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The tidy metalworkers of Fröjel

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In the summer of 2000 an intriguing find was made during excavations by the Fröjel Discovery Programme, Gotland, Sweden. In a pasture known as "Irma's hage", which had never been ploughed, traces of a metal workshop were uncovered.

The settlement and cemeteries of Fröjel are well known thanks to several previous articles in Viking Heritage Magazine. Over the years, more and more information about the site has been collected through excavations.

The surveyed and excavated area is mainly situated within tilled farmland and thus the context is disturbed above a certain depth. However there are more or less undisturbed areas at Fröjel. One such area, "Irma's hage" or officially Bottarve 1:19, was excavated in the late summer of 2000. Several possible traces of houses were visible even with the turf still intact. One of the better defined of these would-be houses was selected and a trench was laid out.

The workshop site

The trench was, in turn, divided in two equally large sub-trenches separated by a 10 cm wide baulk. Early on in the excavation a three-sided stone foundation was noted – its larger stones clearly visible above the turf.

Three layers could be identified in the trench and debris from several crafts, such as glass beads and antler and metal shavings, was found. In addition to this, two well-defined furnaces were found, one in each sub-trench (fig. 1). The furnaces had been filled in and in the fill material several pieces of moulds and hearth lining as well as 11 crucible fragments and two intact crucibles were found along with slag, undefined burnt clay and charcoal.

