analysis has shown that it was not a Grubenhaus but a series of interlinked pits, one of which (1002) showed signs of "in-situ burning" and contained a "lot of charred wood". There is insufficient evidence to suggest that this pit was the hearth, and the slag probably represents a dump of smithing debris. The pits are still dated to the Saxon Period. Two other Grubenhäuser near to GH213 also contained significant amounts of slag. GH72 (414(N) 639(E)) contained 1.5kg of tap slag and 1.8kg of smithing debris (HBM+SSL+HL), but in the excavation notebook it was recorded that "substantial quantities of slag" were recovered from this hut. It has not been possible to determine whether the excavator retained a sample of the slag or considered 3.3kg a large amount. GH75 (415(N) 583(E)) produced 2kg of hearth bottoms and a fragment of tap slag. These groups could not be stratigraphically associated, but are thought to be contemporary. The tap slag in GH72 represents the second largest deposit of this slag type in the Saxon Period at Mucking.

TABLE 2.2.7 Weight of Slag in Area 7

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		0.070
Slag Block		-
Dense Iron Silicate Slag		-
Smithing Slags	(number)	
Hearth Bottom	5	1.520
Smithing Slag Lumps		1.140
Hammer Scale (Present?)		-
Cinder		0.310
Non-Diagnostic Slags		
Hearth/Furnace Lining		1.935
Fuel Ash Slag		0.280
Other		-
	Total	5.225

2.2.8 Area 8 (Northing)393 to 410 (Easting)145 to 155.

This area contained a small scatter of smithing and smelting slag (Table 2.2.8) probably deriving from Cut 159, a Romano-British ditch, although the plans indicate that it was associated with a later gully (Cut 8377), for which there was no dating evidence.

TABLE 2.2.8 Weight of Slag in Area 8

Diagnostic Slags		Weight (kg)
Smelting Slags		
	Tap Slag	-
	Slag Block	-
	Dense Iron Silicate Slag	1.100
Smithing Slags	(number)	
	Hearth Bottom	-
	Smithing Slag Lumps	0.655
	Hammer Scale (Present?)	?
	Cinder	0.050
Non-Diagnostic Slags		
	Hearth/Furnace Lining	0.025
	Fuel Ash Slag	0.065
	Other	-
	Total	1.895

2.2.9 Area 9 (Northing)449 (Easting)575.

A deposit of smithing debris and a small quantity of TSL (Table 2.2.9) in a ditch (Cuts 967 and (re-cut) 969) and a pit (Cut 971) cut into the ditch. In the excavation notes it was described as a "smelting hearth", but there is no evidence that ironworking was carried out here. There is no dating evidence for either the ditch or the pit.

TABLE 2.2.9 Weight of Slag in Area 9

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		0.390
Slag Block		-
Dense Iron Silicate Slag		-
Smithing Slags	(number)	
Hearth Bottom	3	1.400
Smithing Slag Lumps		0.205
Hammer Scale (Present?)		-
Cinder		-
Non-Diagnostic Slags		
Hearth/Furnace Lining		0.212
Fuel Ash Slag		0.135
Other		-
	Total	2.342

2.2.10 Area 10 (Northing)725 to 726 (Easting)110 to 115.

A dump of five HBM's (total weight 1.94kg) was recovered from Grubenhaus 42. The absence of other slags may indicate that the five hearth bottoms have been used for a specific purpose, eg post packing.

2.2.11 Area 11 (Northing)755 to 770 (Easting)90 to 110.

A large dump of predominantly smelting slag was recovered from Grubenhaus 45 and smithing slag from Grubenhaus 44 (Table 2.2.11). This is the strongest evidence for smelting and smithing in the 7th Century. The smelting slag comprised SLB's with a small quantity of TSL. The smithing debris was a typical mixture of HBM's, SSL, CLK and HL, indicative of a smith's dump. A small amount of TSL was also identified, but it may have been run smithing slag. Both deposits are dumps rather than in-situ deposits of iron working debris. The presence of all types of smithing residues in GH44 indicate that the activity was in the vicinity of the Grubenhaus.

