



# Excavation and Sampling Strategies for Metalworking Sites

Identifying the nature and extent of metalworking processes on an archaeological site relies on adequate recovery and recording of the evidence of these activities. This sheet provides advice on how standard archaeological practice can be supplemented to achieve this.

## The Evidence

(For detailed description see relevant Datasheets and English Heritage's Guidelines) The archaeological evidence for **iron** smelting (see Datasheet 5) may include furnace remains, fuel, ore and slags. The evidence for iron smithing (Datasheets 6&7) includes hearth structures, blocks or bars of iron stock, scrap iron, fuel, and slags, including hammerscale. Structural remains may be extremely ephemeral. The quantity of slags can vary greatly, depending on the nature of the activity, and the area excavated from less than ten kilograms to many tonnes.

Evidence for **non-ferrous** metal smelting will be similar to that for iron. However, as the distribution of copper, lead and tin ores in the British Isles is significantly more restricted than iron sources, smelting sites for these metals will be far less widespread and smelting sites for other metals are rare. The relevant Monuments Protection Program Step 1 and 3 Reports (Arsenic, Copper, Lead, Minor Metals and Vein Minerals, Tin and Zinc outline national priorities, with an emphasis on upstanding earthworks and structures. Secondary non-ferrous metalworking activities (Datasheets 1&2) are found on a surprisingly wide range of sites. Evidence will comprise one or more of the following: fuel, hearth structures, crucible fragments, mould fragments, cupellation debris including litharge cakes, parting vessels, stock metal,

metal prills, failed castings, part manufactured objects and spillages.

## Excavation preparation

Geophysical data from magnetic techniques should readily record ironworking slags and surviving hearths/furnaces (Datasheet 4). It is essential that the raw (i.e. not filtered or 'de-spiked') data be examined, as large 'noisy' anomalies in ditches etc. may be dumps of metalworking debris or even in situ furnaces. Excavators should have access to a strong magnet which will readily pick up hammerscale (Datasheet 10). A low powered hand lens is useful for checking for other micro-residues and a ceramic streak plate (obtained from mineralogy suppliers) can be used to identify fayalitic slags, which give a characteristic grey streak.

## Contexts

Metalworking residues may be recovered from buildings or areas in which metalworking was practised (primary deposits) but are also recovered from where debris has been dumped in middens, pits and ditches, or used for surfacing trackways etc. (secondary deposits). The excavation of the two types of deposits need to be approached in slightly different ways, since the type of evidence recovered and its interpretation will be different.

In **primary deposits**, metalworking structures (furnaces, hearths, and pits) may be encountered, and the distribution of the residues in a building can be crucial in identifying and separating different activities within the area. For example on an iron-smelting site, charcoal production, ore roasting and bloom smithing may also be carried out in proximity to the smelting. The excavation of areas where metalworking has been carried out will require gridding and careful sampling,

both for hand recovered material and soil samples for micro-residues, in particular hammerscale. Excavation of furnaces and ground-level hearths is a time consuming process. The possibility that waist high or above-ground hearths may have existed must be considered. However, of these only the bases or platforms are likely to survive in the archaeological record. 3-D recording of bulk finds, e.g. slags, is not feasible. However, crucibles, scrap metal etc. should be treated as 'small finds'. Heating regimes which are oxidising will fire clay to an orange colour, whereas reducing (low oxygen) will turn the same clay grey. Information on colour is thus important for understanding the metallurgical process being carried out and careful recording and notation of plans of fired structures should be undertaken. If undisturbed, such fired structures should also be considered for archaeomagnetic dating.

**Secondary Deposits** include features and deposits which are contemporary with, or later than, the metalworking activity which produced the debris. Careful recording of the residues may indicate the direction from which the material was dumped. Soil samples should be taken for recovery of micro-residues. Where the fills of hearths or furnaces are dumped, the complete range of debris may be present. Larger features may contain larger, more representative, deposits of metalworking debris. If very large features, e.g. extensive boundary ditches, are only sectioned then dumps of material may be partially recovered or missed altogether. Detailed analysis of geophysical data may identify the extent of such deposits.

## Excavation Policy

- As far as possible all slags and residues should be kept. If features were only partly excavated, record the proportion to provide an estimate of the total quantity of slag. Achieving a reliable estimation of the total slag present in any partly excavated, or unexcavated large feature (such as a slag heap) is difficult, but is essential in obtaining a measure of the scale of activity on the site. A simple formula for achieving this is to calculate the volume of the feature (in cubic metres), multiply this by a factor between 0 and 1 for the proportion of slag by volume (estimate this), then multiply by the density of the slag (if not measured, assume 3.5 grams per cubic centimetre) to give the total weight in tonnes.

### Example:

A pit contains 70, 10litre buckets of fill of which half the volume appears to be slag.

Total weight of slag  
= volume x packing factor x density  
= 0.7 x 0.5 x 3.5 = 1.2 tonnes

- A site reference collection should be established. This will form the basis on which all slags and residues will be classified. The quantities recovered for each category, by context, must be recorded. Dimensions of certain debris should be recorded; e.g. diameters and depths of furnace or hearth bottoms, size of crucibles, diameter of hole in tuyère mouths or blowing holes.
- The reference collection should be revised if necessary. It is inevitable that sub-categories will be recognised. It is also likely that a proportion of the residues cannot be clearly ascribed to any particular type, they therefore become an intermediate group. Not all recognisable categories can be associated with a process; for instance some morphologically indistinct types of slag could derive from either

smithing or smelting.

- “Industrial” samples must be taken from all relevant contexts and, for comparison, from a range of contexts spatially or chronologically removed from the ironworking activity. Samples can be screened by magnetic susceptibility for micro-residues (Datasheet 10), and where these are present the samples should be sieved. The size of soil sample will vary, and discretion must be used. A 30 litre sample should be adequate for complete recovery of all (macro and micro) residues by sieving, whilst a 0.5 litre sample would be adequate for magnetic susceptibility screening.
- Most residues are robust and should be cleaned. Washing and drying will enable debris to be more easily identified, will prevent seed germination or mould growth and will reduce the weight and volume of material to be stored. Other debris such as clay mould fragments, may require more careful treatment if weak fabrics are not to be damaged or loosely attached micro-residues lost (Packaging datasheet forthcoming). Lead and some other waste materials are toxic by skin absorption and inhalation. Personal protective equipment should be worn when these are present.
- All charcoal should be collected to provide material for species identification and tree age - this can provide important evidence on the exploitation of wood resources for metalworking. Radiocarbon samples should be processed in the usual manner to avoid contamination.

## Post-Excavation Policy

- After classification and weighing, some slags and residues could be discarded, e.g. those from unstratified contexts. However, if there is a requirement to reduce the volume of material to be retained then

any further selection should await the completion of the final report, after recording of the total assemblage has taken place.

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- In most cases slags and residues are extremely robust and do not require specialised storage conditions. However, Any slags with a high metallic iron content (test by magnet) should be treated as metal finds. Crucibles, moulds and metal finds should be carefully packed like other small finds.

It is important that any external finds specialist brought in to assess, or to provide a definitive report on the metalworking evidence, be provided with the archaeological background to the material. This should include at least a brief summary of the site, more detailed description of the type, phasing and dating of contexts from which debris was recovered and as much information as is available on any possible metallurgically related structures. It should be noted that finds classed as artefacts (and presented to the relevant materials specialist) may include items of considerable relevance to the metalworking specialist and access to these objects should be provided.

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