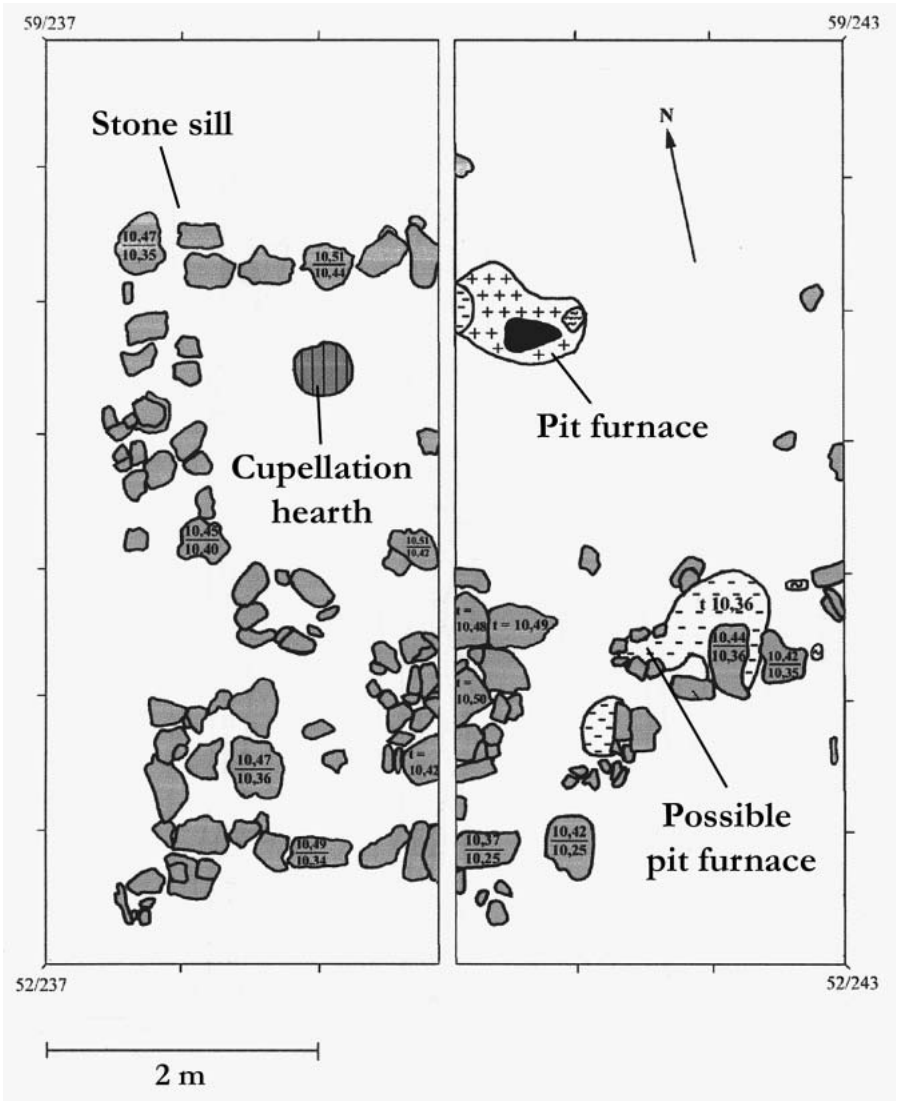

Fig. 1. The workshop site. The stone foundation shows a rectangular building, about 4 x 5.5 meters in size, possibly representing a long-term continuity at the site – after working in simpler buildings the craftsmen may have been occupied a permanent house in the later phase. The cupellation hearth belongs to the earlier phase (roughly the 11th century) and the large pit furnace possibly to the later, according to radiocarbon dating. After Dahlström & Eriksson 2002.

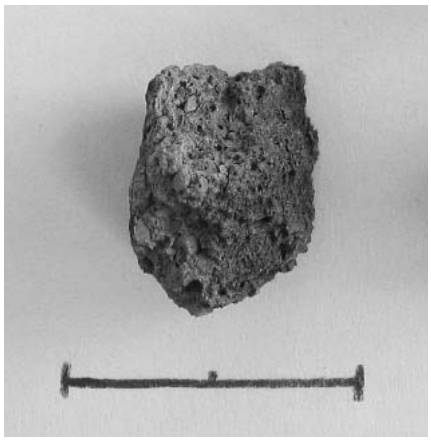

Fig. 2. A piece of bone-ash hearth lining, scale bar 20 mm. It doesn't look very significant, but it makes a huge difference to the workshop. Photo Anders Söderberg.

Two samples of charcoal were later radiocarbon-dated and yielded a rough dating for the workshop. The sample from the furnace in trench 5:1 could be dated to AD 970–1160 (68.2 % accuracy) and the one from the furnace in trench 5:2 to AD 1110–1230.

Examination of metallurgical ceramics

The moulds, crucibles, hearth lining and slag from the Fröjel workshop were examined during the spring of 2005 as a part of the project "Metallurgical ceramics 800–1200". The study also included material from Sigtuna (Kv. Trädgårdsmästaren, excavated 1988–1990) and Skänninge (Skänninge Kriminalvårdsanstalt, excavated in 2003).

