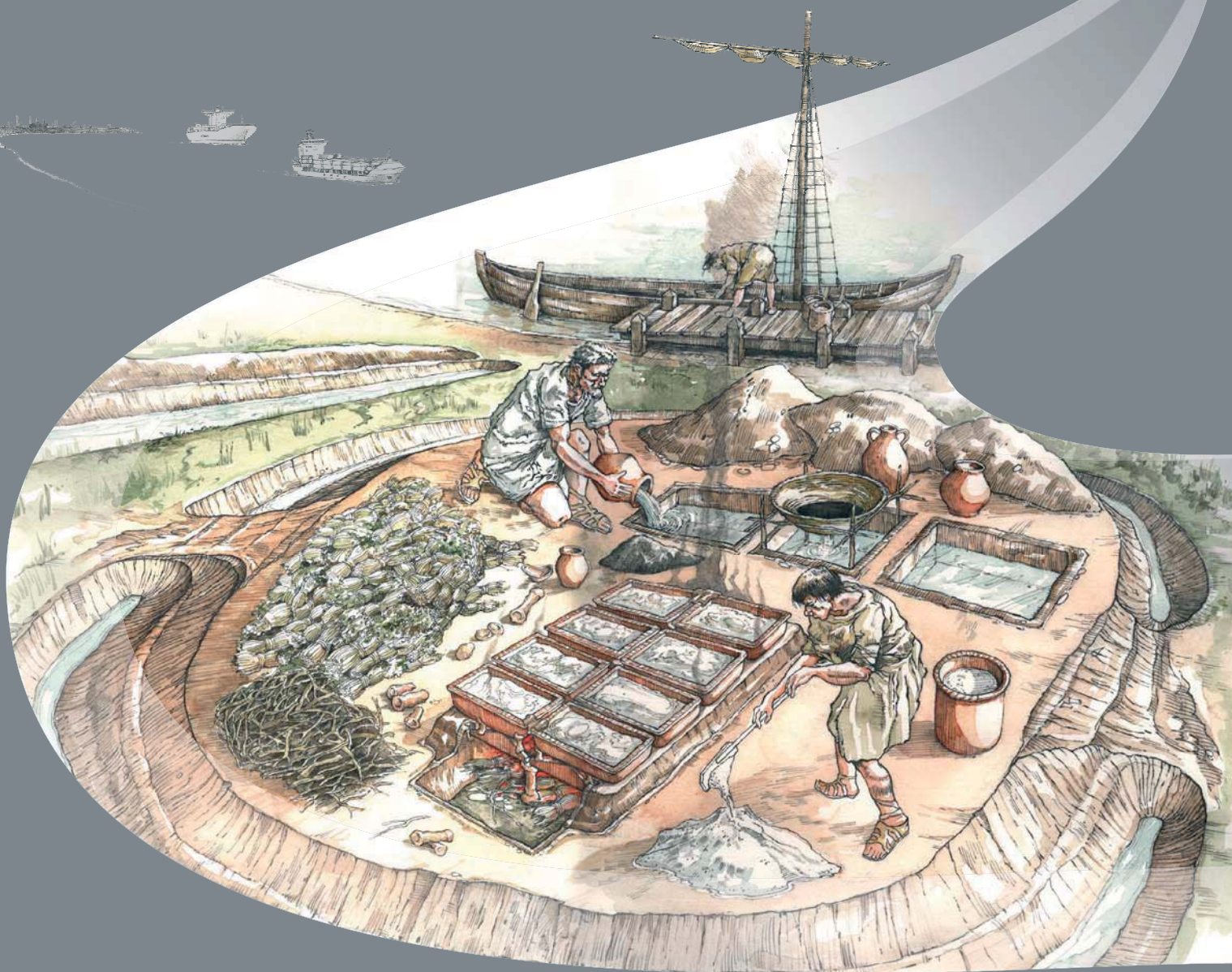


LONDON GATEWAY

IRON AGE AND ROMAN SALT MAKING IN THE THAMES ESTUARY

EXCAVATION AT STANFORD WHARF
NATURE RESERVE, ESSEX



SPECIALIST REPORT 6

SLAG AND HIGH-TEMPERATURE DEBRIS

BY LYNNE KEYS

Specialist Report 6

Slag and High-Temperature Debris

by Lynne Keys

Introduction

A small assemblage (just over 10.05kg) of slag and related high-temperature debris was recovered by hand during excavation and from soil samples processed afterwards; most was from Area A. For this report it was examined by eye and categorised on the basis of morphology alone. Each slag type in each context was weighed. Quantification data are given in Table 6.1 in which weight (wt) is shown in grammes; length (len.), breadth (br.) and depth (dep.) in millimetres.