TABLE 2.2.11 Weight of Slag in Area 11

Diagnostic Slags		Weight (kg) GH44	GH45
Smelting Slags			
	Tap Slag	0.075	0.250
	Slag Block	-	19.305
	Dense Iron Silicate Slag	-	-
Smithing Slags	(number)		
	Hearth Bottom	7 4.120	-
	Smithing Slag Lumps	1.525	-
	Hammer Scale (Present?)	-	-
	Cinder	0.150	-
Non-Diagnostic Slags			
	Hearth/Furnace Lining	0.650	-
	Fuel Ash Slag	0.030	-
	Other	-	-
	Totals	6.550	20.290

2.2.12 Area 12 (Northing)840 to 910 (Easting)140 to 210.

This area contained the largest concentration of smelting and smithing slags (Table 2.2.12). The area contained a complex series of ditches and pits. The slag confined within the area of the major ditches is also listed under RB?, the first column giving the total weight of each slag type recovered from the whole area. Analysis of the distributions showed that the majority of the smithing debris derived from the ditches (Contexts 7694 7698, 13212, 8216, 8218, total weight HBM+SSL=21.423kg), which have been dated to the first century AD. The archaeological recording could not determine whether the slag was distributed throughout the fill of the ditches or whether it was concentrated in a particular layer. All the (SLB) smelting slag (except for 0.04kg) was derived from a group of pits centred on Cut 14325 within the enclosure defined by the ditches. Associated with this material was a large quantity of smithing debris. There was no dating evidence for these features but the total absence of datable finds indicates that they were either pre- or post-Roman. The slag-blocks were morphologically the same as those that were recovered from the Saxon Grubenhäuser and are therefore likely to date to the Saxon period.

The interpretation for this area is that iron smithing was carried out during the first century AD, the material being dumped into adjacent ditches. During the Saxon period the area was used for iron smelting and smithing.

TABLE 2.2.12 Weight of Slag in Area 12

Diagnostic Slags		Total Weight (kg)	RB? Weight (kg)
Smelting Slags			
Tap Slag		0.202	0.015
Slag Block		9.000	0.025
Dense Iron Silicate Slag		2.000	0.655
Smithing Slags	(number)		
Hearth Bottom	40	8.160	4.915
Smithing Slag Lumps		26.198	16.508
Hammer Scale (Present?)		yes	-
Cinder		1.355	0.075
Non-Diagnostic Slags			
Hearth/Furnace Lining		2.494	1.929
Fuel Ash Slag		1.129	0.605
Other		0.090	0.085
Totals		50.763	25.712

2.2.13 Area 13 (Northing)903 to 907 (Easting)219 to 219.

This area was 30 feet to the north-east of the smelting/smithing deposits described in 2.2.12. It was a typical deposit of smithing debris, ie SSL, HL and CKR (Table 2.2.13). Most of the debris came from a single pit (Cut 7656) which was undated. It is probably correct to assume that it is an extension of the deposits in 2.2.12, and derived from the Saxon rather than the Roman activity, because of the absence of dated finds.

TABLE 2.2.13 Weight of Slag in Area 13.

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		-
Slag Block		-
Dense Iron Silicate Slag		-
Smithing Slags	(number)	
Hearth Bottom	2	1.055
Smithing Slag Lumps		6.740
Hammer Scale (Present?)		-
Cinder		0.075
Non-Diagnostic Slags		
Hearth/Furnace Lining		0.355
Fuel Ash Slag		0.180
Other		-
	Total	8.405

2.2.14 Area 14 (Northing)930 to 942 (Easting)165 to 169.

A small deposit of smithing debris (2.865 kg) recovered from the continuation of the large Romano-British ditch (Context 7694) described in 2.2.12.

2.2.15 Area 15 (Northing)1041 to 1053 (Easting)622 to 642.

All the slag is smithing debris (Table 2.2.15) and was recovered from the fill of Well IV. It is all securely dated to the Roman period. Its presence in the well is certainly secondary and probably reflects smithing activity in the immediate vicinity when the well had ceased to be used.

TABLE 2.2.15 Weight of Slag in Area 15.

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		-
Slag Block		-
Dense Iron Silicate Slag		-
Smithing Slags	(number)	
Hearth Bottom	7	3.630
Smithing Slag Lumps		4.948
Hammer Scale (Present?)		-
Cinder		2.350
Non-Diagnostic Slags		
Hearth/Furnace Lining		1.345
Fuel Ash Slag		0.670
Other		0.050
	Total	12.993

2.2.16 Area 16 (Northing)1898 to 1903 (Easting)968 to 979.

A small deposit of smithing debris was recovered from the fill of an Iron Age ditch (Levels 0 - 3 with one piece of FAS in Level 7), and a Grubenhaus (GH129, Levels 0 to 6) cut into the ditch. The localised spread of the debris and its presence in the upper layers of the ditch, but throughout the Grubenhaus fill suggests that it was dumped in the Saxon period, rather than being Iron Age and disturbed by the Saxon occupation.