The basic aim was to try to establish whether specific crafts could be connected

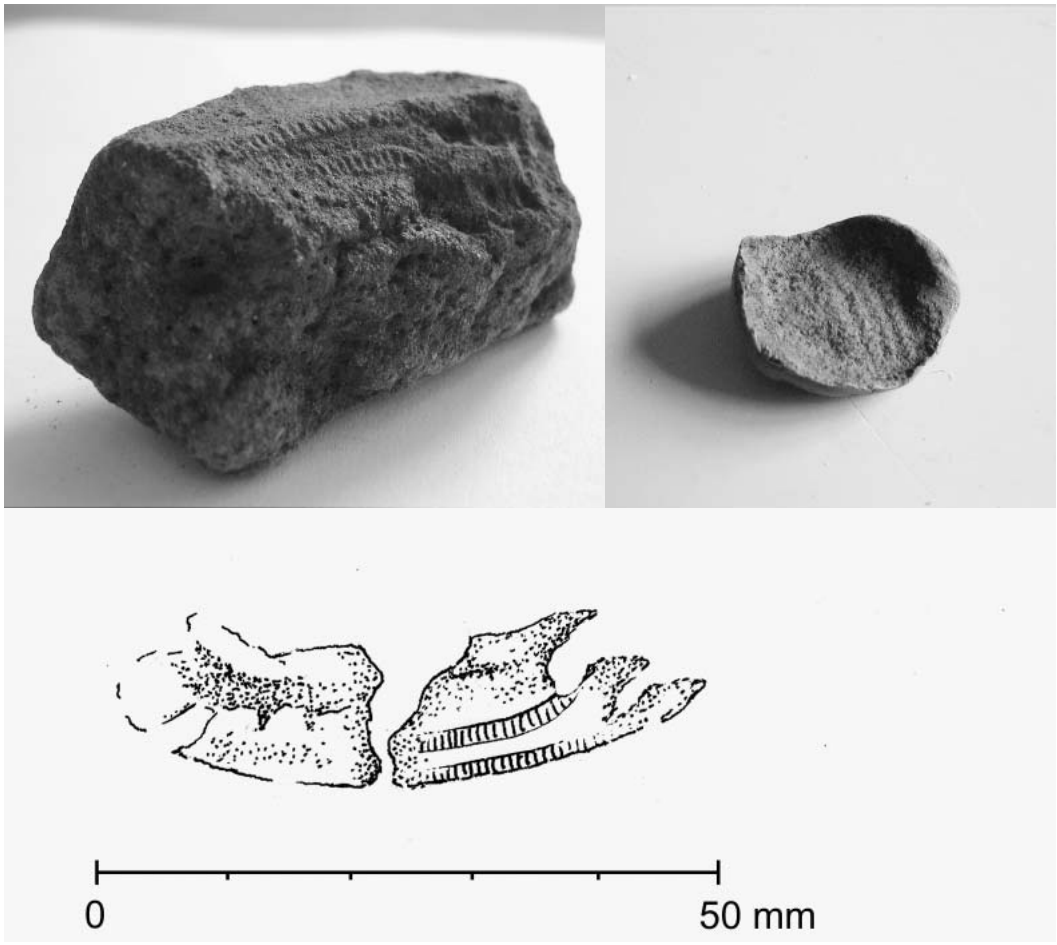

Fig. 4. Mould fragments found in the cupellation pit. Generally, the patterns in the mould fragments from Fröjel are poorly preserved. Left: *one of two fragments from the same mould, below a sketch of the pattern. The nature of the object is still uncertain.* Right: *an imprint of a small fragment, the sketch below showing its zigzag pattern; a common pattern in the centre part of Gotlandic arm rings. Photo Anders Söderberg.*

to specific levels in the hierarchies of the contemporary society. This can be dealt with in several ways. We chose to study metallurgical ceramics – a find category that we today know is more diverse than it was earlier thought to be.

Crucibles and clay moulds are well known and accounted for, but there are several other types that have been identified during the last decade. Within the project we have surveyed two of these lesser known find types: *heating trays and brazing packages,* the later divided into the sub groups *box-shaped brazing packages* (mainly deriving from padlock brazing) and melting bowls deriving from manufacture of weights.

These types of ceramics represent separate techniques but they also have several features in common. One such similarity is the high degree of heat exposure – the surfaces of the fragments found in archaeological contexts are generally quite glazed or vitrified. This, in turn, means that the often small and fragmented shards of metallurgical ceramic could be – and are – mistaken for slag. This is rather unfortunate since slag seldom attracts any greater interest from researchers. It is generally just weighed and dealt with quantitatively, whereas metallurgical ceramics, when dealt with qualitatively, can yield much information.

Instead of generally stating that "forging occurred" on a site, several metallurgical techniques such as brazing, plating, parting and case hardening or box carburisation can be identified, hence broadening the understanding of what really took place on the site in question.

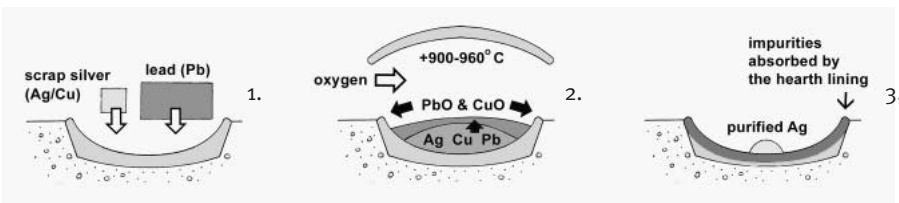

Fig. 3. Refining silver by cupellation: 1) The re-cycled silver is alloyed with an excess of lead, in a hearth lined with bone-ash material. According to the size of the Fröjel pit and to similar finds from 12th century Sigtuna, the hearth would have been 15 – 25 cm wide. 2) Oxygen is blown over the melted alloy. Lead and copper are oxidized and absorbed by the hearth lining. Probably a heat preserving dome or muffle was used over the hearth, but we don't know how this could have been constructed. 3) The silver is now pure, all the lead oxide and copper oxide remain in the hearth lining. Picture by Anders Söderberg

Cupellation hearth lining

The Fröjel workshop showed none of the find types mentioned above, except for a vague fragment of a brazing package. But another, and from a specifically Gotlandic perspective, interesting type of metallurgical ceramics was present: a multitude of very heavy greyish fragments of hearth lining (fig. 2). When examined more closely it could be established that they probably contained copper oxide, and their weight alone indicated that they contained quite substantial amounts of lead.