Discussion of the assemblage

Iron slag was a small proportion (704g) of the assemblage. Minute quantities of non-magnetic, silica-rich spheres may derive from Iron Age smelting but the lack of other bulk evidence argues against this. The diagnostic iron slags are those of secondary smithing. One smithing hearth bottom (a plano-convex slag cake which builds up in the hearth base) and 5g of hammerscale flakes and magnetic spheres were recovered (Table 6.2).

Hammerscale flakes are produced by ordinary hot working of a piece of iron (making or repairing an object), while the tiny magnetic spheres derive from high temperature welding used to join or fuse two pieces of iron. The more bulk slags are moved about, the less hammerscale is likely to remain with them. The quantities from the Stanford Wharf samples are so small they indicate that no intense smithing took place and the hammerscale was not near any focus of smithing.

Iron slag described as undiagnostic cannot be assigned to smelting or smithing either because of morphology or because it has been broken up during deposition, re-deposition or excavation. Less than a kilo of undiagnostic slag was recovered, lending support to the argument that no serious iron-working activity took place in the area. There is the possibility that larger smithing slags produced may have been removed for recycling on roads and as hard core elsewhere during the Roman period.

Other types of debris in the assemblage may derive from a number of high temperature activities – including domestic fires – and cannot be taken on their own to indicate that iron working was taking place. These include fired clay, vitrified hearth lining and cinder. Vitrified hearth lining comes from nearest the tuyère region (the region of highest temperature) of a hearth or furnace. Cinder is a very porous, highly vitrified material formed at the interface between the alkali fuel ashes and siliceous material of a hearth lining. If found in association with iron smelting and/or smithing slag these materials are almost certainly products of the process, but this is not the case here and other industries involving heat were taking place and could have produced them.

Fuel ash slag was the largest quantity of slag recovered (over 2.9kg). It is a very lightweight, highly porous, light coloured (whitish-grey to grey-brown) residue produced by a high temperature reaction between alkaline fuel ash and siliceous material such as a clay lining or surface. It can result from any high temperature activity where these two constituents are present, including domestic hearths, accidental fires (burning down of wattle-and-daub and thatched buildings), and even cremations. On its own it does not represent metalworking activity; only when associated with diagnostic evidence can it be so attributed (for further discussion on the subject, see Bayley 1985, 41; Henderson *et al.* 1987a; 1987b). Fuel ash slag is frequently found in quantity as large lumps on Iron Age sites, but any such pieces subjected to re-deposition and disturbance will quickly break up. Some fragments in the Stanford Wharf assemblage are so hard – almost stoneware-like – that they may include some saline element in their make-up.

Ferruginous concretions are made up of a re-deposition of iron hydroxides (rather like iron panning), enhanced by surrounding archaeological deposits, particularly if there is iron-rich waste present as a result of iron working. It forms the second largest group (2.6kg) of material submitted for examination as ‘slag’ but more likely indicates the presence of iron in quantity in some deposits. Support for this may be the many tiny non-slag iron flakes recovered by sampling during excavations; perhaps iron vessels or other sheet material were being used (and sometimes shaped) here.

Discussion by period

Iron Age

Area A layer 5849 contained small iron flakes and some broken pieces of flake hammerscale (total 0.5g). A layer of dumping (5024) in Area A produced 36g of iron-rich undiagnostic slag. Also in Area A, layer 5026 contained 6g of slag dribbles and small cindery runs.

Roman

Layer 1745 in Area A contained non-magnetic, silica-rich spheres (0.5g) which could be produced by smelting and, less often, iron smithing. The only smithing hearth bottom came from layer 6743 in Area A; it also contained a small quantity of undiagnostic iron slag. Area B feature 4786, fill 4787, contained some silica spheres in a residue mainly consisting of fuel ash slag.

Middle Roman

Layer 5735 contained small iron flakes, an iron nail and ferruginous concretions (total 5g), which may be waste from smithing or just iron and resultant corrosion products dumped here.

Late Roman

In Area B, fill 4065 of ditch 4063 produced non-magnetic silica-rich spheres, some cinder and fuel ash slag.

Late Roman 1

Fill 1021 of posthole 1022 in Area A contained a small quantity of non-magnetic, silica-rich slag spheres. Fill 5708 of enclosure ditch 5816 contained six pieces of undiagnostic slag weighing 112g.

