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Ancient Monuments Laboratory
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EXAMINATION OF SLAG AND OTHER METALWORKING DEBRIS FROM WESTHAMPNETT BYPASS, CHICHESTER, WEST SUSSEX

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Summary

A very limited quantity of debris from late Iron Age contexts attested to small-scale iron smithing and high temperature working of copper alloys.

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Introduction

Excavations carried out by Wessex Archaeology in advance of the construction of the A27 Westhampnett By-pass revealed many phases of occupation. In Area 5, an unenclosed settlement primarily of Mid to Late Iron Age date, a small quantity of metalworking debris was found, most of which concentrated in features containing Mid to Late Iron Age pottery, or late Iron Age and Romano-British pottery. In the same area one or more four-post structures had been burnt down and large quantities of macrofossils were recovered from the post holes.

Examination of the slags and metalworking debris was carried out by the Ancient Monuments Laboratory for Wessex Archaeology who were undertaking post excavation research and publication of the site. The assemblage examined totalled 1.2kg. This was the entirety of the metal working debris recovered from the site, although some further fired clay/burnt daub was found, significantly this also concentrated in the same area as the slag.

Visual examination and explanation of classes of slags

All slag was examined visually, classified and weighed. One fragment was examined by X-ray fluorescence analysis. The results of the examination were as follows:

Summary of metalworking debris from Westhampnett Bypass, Chichester				
context No.	**dating (ceramic)**	**weight (g)**	**interpretation**	**comments**
50043	no pottery	32	burnt daub	
50045	no pottery	11	cinder	
50047	late I.A. & R-B	12	fuel ash slag	
50055	late I.A. & R-B	14	vitrified hearth lining	black glaze
50117	late I.A. & R-B	36	smithing hearth bottom	very small (45x40x20mm)
50169	late I.A.	6	fuel ash slag	
50231	late I.A.	3	undiagnostic ironworking slag	
50359	no date given	23	plate tuyère fragment*	"liverish" red coloration. XRF analysis revealed traces of copper on vitrified surface.
51345	late I.A.	981	smithing hearth bottom	stacked, double (110x90x70)
51345	late I.A.	40	undiagnostic ironworking slag	
51345	late I.A.	<1	flake hammerscale	
	total	1189		

* Originally submitted as an example of burnt/vitrified clay.

Material diagnostic of the **high temperature working of iron** was found as **smithing hearth bottoms.** These are recognisable by their characteristic plano-convex form, having a rough underside and a smoother, vitrified upper surface often hollowed as a result of downwards pressure from the air blast of the tuyère. Compositionally, hearth bottoms are largely fayalitic (iron silicate) and result from high temperature reactions between the iron, iron scale and silica from either the sand used as flux or from the hearth lining.

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. Hammerscale is considered important in interpreting a site not only because it is highly diagnostic of smithing but, because it is often allowed to build up in the immediate vicinity of the smithing hearth and anvil, it may give a more precise location of the activity than the bulk slags which may be transported elsewhere for disposal[1]. During visual examination of the Westhampnett slags, small quantities of flake hammerscale were identified in the soil attached to unwashed slag from context 51345. This information has been noted in the Table although the amount present was too small to justify quantification.

A small proportion of the assemblage was identified as **undiagnostic ironworking slag.** This material is of largely fayalitic (iron silicate) composition, is relatively dense having low to medium vesicularity and of amorphous form. However, as similar material can originate from either iron smithing (hot working) or iron smelting (extraction of metal from ore) it cannot help to distinguish the nature of the iron working activity on site.

The fragment of **vitrified hearth/furnace lining** might derive from structures built either for iron smelting, iron smithing or nonferrous alloy melting/working. The material forms as a result of a high temperature reaction between the clay lining of the hearth/furnace and the alkali fuel ashes or fayalitic slag. The material from Westhampnett By-pass shows a compositional gradient from unmodified clay on one surface to a black glassy material on the other. An associated material, classed as **cinder,** comprises a porous, hard and brittle slag formed as a result of high temperature reactions between the alkali fuel ashes and either fragments of clay which had spalled away from the hearth/furnace lining or another source of silica, such as the sand used as a flux during smithing.

A **tuyère** is a component of a furnace or hearth through which air is forced to increase the temperature. These may exist in a number of forms and materials, of which the best known is a pre-fired, pierced, clay "block tuyère". However, the fragment from Westhampnett is of a type referred to as a "plate tuyère". This is simply a clay patch applied around the air inlet on the inside of the hearth or furnace, at the point that the heat is most intense and the clay lining is most rapidly attacked. The fabric of these resembles vitrified hearth lining, with a gradient from fired clay to vitrified/cindery mass, but the smooth edges of the air hole are visible.

Semi-quantitative X-ray fluorescence (XRF) analysis of the vitrified surface of the plate tuyère fragment from Context 50359 confirmed the presence of iron and manganese as contaminants or as part of the fabric, along with calcium and potassium. More importantly, a weak response was also given for copper, which would have been the element responsible for the "liverish" red coloration, and an indicator of the **high temperature working of copper alloys** on the site.

Small amounts of material were classified as **fuel ash slag,** a very lightweight, light coloured (grey-brown), highly porous material which can result 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, however it would seem likely that much of the fuel ash slag from Westhampnett By-pass is the product of fiercely heated daub, for which other, less thoroughly fired, fragments have been identified as **burnt daub.**

No metalworking debris diagnostic of iron smelting was found.

Conclusions

The metalworking slag assemblage from Westhampnett Bypass is of very small size and this limits the extent of any interpretation which can be placed upon it. Many of the slags were of undiagnostic type, but a few were sufficiently characteristic to be able to be certain that they derived from two processes: the smithing (ie hot working) of iron, and the heating in some form of hearth or furnace of copper alloys. It is not possible to be more specific about the composition of any alloys. It is of course possible that a single hearth was used for both activities. However, examination of the finds distribution, shows that the tuyère fragment was found at some distance from the main concentration of metalworking debris. It must be emphasised that such small quantities of material could derive from the briefest occurrence of such crafts.

Suggestions for further work

More detailed examination and analysis of the metalworking debris would not appear to be justifiable.

In view of the possibility of metal working on site, particular note should be taken of any part finished objects, stock materials (including scrap, bar ends etc) that would provide additional evidence for these activities.

As mentioned above, hammerscale provides a very good indicator of the nature and location of iron smithing, even when structures have disappeared. It is easily detected on site or post-excavation (during soil sample processing); running a bar magnet across the surface, will attract the magnetite-rich hammerscale.

Storage of slag

Ironworking slag, being predominantly fayalitic, is not prone to deterioration and requires no special storage treatment. It is recommended that all the slag should be saved.

References

1. Mills, A. and McDonnell, J. G. (1992) *The Identification and Analysis of the Hammerscale from Burton Dassett, Warwickshire.* Ancient Monuments Laboratory Report 47/92.