

# Korta meddelanden

## *A Viking Period silver workshop in Fröjel, Gotland*

Since 1987 the Fröjel Discovery Programme has undertaken excavations of burials and settlements in Fröjel parish, Gotland (Carlsson 1999). These excavations have produced a wealth of finds of which only a few but important fragments will be presented here.

In 2000 a site was excavated in Irmas hage (*hage*=enclosed pasture), an area that has escaped ploughing and other more intensive agricultural uses (Dahlström & Eriksson 2002). Early on, the context proved to be that of a building on a stone foundation built over the remains of earlier structures indicated by postholes. In the building a central stone-lined hearth was found. Two furnace pits were found, one in the western and one in the eastern trench of the excavations. The site was tidy in terms of broken artefacts and other finds but in the fill inside and around the furnaces a number of clay moulds, crucibles and hearth lining fragments were found. These, along with antler debris and pieces of combs, identified the building as a workshop.

The excavation mainly touched upon the building site and not much of the surroundings. The finds connected to metalworking were few, as could be expected since production waste such as broken moulds and crucibles were usually disposed of outside Iron Age and Early Medieval workshops. Despite this, the collected finds carry a lot of information.

The western furnace pit was radiocarbon dated to 970–1160 cal AD (1 sigma; Ua-18941; 1000 ± 75 BP; the intrinsic age of the sample is unknown). The pit was filled with mould fragments and pieces of heavy hearth lining. The latter were identified by means of EDX analyses (energy dispersive x-ray spectrometry, performed at the Archaeological Research Laboratory, Stockholm) as remains of the lining of a cupellation hearth, due to high contents of calcium, phosphorus and lead (Wojnar-Johansson 2005a).

Cupellation is a selective oxidation process

for refining silver. By mixing copper-alloyed silver with lead, one can oxidize the lead and copper in the molten alloy by means of an intense addition of oxygen, and thereby separate it from the silver which will remain unaffected.

Similar process residues have been described from England and the Continent (cf. Bayley & Eckstein 1997; Rehren & Kraus 1999), but few have so far been identified in Sweden. Reported Swedish finds are from a Vendel Period site in Dagstorp, Scania (Kresten et al. 2000) and a 13th century context at Kv. Trädgårdsmästaren, Sigtuna (Kresten & Larsson 1996). Further similar finds, dating from the 12th century, were identified among the finds from Trädgårdsmästaren in 2005 and were analyzed together with the Fröjel finds (Wojnar-Johansson 2005a).

When recycling silver of different origins with unknown additions of copper and other metallic impurities, an artisan needs a reliable method for refining it before use. By this simple yet sophisticated chemical method one can refine silver to a very high degree of purity. At the time of the Fröjel workshop it had already been the standard method of silver refining for thousands of years, associated with mining, jewellery work and minting. Certainly this must have been an important workshop process in Gotland as well, with its tremendous inflow of silver during the Viking Period.

Bone ash was used for hearth lining because of its absorbent properties. The lead and copper form a molten oxide – litharge – which is absorbed into the porous lining material. When the process is complete, only pure metallic silver is left in the hearth. The impurities will remain in the lining, which is why this type of hearth material is usually surprisingly heavy. Finds from Sigtuna show densities of 4.38–4.40 g/cm<sup>3</sup> (Kresten & Larsson 1996). When found, the pieces are usually grey or partly greenish aggregations of ground-up bone ash and a little clay,



Fig. 1. Modern clay imprint and fragment of a mould for a Gotlandic armring, with a sketch of the ring; Stenberger's type *Ab 3*. Photograph and drawing by Anders Söderberg.

held together by litharge. Sometimes small pieces of bone are visible in the matrix.

Another find group of great interest from Fröjel is the fragmented clay moulds. Several display imprints of the objects cast in them. By means of wet clay we managed to make positive imprints of their patterns without harming the moulds. These positives could then in turn be compared with extant Gotlandic artefacts. Several of the positives are similar to various Gotlandic types of massive silver armlets of which Stenberger's type *Ab 3*, shown in fig. 1, dates from the mid-10th to the end of the 11th century (Stenberger 1958, p. 110). Other pieces may represent penannular brooches. Hence it is clear that the craftsmen in the workshop produced silver jewellery of a very high standard. This is a rather striking discovery. While silver armlets have been found in great numbers in hoards, no moulds from their manufacture have been identified before.

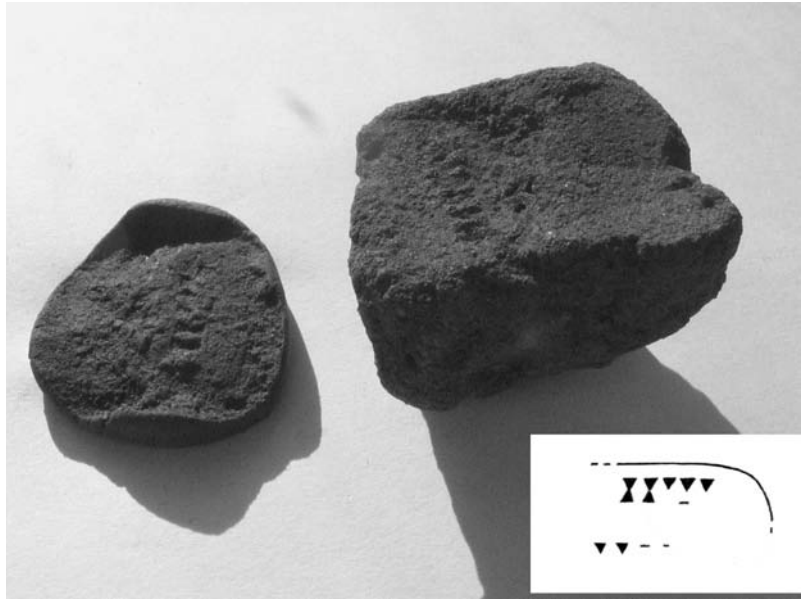
In all, these circumstances indicate that an entire production process took place in the workshop – from the refining of scrap silver to finished silver jewellery. This was also confirmed by analyses of two mould fragments from the cupellation pit and a contemporaneous crucible found

in connection with the eastern furnace pit. According to trace elements in the silver, like platinum and arsenic, raw metal of similar compositions have been treated at all the different stages of the production process (Wojnar-Johansson 2005b). Traces of gold and mercury suggest possible re-cycling of mercury-gilded silver jewellery in the workshop. Noble metals like gold and platinum cannot be removed from silver by means of cupellation.

The processing of silver raw material at a high technological level and the casting of silver arm rings can be seen in the light of earlier discussions of Viking Period silver arm and neck rings, made and used as primitive currency (cf. Hårdh 1996). The craftsmen's knowledge of cupellation allowed them not only to purify debased silver but also to produce alloys with controlled silver concentrations. In this sense the Fröjel workshop may, perhaps a bit drastically, be considered an "archaic mint" producing unminted currency for the pre-monetary economy.

An interesting methodological spin-off of this examination is that it shows that mould fragments carry enough metal traces to be detected by analyses, despite the very brief expo-

Fig. 2. Modern clay imprint and mould fragment showing parallel rows of juxtaposed triangles. The ornaments were pressed into the wax model before the mould was made, not punched into the piece after casting. Photograph and drawing by Anders Söderberg.



sure to molten metal that occurs during pouring before the metal sets. More on this, together with discussions of the analyses of the hearth material, will be published in forthcoming papers.

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