Late Roman 2

In Area A layer 1007 contained tiny iron flakes. Layer 1018 contained 30g of undiagnostic iron slag. Fill 1525, feature 1526, contained 15g of undiagnostic iron slag. Layer 1626, a slot with burnt material, contained a tiny quantity (0.5g) of broken hammerscale flake, tiny iron flakes and burnt clay. Floor layer 5061 contained 106g of undiagnostic iron slag, probably re-deposited. Fill 6092 of tile-built hearth 6061 contained crushed iron dust, very occasional broken hammerscale flake, tiny iron

flakes, and a very small quantity of undiagnostic iron slag. There is not much, but it does suggest that structure 6090 could have been used for a one-off smithing event, perhaps involving shaping or repair of flat iron objects, such as iron heating pans. Layer 5795 (unit G5) contained 0.5g of microslags in the form of slag bubbles and broken spheres.

References

- Bayley, J, 1985 What's what in ancient technology: an introduction to high-temperature processes, in *The archaeologist and the laboratory* (ed. P Phillips), CBA Research Report **58**, London, 41-2
- Henderson, J, Janaway, R C and Richards, J, 1987a A curious clinker, in *Journal of Archaeological Science* **14**, 353 - 365
- Henderson, J, Janaway, R C and Richards, J, 1987b Cremation slag: a substance found in funerary urns, in *Death, decay and reconstruction* (eds A Boddington, A N Garland and R C Janaway), Manchester University Press, Manchester, 81-100

Slag and High-Temperature Debris Tables

TABLE 6.1: QUANTIFICATION OF THE SLAG AND HIGH-TEMPERATURE DEBRIS

ext	sam	slag identification	wt	len	br	dp	comment	pcs
1002		iron nail	17				with ferruginous concretion	
1007	1334	iron	0.25				tiny flakes	
1007		ash lump	17					
1007		clay & iron	414					
1007		ferruginous concretion	1					
1008	1335	copper oxide alloy run	1				translucent, red, glassy	
1008	1335	heat magnetised residue	4				fired clay, grit, iron flakes	
1008		iron	172				and ferruginous concretion	
1008		iron	194				with ash	
1008		iron	12					
1018		undiagnostic	30					
1021	1009	hammerscale	0.5				tiny, non magnetic silica-rich spheres	
1095		fired clay	7					
1096		iron	4				with ferruginous concretion	
1215		ferruginous concretion	406					
1215		iron	66					
1217		ferruginous concretion	13					
1227		fuel ash slag	18					
1363	1236	heat magnetised residue	2				fired clay, grit	
1363		fuel ash slag	23				with fired clay	
1375	1030	mixed residue	3				iron flakes, glassy green fuel ash slag	
1410	1053	ferruginous concretion	14					
1415		fired clay	40				and cinder	
1415		fuel ash slag	1					
1457	1062	heat magnetised residue	1				mostly tiny charcoal fragments	
1495		bricatage	36					
1495		cindery run	0.5					
1495		fired clay	67				or briquetage	
1495		fuel ash slag	13					
1525	1059	undiagnostic	15					
1531	1111	cinder	17				glassy black	
1531		ferruginous concretion	180					
1531		fired clay	16					
1531		iron	64					
1586		undiagnostic	33					
1593	1330	mixed residue	387				fired clay, fuel ash slag	
1593		fuel ash slag	4					
1618	1320	fuel ash slag	554					
1626	1075	hammerscale	0.5				broken flake	

Excavation at Stanford Wharf Nature Reserve: Slag and High-Temperature Debris

1626	1075	heat magnetised residue	0.5				tiny iron flakes, fired clay, grit	
1674	1094	heat magnetised residue	1				fired clay, stones	
1679		fuel ash slag	4					
1680	1090	fired clay	1					
1680	1090	heat magnetised residue	1				fired clay, stones	
1745	1117	fuel ash slag	7					
1745	1117	slag spheres	0.5				silica-rich, non magnetic	
1745		fired clay	7					
1784	1113	cinder	2					
1784	1113	ferruginous concretion	9					
1834	1115	heat magnetised residue	1				grit	
1890	1121	heat magnetised residue	2				fired clay, stones	
1890	1121	heat magnetised residue	2				fired clay, grit	
1915	1137	heat magnetised residue	0.5				ashy charcoal	
1958	1146	cinder	3					
1958		cinder	2					
4065	4002	heat magnetised residue	1				microslag silica spheres, cinder, fuel ash slag	
4240		fuel ash slag	806				so vitrified as to be almost stoneware in composition	
4240		fuel ash slag	233					
4241		fuel ash slag	30					
4245		fuel ash slag	25					
4282		fuel ash slag	58				very hard and vitrified	
4292		fuel ash slag	3					
4298		fired clay	24				white clay with flattened surface	2
4298		fuel ash slag	30				highly vitrified	
4298		vitrified hearth lining	8					
4319	4030	fuel ash slag	203				very tiny pieces	
4333	4011	fuel ash slag	4					
4333	4011	vitrified hearth lining	34					
4356	4024	mixed residue	198				fuel ash slag, fired clay, grit	
4356	4024	mixed residue	81				fuel ash slag, fired clay	
4358	4025	fuel ash slag	348					
4358	4025	mixed residue	219				fuel ash slag, tiny dribbles, cinder	
4382	4028	fuel ash slag	78					
4407		fired clay	32				with vitrified surface	
4407		fuel ash slag	72				highly vitrified	
4430		fuel ash slag	5					
4441	4035	fuel ash slag	63					
4445		fuel ash slag	27					
4446		fired clay	39				highly vitrified	
4567		fuel ash slag	3					
4600	4037	waterlain deposit	22				fired clay	
4600		ferruginous concretion	23				and cess	
4600		fuel ash slag	26					