TABLE 2.2.16 Weight of Slag in Area 16.

Diagnostic Slags		Weight (kg)	
Smelting Slags			
Tap Slag		-	
Slag Block		-	
Dense Iron Silicate Slag		-	
		Ditch	GH129
Smithing Slags	(number)		
Hearth Bottom	1	0.180	2 0.205
Smithing Slag Lumps		0.252	3.630
Hammer Scale (Present?)		-	-
Cinder		0.040	0.200
Non-Diagnostic Slags			
Hearth/Furnace Lining		0.253	1.275
Fuel Ash Slag		0.060	0.605
Other		-	-
Totals		0.785	5.915

2.2.17 Area 17 (Northing)2095 to 2106 (Easting)635 to 775.

The slag in this area showed a similar distribution to that described in 2.2.16, ie slag present in Iron Age ditches and in a Grubenhaus fill (GH173 and a small quantity of HL in GH193). The slag from the ditches was smithing debris with a small quantity of DIS (Table 2.2.17), all of which was widely distributed throughout the depth of the ditch (Levels 1-10). The slag from GH173 comprised smelting and smithing slag, but no ash or hearth lining. The material from the ditches must be considered mostly to be of Iron Age date, rather than Saxon material in the top of the ditch. The material from GH173 lacks HL or CLK and therefore the activity was probably some distance from the Grubenhaus.

TABLE 2.2.17 Weight of Slag in Area 17.

Diagnostic Slags	Weight (kg) GH173	Ditches
Smelting Slags		
Tap Slag	0.135	-
Slag Block	6.085	-
Dense Iron Silicate Slag	-	0.085
Smithing Slags (number)		
Hearth Bottom 2	1.635	2 0.180
Smithing Slag Lumps	0.065	0.811
Hammer Scale (Present?)	-	-
Cinder	-	0.232
Non-Diagnostic Slags	GH193	Ditches
Hearth/Furnace Lining	0.275	0.133
Fuel Ash Slag	-	0.377
Other	-	-
Totals	8.195	1.738

2.2.18 Area 18 (Northing)2140 to 2148 (Easting)780 to 786.

The slag within this area was a dump of smelting slag (SLB=3.900 kg, TSL=0.110 kg) in GH179, which was 30 feet (10 metres) to the north of GH173. The total quantity of smelting slag from both Grubenhäuser was 10.220kg which represents about 10% of the smelting slag recovered from the grouped material, but on known smelting sites this quantity is rarely considered significant (eg the Narrow Lane Site in Romsey produced 350kg of smelting slag, [McDonnell 1988]).

2.2.19 Area 19 (Northing)2445 (Easting)915 to 922.

The slag was contained wholly within the fill of Grubenhaus, GH196, and is therefore of Saxon or post-Saxon date. The debris was a mixture of smelting and smithing slags (Table 2.2.19), including very small quantities of lining and ash (HL and FAS).

TABLE 2.2.19 Weight of Slag in Area 19

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		0.265
Slag Block		9.620
Dense Iron Silicate Slag		-
Smithing Slags	(number)	
Hearth Bottom	3	2.740
Smithing Slag Lumps		0.105
Hammer Scale (Present?)		-
Cinder		-
Non-Diagnostic Slags		
Hearth/Furnace Lining		0.030
Fuel Ash Slag		0.005
Other		-
	Total	12.765

2.2.20 Area 20 (Northing)2490 to 2500 (Easting)960 to 980.

A mixed assemblage of smelting and smithing debris (Table 2.2.20) was dumped into Grubenhaus GH202 which was about 60 feet (20 metres) to the north-east of GH196 (Section 2.2.19). It differed from the other mixed slag dumps because it included a (relatively) large quantity of smelting tap slag, however both the GH202 and GH196 dumps could have derived from the same source. To the north of GH202 were two small pits that contained very small amounts of tap slag, smithing slag and lining (25850 and 25872) as well as non-ferrous metalworking debris, and contained only prehistoric pottery. It is therefore possible that the Grubenhaus material included redeposited Iron Age slag.