The fragments' origin was beyond a doubt – they had formed the lining of a cupellation furnace. The colour of the

fragments was a result of a high content of bone ash, i.e. burned and crushed bones mixed with a minimum of clay as binding material.

Such hearths are known from several other sites abroad, for instance in England, but they are just beginning to be recognised in the Swedish archaeological find material. They are used to refine silver from the contamination of various other metals such as copper. Such hearths would have been a must on Gotland with its enormous inflow of Islamic and later English and continental silver.

A sample of the heavy hearth lining was taken to the Archaeological Research Laboratory of the Stockholm University for a closer analysis. It showed high quantities of phosphorus, calcium and lead and the presence of copper and silver in rather typical proportions. The fragments of hearth lining certainly do derive from a cupellation hearth.

The cupellation process

Cupellation (fig. 3), which is a several thousand year-old process originating in silver mining, takes advantage of the fact that lead and copper oxidise under circumstances when silver remains stable in a metallic state. By mixing copper-alloyed silver with lead, you can oxidise the lead and copper in the molten alloy by means of an intense addition of oxygen from the bellows, and thereby separate it from the silver which will stay unaffected. By this rather simple yet sophisticated chemical method you can refine silver to a purity of 99 %.

Silver used in coins and jewellery is always alloyed with certain percentages of copper in order to make it harder, like *sterling silver* that contains 7.5 % copper. When re-cycling silver of different origins and with unknown additions of copper and other metallic impurities, you need a reliable method for refining it before you re-alloy it into a determined standard percentage.

The use of bone ash for hearth lining is explained by its excellent absorbing properties. The oxidised lead and copper will form a molten oxide, which will then be absorbed into the porous lining material. When the process is finished, only pure metallic silver will be left in the hearth. The impurities will stay absorbed in the lining, which is why this type of hearth material is surprisingly heavy.

Casting moulds

The fragmentary clay moulds from the site were not part of the study. Nevertheless a basic examination of some of the better-preserved shards yielded interesting information about the actual production in the workshop. Especially since lots of them were found in the fillmaterial from the cupellation hearth pit, we considered them highly informative (fig. 4 and 5).

Fig. 5. A few other mould fragments from the Fröjel workshop, which fit well together. The pieces represent the inside of an object. We are still not quite sure what this object may have been – any ideas? Photo Anders Söderberg.

By means of wet clay we were able to get positive copies of the negative impressions of the moulds. Some of these clay positives showed a rather striking resemblance to Gotlandic bronze and silver arm rings. To some extent this was to be expected since the arm rings in question were very common during the late Gotlandic Viking Age. Additionally a concentrated find of small silver shavings were found in what was once the south-west corner of the building, indicating that silver items really were worked there.

It is tempting to assume that the shavings came from the process of retouching various pieces of jewellery – the last and crucial stage during which the jewellery was finished for circulation. Hence we might see the full chain of production in one small location at Bottarve 1:19 – old silver was refined in a cupellation hearth, the refined silver was melted and cast in the shape of native jewellery which was, in turn, prepared for circulation just a couple of feet away from the furnaces.

This is of course a quite obvious line of production, but finding evidence for all the stages preserved in one workshop is highly unusual.

In order to confirm that the moulds in question were really used for casting silver objects, the mould- and crucible fragments will be analysed at the Archaeological Research Laboratory later this winter.

A tidy workshop

The title of this paper is "The tidy metalworkers of Fröjel", as the finds from the very building were very sparse. This is not uncommon. The 1990–95 excavation of the 8th–9th century metal workshops in the Black Earth of Birka revealed very clean interiors and the workshop waste, like fragments of moulds and crucibles were found in rubbish heaps outside, in the passages between the town yards. The metalworkers were careful about keeping their working areas clean.

