Ancient Monuments Laboratory
Report 46/99

ASSESSMENT OF IRON WORKING SLAGS AND LEAD WASTE FROM DUNWICH GREYFRIARS, SUFFOLK

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Summary

Excavation at a medieval friary produced 9.2 kg of iron smithing slags. The recovery of a limited range of slag types and the fragmented nature of these suggests that iron smithing was not carried out within the area excavated. The 6.7 kg of lead waste probably derives from a single period of demolition at the time of the dissolution.

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Assessment of Ironworking Slags and Lead Waste from Dunwich Greyfriars, Suffolk (DUN 025)

David Dungworth

Introduction

The site of Dunwich Greyfriars, Suffolk (a Scheduled Ancient Monument) was the subject of an EH-funded evaluation due to the threat of coastal erosion. Excavations by Suffolk County Council Archaeology Service as part of this evaluation produced 9.2 kg of iron working slags and 6.7 kg of lead working waste.

Assessment of the iron working slags

The total quantity of slag is 117 pieces totalling 9,164 grammes weight (see table 1). Most of the slag examined is fragmented but can be identified as pieces of smithing hearth bottom. A number of categories of slag were noticeable by their absence, especially hearth lining and fuel ash slag (see below for a definition of terms used). A number of samples were analysed qualitatively using EDXRF in order to test for the presence of non-ferrous metals but none were detected. The slag would all have been formed during iron smithing.

Period	**Pieces**	**Weight**	**Comments**
III 2 medieval friary (*c.* 1290-1538)	7	561 g	
IV 1 post-medieval dissolution (*c.* 1538)	75	6051 g	Hammerscale
IV 2 post-medieval (16th–18th century)	6	325 g	
IV 3 post-medieval (19th–20th century)	18	1930 g	Hammerscale
unstratified	11	297 g	
Total	**117**	**9164 g**	

Table 1: summary of technological debris in the west annexe

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Explanation of terms used

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 convèx 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 hearth 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. During the visual examination of bulk slags, small quantities of hammerscale were identified in the soil attached to some of the unwashed slags. This information has been noted in table 1. Hammerscale would normally accumulate immediately around a blacksmith's anvil and it was presumably transported to the site along with the smithing hearth bottom fragments.

Vitrified hearth lining is produced by a high temperature reaction between the clay lining of a hearth or furnace, and the alkali fuel ashes or fayalitic slag. It can be formed by 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.

Fuel ash slag is 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.

Most assemblages of slag include **undiagnostic ironworking slag** which 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.

Discussion

Only a small proportion (6% by weight) of the iron working slags from Dunwich Greyfriars were recovered from stratified deposits associated with the medieval friary. Most of the slag came from contexts dated to the Dissolution of after. There are no differences in the types of slag recovered from contexts of different phases and the post-medieval slags may thus all be residual.

Small amounts of hammerscale were detected in soil adhering to some of the slag samples (contexts 0125, 0359, 0367). These were carefully collected and examined using a low-power microscope and a bar magnet. In each case flakes hammerscale was detected and in one case sphereoidal hammerscale was also detected.

Iron working slag assemblages usually include a variety of slag types (as discussed above). The assemblage from Dunwich Greyfriars is composed entirely of fragments of smithing hearth bottom and undiagnostic slags; there are no fragments of fuel ash slag or vitrified hearth lining. In addition the smithing slag bottoms are more fragmentary than is usually the case. The most likely explanation for the partial and fragmented nature of the slag assemblage is that it was selected, transported and dumped. It is suggested that the smithing hearth bottom fragments may have been used as hard core.

Assessment of the lead waste

A list of all of the fragments of lead compiled by Suffolk County Council Archaeological Service shows 300 fragments, totalling 6,675 grammes. The lead assemblage includes three identifiable types: off-cuts, spillages, and oxidised fragments.

Off-cuts are pieces of sheet lead which have clearly been cut (with shears or a knife). Some off-cuts are relatively neat, geometric shapes while other are more irregular. Several off-cuts show signs of very rough cutting and/or tearing or twisting. While some of the small off-cuts could have been produced during the fabrication of lead artefacts or fittings, the vast majority was probably produced during the recovery of lead from windows and roofs during a demolition phase.

Spillages of lead have the rounded amorphous shapes typical of pieces of metal which have been melted and allowed to solidify on the ground (rather than in any mould). Spillages may have formed during the deliberate casting of lead or when lead artefacts were accidentally burnt in a fire.

The **oxidised fragments** of lead are generally disc-shaped and 4–10 cm in diameter and 1 cm thick. These are probably the remains of some of the lead which oxidised during melting.

Very little of the lead is associated with the medieval friary (11 pieces). Most of these pieces are very small spillages which by themselves are not indicative of lead working. 227 pieces of lead are associated with post-medieval contexts and 217 of these come from a single dissolution period pit. This pit contains mostly spillages of lead with relatively few off-cuts. The only oxidised fragments also come from this pit. The remaining 62 fragments of lead waste are all unstratified and almost all off-cuts. The most likely explanation for this evidence is that the dissolution of the friary was accompanied by a removal of lead from the buildings. This was cut up and melted down on site before removal. The amount of lead which has survived in the archaeological record is not particularly significant compared to the amount of the lead which would have been used during the construction of the medieval friary.

Conclusions

The assemblage of metal working debris from Dunwich Greyfriars, Suffolk consists of 9.164 kg of slag and 6.675 kg of lead. All of the slag is derived from iron smithing operations and most can be identified as fragments of hearth bottoms. The recovery of a limited range of slag types and the fragmented nature of what was recovered suggests that iron smithing was not carried out in the immediate vicinity of the area excavated. The slag may have been brought to the site as hard core. The lead waste probably all derives from a single period of demolition at the time of the dissolution.

Potential for further work

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