ARCHAEOLOGY DATASHEET 104

Introduction to post-excavation techniques for metalworking sites

The HISTORICAL METALLURGY Society

Summary

The excavation of archaeological sites often yields a range of material evidence for metalworking. This datasheet is intended to provide an introduction to the post-excavation study of such evidence. The post-excavation process should in most cases be divided into an initial assessment stage which will identify any need for a full analysis stage.

Excavation records

While the tangible residues of metalworking (especially slag) are usually the main focus of post-excavation study, the use of the excavation records should not be neglected (HMS Datasheets 101 and 102). Where the excavation has included the examination and recording of metalworking structures, in particular furnaces, these records need to be studied carefully to ensure that they are interpreted correctly and reported on effectively for the final publication. The context sheets, plans, sections and photographs will provide vital information to help interpret the nature of the structures excavated. The examination of such records should be shared between a range of project members (director, supervisors, specialists, etc). Excavation records should also contain relevant information about any sampling strategies, especially for very slag-rich sites. The excavation records also form the basis for the chronological phasing of individual contexts. Such phasing is as vital to the correct interpretation of metalworking evidence as it is to any aspect of post-excavation study.

Material evidence for metalworking

The evidence for metalworking takes many forms and its very diversity can generate problems for its appropriate post-excavation study (HMS Datasheet 102). In most cases the only material that is sent to an archaeometallurgist is the slag, however, this is only part of the picture. The metal produced by the smith or metal caster is often sent to metal artefact specialists rather than metalworking specialists. The metal artefacts will often be sent to separate individuals; one for the iron and one for the copper alloys. The small, typologically indistinct artefacts are often not reported on in detail, even though these may be offcuts from smithing or spillages from casting. Other materials used in metalworking can include fired clay and other ceramic materials, stone tools and implements, and bone. The significance of these materials is underestimated and under-reported. The post-excavation study of these different materials should be integrated. The most important way in which this can be achieved is effective communication between all members of the post-excavation team. For larger projects it will help if members of the team can meet and share interim results (HMS Datasheet 102).

Recognition of metalworking debris

It is far beyond the scope of this (or any other datasheet) to provide a full explanation of how metalworking debris is recognised, nevertheless it will be useful to describe the principles employed and some of the inherent limitations.

The examination of metalworking debris uses many of the same principles used in the examination of other types of archaeological material. Most recognition relies on relatively simple criteria such as size, shape, colour and density. In addition, the overall size of an assemblage can be a very useful guide to the nature and importance of any metallurgical activity, although this will also depend on the extent of the excavation. If metalworking was a marginal and/or occasional activity then relatively small quantities of slag will have been generated and recovered by archaeologists, however, if metalworking was a major activity then larger quantities of slag will be recovered. The quantity of slag produced will also vary depending on the nature of the metal that was being worked. Base metals (especially ferrous metals) will produce more slag while precious metals will produce smaller quantities of slag. The size of a lump of slag may also be a guide to the process which has produced it. A few processes, in particular the primary production of metal, will produce relatively large lumps of slag (an individual lump >1kg), while other processes will produce much smaller lumps.

The shape of slag is often the single most important criterion used by the metalworking specialist. An evaluation of the shape of a slag lump will include its overall shape as well as the nature of its surface topography. The overall shape will suggest the sort of space in which the slag formed while the surface topography will often indicate how fluid the slag was when it formed. These features can often be linked to particular processes. Some smelting processes will produce distinctive tap slags while other will yield plano-convex slag lumps of varying size and surface morphology depending on the process.

The colour of slag and other industrial debris is often an important indicator. Most debris contains at least some iron and the colour of iron varies dramatically depending on the oxidising-reducing conditions. Many metallurgical operations require reducing conditions which will make most materials grey or black. Oxidising conditions will tend to make similar materials orange or red. This colour difference can often be seen on fragments of the ceramic superstructure of furnaces or hearths. The outer portions are orange while the inner portions are black or grey. Where the burial environment has altered or obscured the surface of debris it will often be helpful to expose a fresh fracture surface (most commonly using a geological hammer). Almost all slags produced by working copper alloys will contain enough copper to have acquired a distinct green stain after years of burial.