Excavation at Stanford Wharf Nature Reserve: Slag and High-Temperature Debris

4755	4098	fired clay	2				
4764	4099	heat magnetised residue	1			fired clay, tiny stones etc	
4787	4106	heat magnetised residue	3			clay	
4787	4106	heat magnetised residue	10			fuel ash slag, silica spheres, fired clay	
4787		fuel ash slag	63			vitrified and with glassy surface	
4787		fuel ash slag	92			so vitrified as to be almost stoneware in composition	
5005		mixed residue	33			fuel ash slag, fired clay, cinder	
5024		fuel ash slag	17				
5024		iron-rich undiagnostic	36				2
5026		fired clay	68				
5026		fuel ash slag	8				
5026		slag dribbles & cindery runs	4				
5039		ferruginous concretion	75			with nail	
5041	1162	fired clay	3				
5041	1162	undiagnostic	106			very ferruginous	
5133		cinder	5				
5133		fuel ash slag	36				
5133		fuel ash slag	12			iron-rich	
5133		undiagnostic	135				1
5133		vitrified hearth lining	57				
5155	1165	heat magnetised residue	1			fired clay, stone grit; very ashy	
5165		cindery runs	3				
5250	1360	heat magnetised residue	1			fuel ash slag, fired clay, grit	
5315	1200	slag spheres	1			silica-rich, non magnetic	
5364	1189	heat magnetised residue	1			fired clay, grit	
5434	1210	fuel ash slag	4				
5506		fuel ash slag	22				
5532	1359	waterlain deposit	983			fired clay, fuel ash slag, tiny pebbles	
5568		cinder	1			iron-rich	
5568		fired clay	2				
5707		cinder	3				
5708		ferruginous concretion	34				1
5708		fired daub	15			with whitewashed surface	
5708		undiagnostic	112				6
5735	1247	iron	5			iron nail, iron flakes, ferruginous concretion	
5795	1254	microslags	0.5			slag bubbles & broken spheres	
5835	1280	fired clay	1				
5849	1269	mixed residue	0.5			iron flakes & broken hammerscale flake	
5849		mixed residue	9			iron-rich undiagnostic, fuel ash slag, fired clay	
5851	1303	waterlain deposit	26			mostly clay	
5852		ferruginous concretion	58				
5985		fuel ash slag	0.5				

Excavation at Stanford Wharf Nature Reserve: Slag and High-Temperature Debris

5985		fuel ash slag	4				
5987		fuel ash slag	1				
6052	1297	heat magnetised residue	7				fired clay, grit, very occasional tiny fragments of hammerscale flake
6092	1346	heat magnetised residue	10				iron flakes, fired clay, grit, tiny undiagnostic
6092	1346	heat magnetised residue	5				crushed iron dust, occasional broken hammerscale flake
6140	1317	concretion around root	112				
6140	1317	ferruginous concretion	3				
6140	1317	fired clay	27				
6150		fired clay	7				
6192	1316	fired clay	19				
6236		cinder	12				
6255		fuel ash slag	8				
6259	1358	ferruginous concretion	1732				waterlain and concreted with pebbles
6530		ferruginous concretion	4				
6669		cinder	13				
6743		smithing hearth bottom	135	80	65	30	
6743		undiagnostic	90				

TABLE 6.2: SLAG TYPES, PROCESSES AND WEIGHTS

process	slag type	Wt (g)
non-diagnostic	cinder	58
non-diagnostic	vitrified hearth lining	99
non-diagnostic	fired clay	502
non-diagnostic	ferruginous concretion	2552
non-diagnostic	fuel ash slag	2906
smelting	non-magnetic slag spheres	1.5
smithing	hammerscale	4
smithing	smithing hearth bottom	135
undiagnostic	cindery runs	3.5
undiagnostic	slag dribbles	4
undiagnostic	iron-rich undiagnostic	36
undiagnostic	undiagnostic	521