TABLE 2.2.20 Weight of Slag in Area 20

Diagnostic Slags		Weight (kg)
Smelting Slags		
Tap Slag		4.142
Slag Block		10.655
Dense Iron Silicate Slag		0.695
Smithing Slags	(number)	
Hearth Bottom	1	0.975
Smithing Slag Lumps		4.010
Hammer Scale (Present?)		-
Cinder		-
Non-Diagnostic Slags		
Hearth/Furnace Lining		1.180
Fuel Ash Slag		0.005
Other		0.150
	Total	21.812

2.3 Isolated single deposits of large quantities of slag

There were eight deposits of single large lumps of slag. They are less significant since the slag types present (SLB, DIS and HB) form as individual lumps. Their large weight is either because they are especially large, or more commonly that they are complete, whereas examples in the groups occur as fragmented examples. This data is presented in a table format with additional discussion in the text.

Table 2.3.1 Single deposits of Slag (weight kg)

North	East	Context	Weight	Type	Date	Comment
250	-40	-	2.100	SLB	post-R	
350	-152	14129	1.200	SLB	?	also DIS(0.345kg)
818	272	6050	1.500	DIS	?	also fired clay
820	396	12327	1.875	SLB	?	no other finds
950	750		1.000	DIS	?	unstratified
1247	447	8840	5.000	SLB	?	
1765	545	10218	24.000	SLB	A/S	A/S pot
1797	373	10050	1.650	DIS	IA?	see text
1853	481	GH98	1.300	HBM	A/S	

There is very little dating evidence for any of the deposits and, given their isolation, any associated evidence must be treated cautiously. The only strong dating is for the block found at (N)1765 / (E)545 which was from a ditch (10218) that can be definitely dated as Saxon by association with pottery. The SLB recovered from (N)250 / (E)-40 derived from a post-Roman feature. The large hearth bottom from GH98 may belong to the Anglo-Saxon period, but it may also have been re-used, as was suggested for the hearth bottoms found in GH42 (section 2.2.10). The DIS (context 6050) could be dated to the Iron Age by association with Late Bronze Age/Late Iron Age flint gritted ware present in a related context (context 1797). DIS also occurred in association with a slag block (area (N)350 / (E)-152), which would infer a Saxon date. Since the genesis of DIS has not been resolved, (ie does it derive from the smelting or the smithing process?), the failure to satisfactorily date it only contributes to the lack of understanding about this slag type. On balance the evidence would suggest an Iron Age rather than Saxon date.

3 Temporal Distribution of the Slags and Residues

3.1 Introduction

In general the slags and residues are poorly stratified, nor can they be dated on morphological grounds, with the exception of the slag blocks (SLB's). The problem is further confused by the probability of slags from earlier periods being redeposited in later features. The large deposits of slag derived from large features, eg ditches and Grubenhäuser, which probably puts a bias on the interpretation. It can be assumed that on most settlement sites dated to the (late) Iron Age or later some smithing activity would have been carried out, so small amounts of smithing slag are to be expected. The type of smithing would influence the quantity and distribution of the slag. Occasional, small scale activity may be carried out at any suitable place, rather than at permanent "smithy". This would generate widely distributed small quantities of slag which may become further dispersed after deposition. Thus identification of such activities is difficult.

3.2 The Iron Age

There is very little evidence for iron working in this period. The only slag possibly dated to the Iron Age was from a ditch (cut 10526) in area (N)2095-2106 / (E)635-775 (section 2.2.17). This material was overlaid by slag from a Saxon Grubenhaus, but it is more likely that it is dated to the Iron Age. This slag comprised a small amount of smithing debris, ie slag and hearth lining, with a total weight of 1.738kg. This can be interpreted at best as small localised smithing. Included with this group was a piece of DIS slag.

A large deposit of "roasted" iron ore was recovered from a pit (738(N) /435(E)) which at the time of excavation was described as a roasting pit. The pit was cut by a second pit containing Iron Age and Belgic wares, which in its turn was clipped by a Romano-British ditch. The "roasting" pit can therefore be securely dated to the Iron Age. The "ore" was a ferruginous sandstone that could have been used for iron smelting, but there was no conclusive evidence that this was what it was intended for.

3.3 Romano-British Period

The evidence for Romano-British ironworking can be divided into two groups. The first is definitely Romano-British (see 3.3.1) while the second is Romano-British or later (see 3.3.2).