The density of metalworking debris is often a useful indicator of the sort of process that produced it. Density is rarely measured but is estimated by holding a piece of debris in the hand and feeling its heft. Some debris associated with the working of metals such as lead are particularly dense. Many ironworking slags contain a considerable proportion of iron and so are considerably denser than ceramics. Blast furnace slags contain very little iron and may have densities close to ceramics. Some non-metallurgical materials, such as fuel ash slag, have densities that are less than ceramics. Estimating the density of debris may be complicated by its degree of porosity: a dense but porous slag may appear to be less dense than it really is.

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Determining whether debris is porous or not will usually require the exposure of a fracture surface.

The degree of fragmentation/completeness can often provide information about how metalworking debris has been treated after it has formed. If large and complete pieces of slag are recovered then it is likely that they were deposited close to where they formed and that this happened soon after they formed. Where slags have become high fragmented it is likely that they have not been buried for some time and may have moved considerable distances from the hearths or furnaces where they originally formed. In some cases, however, slags may be deliberately broken up in order to extract metal droplets or prills.

An archaeometallurgical specialist will be able to determine which sorts of processes are likely to have been carried out. There are, however, some limitations which even the most experienced specialist is unlikely to overcome using the techniques described so far. Most slag has undergone some fragmentation. In many cases individual fragments of slag may be so small that it is not possible to determine the original size, shape and surface morphology of slag. Such slag defies easy categorisation. In addition, some rather different processes may give rise to slag which has the same appearance. While Roman and medieval bloomery iron smelting (HMS Datasheet 301) both yield a distinctive iron-rich tap slag, there are a number of later processes, such as puddling, which produce similar tap slags. The proper identification of such problematic debris may require the application of scientific techniques of analysis (HMS Datasheets 105 and 106).

Assessment

The approach used to assess metalworking materials will vary depending on the archaeological context, their quantity and their potential importance. At the assessment stage the quantity of metalworking material should be recorded or estimated. The quantification of metalworking debris at both assessment and analysis stages is usually achieved by weighing slag. The fragmentation of slag will usually make the counting of fragments tedious and of limited value. It will not always be necessary to examine every fragment at the assessment stage but all material should be scanned to identify the main types of material present. This will help to identify the range of metalworking processes that may have taken place on site. If this approach is followed then a sample of the material recovered should be examined in detail to test the reliability of the scanning. The assessment report should also relate the range of metalworking materials to the archaeological stratigraphy. In most cases a metalworking assemblage will be more important if it derives from securely dated contexts. The situation is slightly more complex with material from recent sites where substantial re-deposition can occur; slag may be completely absent from some industrial sites because it has been dumped elsewhere.

Scientific techniques (HMS Datasheets 105 and 106) will rarely be applied to metalworking residues during the assessment stage, however, their use should not ruled out. The correct assessment of metalworking process and so the accurate estimation of significance and potential for analysis may benefit from carefully targeted scientific analysis.

A metalworking assessment should identify tasks to be completed during the analysis stage. These tasks will all be justified by the results of the assessment. In some cases, for example where only a small quantity of material is recovered from unstratified contexts, it may be appropriate to recommend that no further examination is undertaken.

Analysis

The examination of metalworking evidence during post-excavation analysis will vary in extent and intensity depending on the nature of the material recovered and its archaeological context but will have all been identified during the assessment stage. In most cases, all metalworking residues will be examined during the analysis phase (using the same principles used during the assessment). Supplementary details may be recorded, such as the dimensions of smithing hearth bottoms.

The correct identification of different residues will often be confirmed through the use of scientific techniques (HMS Datasheets 105 and 106). An understanding of the metalworking technologies represented in the material evidence will also be enhanced by such approaches. These may identify the types of raw materials, details of the metalworking processes employed and the nature of the metal produced.

The quantification of the metalworking debris (and the results of any scientific analysis) should be thoroughly analysed in relation to archaeological context. This will yield information on both the chronological and spatial variations in metalworking.

David Dungworth
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