As the Fröjel excavation mainly examined the actual house site, it didn't reveal the waste depositions that are probably still buried a few meters away. Despite this the collected traces of activity reveal lots of information about the workshop.

The possible handling of large quantities of silver at a very advanced technical level, combined with the fact that the workshop was situated in the periphery or even outside of the Fröjel market area is interesting. So are the traces of a permanent workshop building at a later phase.

Who managed such a workshop? The combination of large quantities of precious metals and high technological know-how indicates a connection to the highest and administrative levels of society. The possible production of arm rings with a likewise possibly standardised high silver content at Fröjel, leads our thoughts towards a managed production of highly valued objects which could even be considered as primitive currency.

According to the finds, the workshop also produced glass beads and antler combs, as was the case with a contemporary royal workshop on the mainland: the mint of King Olof Eriksson Skötkonung in Sigtuna. Viking workshops weren't strictly specialised yet, not even the workshops of kings and obviously not even a workshop with the dignity of a mint.

Tube-shaped clay packages

We also made a brief examination of the finds from Bottarve 1:17, representing the activities in the centre of the Fröjel harbour and market area. Obviously many handicraft activities had also been taking place there; making these finds good references to the materials from the workshop in Irma's Hage.

A very special sort of ceramic packaging material for metallurgical processes found here is a large fragment of a *tube-shaped clay package* (fig. 6). This is a common but not yet satisfactorily interpreted type of package found at several sites throughout Western and Northern Europe dating from the Migration Period and into the later Middle Ages.

They often seem to be connected with forging, and according to imprints of bindings inside the tubes, they could possible originate from the clay cases used in box carburisation of steel for tools and weapons.

In early 12th century the priest Theophilus describes the process in his book "On Divers Arts": *"…smear them with old pig fat and wrap them around with leather strips cut from goat skin and bind them with linen thread. After this cover them individually with kneaded clay, leaving the tangs bare. When they are dried, put them into the fire, blow vigorously, and the goatskin will be burnt. Hastily extract them from the clay and quench them evenly in water. Then take them out and dry them at the fire".*

Still more information to interpret

Obviously, there is a lot of information still to be retrieved from the materials collected in the Fröjel Discovery Programme. Our project is an example of the work that takes place after the actual excavation, which is mainly a phase of collecting objects and registering information.

The main part of the work takes place afterwards, in the examination and interpretations that can put life and colours into, for instance, some dull rows of stones enclosing a tidy area containing two pits and a few rather obscure pieces of ceramics and slag. This is in fact the most thrilling part of archaeological work – and the most time-consuming.