3.3.1 Definite Romano-British Activity.

There were two areas of activity that could be securely dated to the 1st Century A.D. The material from the first area (Section 2.2.1) comprised a small dump of smithing debris, including one piece of DIS slag. The second area (Sections 2.2.12 and 2.2.14) contained 28kg of smithing debris derived from a large Romano-British ditch. It was concentrated in a few areas within the length of the ditch and is typical of a smithy dump. The last slag deposit derived from the fill of a Romano-British well (Section 2.2.15), and probably represents a small dump of smithy debris. The well was within a Romano-British farmstead where a workshop or smithy would be expected. The quantity recovered from the well is too small to represent the by-product of a long-lived smithy, but there was no other significant concentrated slag deposit within the area defined by the farmstead enclosure ditch. The total quantity of slag from the area, including that from the well, was about 31kg. Since dumps of slag within ditches can be discrete, other deposits may have been present in unexcavated lengths of the boundary ditch.

Except for very small amounts of TSL and SLB recovered during cleaning from the surface of a large Romano-British ditch to the north of the farmstead enclosure (Section 2.2.12 and 2.2.14), there was no smelting slag recovered from well stratified Romano-British contexts. The evidence shows that there was some smithing activity in the 1st Century AD, but the total quantity of slag recovered is not comparable to that recovered from the excavation of farm buildings at Amersham Mantles Green (McDonnell 1986) which produced 130kg of smithing slag (HBM+SSL).

TABLE 3.3.1 Areas of Romano-British Ironworking

North1	North2	East1	East2	Section	Slag Types	Date
-228	-230	345	356	2.2.1	Smith+DIS	1st C AD
840	910	140	210	2.2.12	Smith	1st C AD
930	942	165	169	2.2.14	"	1st C AD
1041	1053	622	642	2.2.15	"	RB

3.3.2 Romano-British or Later Ironworking Activity.

Four areas were identified as Romano-British or later. The first two areas were relatively close together, (Sections 2.2.2 and 2.2.3), and the types of slag recovered are similar to those recovered from the definite Romano-British deposits, ie smithing debris but no evidence for iron smelting. It is therefore

argued that this material is most likely to be of Romano-British origin.

The third area (2.2.4) produced smithing and smelting evidence, but the latter was unstratified. Again, therefore, if the unstratified material is ignored, the range of slags recovered would conform to the Romano-British pattern.

The fourth area produced a small quantity of slag (<2kg), but one of the largest deposits of DIS (1.1kg). The dating is inconclusive.

If the slags recovered from these areas were ascribed to the Romano-British period they would not alter the overall interpretation for ironworking in that period, ie smithing but no smelting activity. The odd group is the fourth area containing the DIS slag.

TABLE 3.3.2 Areas of Romano-British or Later Ironworking

North1	North2	East1	East2	Section	Slag Types
160	188	135	155	2.2.2	Smith
190	200	80	100	2.2.3	" + DIS
230	242	-75	-81	2.2.4	" +TSL+SLB
393	410	145	155	2.2.8	" + DIS

3.4 The Anglo-Saxon Period

The majority of the slag deposits that can be dated to the Saxon Period are characterised by the presence of smelting slags, in particular the distinctive slag blocks (SLB), and most were deposited in the fills of Grubenhäuser. The other large slag weights derived from a single pit deposit and a pit group. This follows the overall pattern of the slag distribution at Mucking of large slag weights recovered from large features. All these deposits represent dumping of ironworking residues, and not in-situ ironworking.

There were five deposits containing a total of no more than about 5kg of slag, three of which were deposits of smithing slag and two contained only smelting slag. They can only be considered as evidence for ironworking activity being carried out in the area in general, rather than as specific pointers to the close location of the smithing and smelting activity.

The larger deposits are more significant. They all contain both smelting and smithing slag indicating that the processes were carried out in the same place (see Table 3.4.1). In particular the deposit in the pit group (Section 2.2.12) suggests an area of ironworking.

There is a second focus of activity centred on Grubenhäuser 196 and 202, and a third on Grubenhauser 44 and 45.

