Crucibles and moulds

Crucibles and moulds are fairly easy to recognise and their identification should alert the fieldworker to the presence of metalworking on site. This provides an early opportunity to link the finds to associated materials (like scrap and waste metal, furnace lining and slags) and structural features, such as hearths.

Some of the vessels that may be identified as crucibles in the course of excavations were actually used for processes other than metal melting. Glass working is one of these processes (the vitreous deposits are relatively homogeneous and are mainly inside the crucible). Precious metals were refined using vessels that can be confused with crucibles; these processes and the finds associated with them are described in Datasheet 2.

Metal melting crucibles Crucibles are ceramic containers used to hold metals being melted. Their fabrics must be refractory (able to withstand high temperatures) and are almost invariably reduced fired (grey or black) as metals have to be melted under reducing conditions to stop them being oxidised and lost into the crucible slag. Because of the high temperatures at which they are used, crucibles become vitrified, like hearth lining. This vitrification can be just a thin surface gloss or glaze but in more extreme cases the whole of the thickness of the fabric can be affected, losing its normal structure and, at times, developing a vesicular, spongy texture. Some crucibles have an added outer layer of less refractory clay which is usually heavily vitrified.

Small quantities of the metal being melted may have become chemically bound in the vitrified surface of the crucible, or physically trapped there as droplets. Chemical analysis of the slag layer or the metal droplets can indicate, with more or less certainty, the composition of the metal being melted. In some cases analysis may be the only way of identifying processes like the manufacture of brass by cementation. Visual examination, with the naked eye or under low magni~cation (xl0-x30), can often give some idea of the metal being melted. Copper and its alloys can be seen as green corrosion products, like on metal objects, or as bright red patches where they are chemically bound in the vitrified surface of the crucible. Silver is visible as dark brownish-black blobs up to a few mm across which are quite soft and sometimes have pale purplish powdery corrosion deposits around them. Gold is unaltered, though it is usually only present as tiny droplets, well under 1mm in diameter. Crucibles used to melt silver and gold often have copper-red areas on them as the precious metals usually contained enough copper to produce this colour. Lead and tin have low melting points and so were not usually melted in crucibles; any domestic pot would do instead.

Crucibles come in a great varicty of sizes and shapes, though at any one period a more limited range was in use. From the Roman period onwards, some crucibles arc wheel-thrown but hand-made crucibles continue and are still found in medieval times. Their volume runs from thimble-sized to more than pint beer-mug size. The larger sizes sometimes date to the Roman period but most are later medieval or post-medieval. Some forms are relatively well-dated but simple hand-made thumb pots are virtually undatable. Most crucibles were open-topped though a few types had lids or the rims were pinched together to produce an enclosed form. A few crucibles had knob-like handles on the side or lid.

On sites where large numbers of crucibles have been found there is some suggestion that individual types were preferred for particular metals. However, there is also evidence that whatever was available was used. In general, precious metals, particularly gold, were melted in small quantities :rod so are usually found in smaller crucibles.

Moulds
Molten metal was cast, either direct into objects, or into small ingots. These could be hammered to produce rods, wire or sheet which were in turn made into objects. Ingot moulds are usually made of stone though some are brick or tile with shapes cut into them. The commonest shape in ingot moulds is a bar about one cm across, though discs and other shapes are also found. Surface finish was not important as the metal ingot was to be worked. The mould surface in and around the cut-out shapes is often blackened and traces of metal may survive.

Moulds for small objects were usually made of either fired clay or (less-commonly) fine-grained stone. For casting lead or its alloys, wood or antler moulds could also be used. Clay moulds are not very common finds, partly because they are friable and so do not survive well unless they were buried soon after being discarded.

Diagnostic features of moulds are the funnel-shaped in-gates or sprue cups, runners (channels the molten metal ran through) and the matrix for the object being cast. They are usually reduced fired (grey or black) in and near the runners and matrix but the rest of the mould is often oxidised fired (red or brown).

Two main types of clay moulds, investment moulds and piece moulds, are found.

Investment moulds were made by modelling the object to be cast in wax and coating it thickly in clay. The mould was then fired, the wax melted or burnt out, and the molten metal poured in. This type of lost wax *(cire perdue)* mould was in general use in the Iron Age but was normally used at later periods only for larger, complex castings. The moulds had to be broken to remove the casting so fragments are usually small and have broken edges all round. The only original inner surface is that of the matrix.

Unlike investment moulds, the valves of piece moulds could be taken apart, but this was only so the pattern from which they were made could be recovered; they are not likely to have been used more than once. Stone moulds were far more durable and would have been used many times over. Clay piece moulds can be identified by their original edges, the mating surfaces around the matrix (often with locating marks) and traces of luting clay on the outside, all of which are absent from investment moulds.

Large objects such as cauldrons and bells were also cast in moulds, sometimes with a tallow model which had to be melted out, and sometimes without. The process of making these moulds is well known from medieval documents such as Theophilus' *De diversis artibus.* They are normally found in small fragments as the mould was broken to remove the casting and the organic tempered fabric that was usually used tends to be soft. Typical fragments of the cope (outer part of the mould) are about 2-3 cm thick while the core (inner part) can be thicker. A zone up to about one cm from the modelled face is usually black or grey while the rest of the mould is oxidised fired. Sometimes the inner surface is coated with a fine white slip.

Handling and storage
Most crucibles are fairly robust and do not need any special storage conditions. Even vigorous washing is unlikely to do much damage as the metal droplets are usually firmly held by the slag layers.

However, if large quantities of metal are trapped in them it is best to store them as though they were metal objects.

Moulds are generally not well-fired and so are fragile and friable. A vigorous wash will certainly remove almost all traces of metals -- which may not have been visible to the eye -- and can even destroy the moulds.

Further reading
The following publications all contain illustrations of a range of crucibles and moulds of different dates, as do many excavation reports.

Bayley, J (1988) Non-ferrous metalworking: continuity and change. In E A Slater and J O Tate (eds) *Science and Archaeology, Glasgow, 1987,* 193-208. BAR Brit Ser 196.

Bayley, J (1990) *Evidence for metalworking.* Datasheet 12. Finds Research Group 700-1700 AD.

Bayley, J (1992) Metalworking ceramics. *Medieval Ceramics* 16, 3-10.

Tylecote, R F (1986) The *prehistory of metallurgy in the British Isles.*

Youngs, S (ed) (1989) *'The workof angels' Masterpieces of Celtic metalwork, 6th-9th centuries AD.*

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