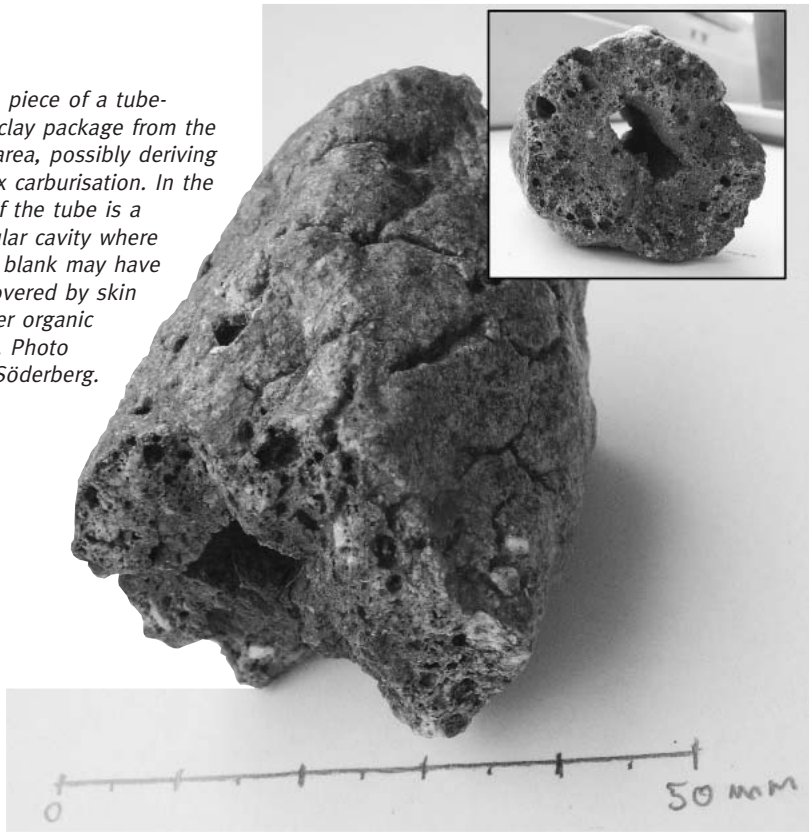

Fig. 6. A piece of a tube-shaped clay package from the market area, possibly deriving from box carburisation. In the centre of the tube is a rectangular cavity where the iron blank may have been, covered by skin and other organic material. Photo Anders Söderberg.

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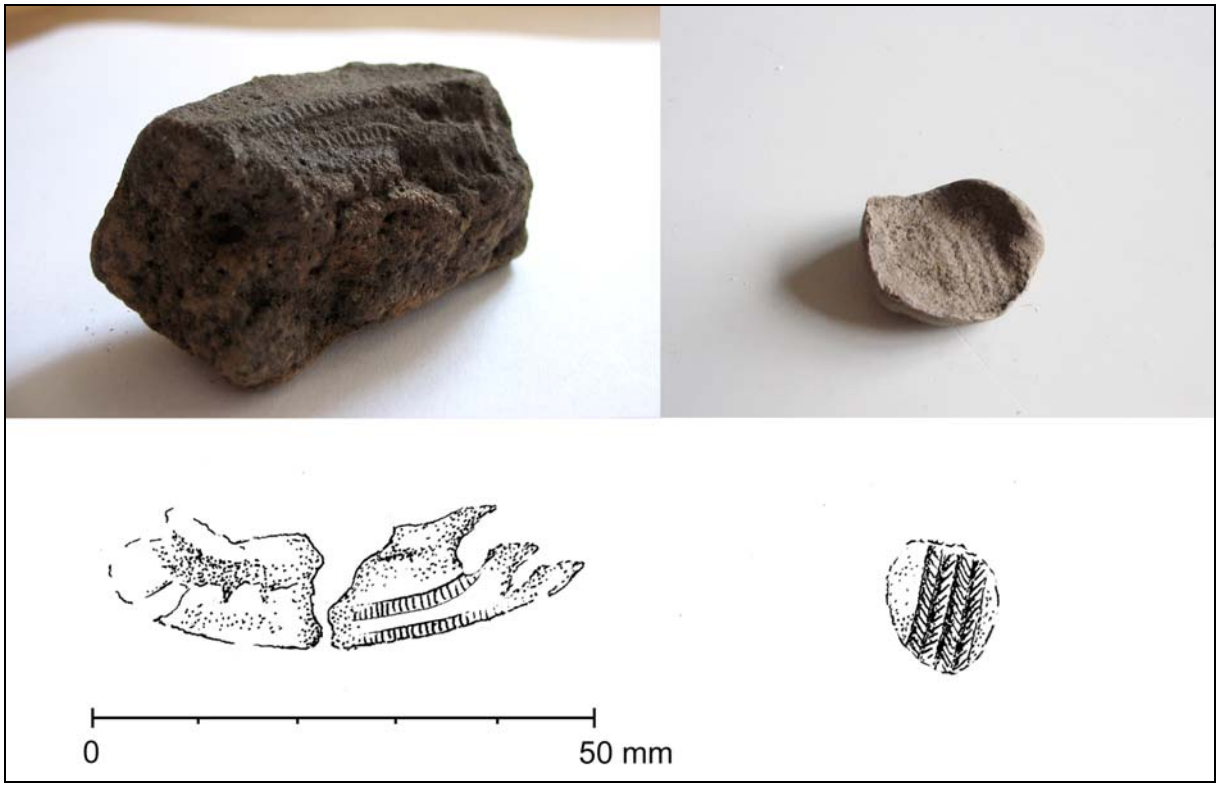
Errata

Picture no 4 has by accident been cut in an unfortunate way. An important part of the picture has disappeared, which makes the figure caption hard to understand. The original and proper picture looks like this:



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