The smelting slag is mostly in the form of slag blocks, except for the deposits in GH72, (discussed in Section 2.2.7) which contained 1.5kg of tap slag and GH202 (Section 2.2.20) which also contained 4kg of tap slag. Evidence from Little Totham in Essex (Adkins 1989) has dated slag blocks to the 7th Century AD, which is in agreement with the archaeological evidence from Mucking. The total quantity of slag blocks from Mucking is 118kg (Table 1.1.1), and this represents either a single phase of iron smelting activity or a series of small smelting operations carried out over a longer period (assuming all the slag blocks are of roughly the same date). It does not represent a major centre of iron smelting of the Saxon Period. The evidence emerging from Essex appears to indicate small scale operations to satisfy local needs. It is not known what iron ores were used, but it is probable that they were extracted locally, ie within a mile or so as there would be no reason to transport small quantities of ore long distances. The most likely sources were either "bog ores" from 'waterine' environments, ie the concentration of iron compound by precipitation from slow moving or stagnant waters, or the recovery of ironstones from glacial deposits of clays or gravels. The smithing debris from the pit group (section 2.2.12) is the only deposit large enough to suggest the locality of a smithy; the others are small single dumps of material.

There are few sites that can be used as a comparison for Saxon Mucking since only a small number of ironworking sites dated to this period have been excavated. The understanding of ironworking technology in this period is further confused by the high quality of some iron edged tools (McDonnell 1989). The picture emerging at present is of the ability of some Saxon smiths to produce high quality artefacts, especially edged tools such as knives, but there is no evidence for centres of iron and steel production. There are no identified smelting sites from regions that were major centres of iron production in the Romano-British or medieval periods, eg the Sussex/Kent Weald.

Slag block smelting technology was the main method of iron smelting used at Mucking, although slag tapping may also have been employed as some was found, eg in GH72. SLB technology has been recorded at Little Totham and at Romsey, Hampshire (McDonnell 1988). Neither of these areas has major iron ore deposits. The iron smelting activity in Romsey is thought to be dated to the 6-7th Centuries, but it has not yet been confirmed by independent methods. The quantities of slag recovered from Romsey are much greater than those recovered from

Mucking. This strengthens the argument that the smelting slag from Mucking represents small scale activity.

There is also little comparable data for smithing sites in this period. Hamwih, Southampton (Andrews in prep) is slightly later but must be considered an "urban" site. A small rural Late Saxon smithy has been excavated at Wharram Percy, East Yorkshire from which about 100kg of smithing debris was recovered (McDonnell 1985). This material was tightly concentrated around the smithy, and had suffered little or no later disturbance. If this is a typical example of its type, the Mucking smithing debris can be seen as representing a similar scale of activity; the main differences are the wider dispersion of the slag and the fact that much of it come from unstratified contexts.

TABLE 3.4.1 (Definite) Anglo-Saxon Slag Areas

North1	North2	East1	East2	Section	GH	Slag Type (weight kg)
375	382	715	725	2.2.7	(213)	Smith +TSL (3) (0.07)
-725	726	110	115	2.2.10	42	Smith (2)
-755	770	90	110	2.2.11	44/45	Smith+Smelting (6) (19)
840	910	140	210	2.2.12	pit group	Smith+Smelting (14) (9)
1247	1247	447	447	2.2.3	pit	Smelting (5)
1898	1903	968	979	2.2.16	129	Smith (5)
2140	2148	780	786	2.2.18	179	Smelting (4)
2445	2445	915	922	2.2.19	196	Smith+Smelting (3) (10)
2490	2500	960	980	2.2.20	202	Smith+Smelting (6) (14)

3.5 The Medieval and Later Periods

There were no slag concentrations identified as medieval or later. The pattern of settlement had changed and the smithies would have have been located at the new settlements.

4 Conclusions

The quantities of slag ascribed to each period is given in Table 4.1, these amounts include only the material listed in 2.2. Smithing was carried out in the Iron Age and Romano-British periods, and both smelting and smithing were practiced in the Saxon period. The quantity of Iron Age smithing debris is very low and would normally be ignored as "background" level. The presence of smelting slag in the Romano-British period is doubtful since the only lump was a fragment of slag block recovered from an area where there was Saxon smelting activity. The evidence for ironworking is the strongest in the Saxon Period. In only one area is there any indication of continuity from the Romano-British period (Section 2.2.12). The total amount of slag recovered from the whole site is not as great as might be expected. This is probably due to the sampling strategy and that large features, in which the slag was concentrated, were not fully excavated.

Table 4.1 Summary Table of Slag Distributions by Period

Period	Smelting Slags	DIS	Smithing Slags	Non-Diagnostic Slags/Residues
Iron Age		0.085	1.223	0.510
Romano-British	0.040	0.780	29.183	3.222
Saxon	39.544	2.040	40.067	7.769

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