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A short notice on the manufacture of copper-wire at Birka

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As part of a study on the construction of B-type case-combs found at Birka, X-ray microanalyses were made to determine the material of the rivets connecting the bone plates of the combs and their cases. It has mostly been assumed that the material of the rivets was bronze. Data from the analyses has shown, however, that the rivets were almost exclusively made out of non-alloyed copper. Surface-structure analysis verifies that the wire was in fact drawn. These results fit better with the probable fact that wire-drawing was a well known technique during this period, and suggest that refinement of copper was a standard procedure at Birka during the 10th century.

Introduction

Scholars have assumed that the combs of Birka either had rivets of iron or of bronze (e.g. Ambrosiani 1981). Considering the existent typology, it has been shown that the A-combs of the early Birka-period (c. AD 750–900) were fitted almost exclusively with iron rivets, and that the majority of the B-combs, that dominate during the late Birka-period (c. AD 900–975), had non-iron rivets (Ambrosiani 1981:72, 74–82).

As the stylistic character of the B-combs suggests that the production was local, it would be of certain interest to study the construction of the B-combs, as this could shed some light on the crafts production at Birka during the 10th century. Further reasons for analysing the material of the rivets would be that it has been hypothetically suggested that the "bronze rivets" might be of copper or brass (Tempel 1969:69), and that proper data on the material of wire is scarce. So far analyses of wire from the late Viking Age has been made of inlayings or incrustations on objects from Birka (Nordahl 1963:60), and of objects from York (Bayley 1992). In the case of Birka, it is not known whether the wire was hammered or drawn. In York, however, both types occur, and the wire is of brass or copper.

Wire-drawing

During the Viking Age it is known that different sorts of metal wire were manufactured by means of manual drawing using draw-plates (cf. Tylecote 1987:269). This method only allowed the drawing of metals that easily deform, like gold, silver, tin or copper. In Scandinavia draw-plates, that would be the principal tool for deforming non-iron metals into wire, have been found at Birka (fig. 1; Arrhenius 1968), Hedeby (Naumann 1971), Sigtuna (Floderus 1928), Mästermyr (Arwidsson 1983) and at several places in Norway (cf. Müller-Wille 1977).

The draw-plates were in general made of iron or steel, but when it came to deforming metals of high ductility, it is possible that the craftsmen used plates of bone. The exact practices for drawing different metals remain unclear however (cf. fig. 2).

Basically, the drawing of wire was made in two different ways: by the drawing of either a twisted metal strip, or a folded strip (fig. 3). Hypothetically it is also possible that a hammered and annealed rod was used, a technique later noted by Weigel (Weigel 1698; cf. Theobald 1933:275).

It is uncertain how the technique for drawing evolved, and under what circumstances it was introduced in Scandinavia.

W. Epprecht and A. Mutz (1975) have published the results of an analysis of wire that simply is presented as Roman. The study is narrowly technical, and does not discuss the results with respect to their context. The authors suggest that drawn wire occurs abundantly in Roman archaeological material (Epprecht & Mutz 1975:158). Using surface structure analysis they verified that at least one of the seven samples analysed was drawn. Metal microstructure analysis lead to the conclusion that four other samples also had been drawn. In the first case, the material of the wire

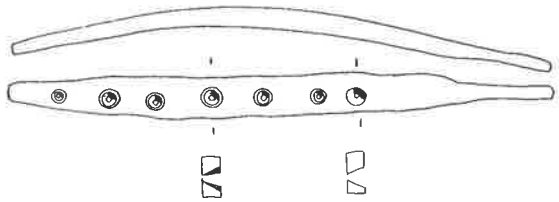

Figure 1. Draw-plate from Birka. Scale 3:4. After Arrhenius 1968.

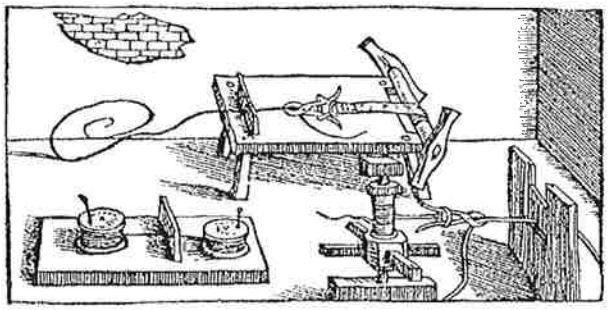

Figure 2. Three different methods for drawing wire, as illustrated in Biringuccios Pirotechnia from 1540. After Theobald 1933: fig. 58.

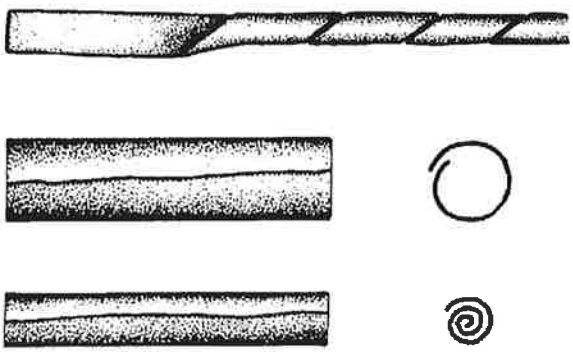

Figure 3. The two basic principles for producing strip-twisted wire (above) and strip-drawn wire (below). The figure show the wire before it is drawn. After Andersson 1995: figs. 93 & 90.

was bronze, in the other four it was brass. (Epprecht & Mutz 1975:159–161).

Material

As part of a study on the construction of B-type case-combs found at Birka (Stjerna 1997), X-ray micro-analyses were made to determine the material of the rivets connecting the bone plates of the combs and their cases. Therefore the sample is limited to wire-metal from graves that have been noted to contain case-combs (cf. Ambrosiani 1981) and wire-metal from excavations of the Garrison made in 1877 (Inv. no. Bj 596) and 1934 (Inv. no. 21064). Theoretically, it would have been possible to obtain a greater sample of wire-metal, this would, however, not have been in line with the purpose of the case-comb study.

The dimension of the wire samples vary between 1 and 2 mm in diameter.

Analytical method

Prior to analyses, the samples were prepared with 2% EDTA (pH 6.5; 8°C) as well as deionized water to remove corrosion. Remaining EDTA was removed with ultrasonics. The samples were then dried for 24 hrs. at 50°C.

The analyses were made using an ISI Super III-A scanning electron microscope, and an analogue PGT energy dispersive spectrometer with beryllium window detector end-cap. The accelerator voltage was 18 kV. Each sample was tilted 30° and the working distance was set to 23 mm, which together with the geometry of the chamber gave the emitted rays an effective take-off angle of 33.8° (cf. Friel 1995:36). As the analyses were made at ×300 magnification, the scanned surface measured 0.03 mm². The samples were each scanned three times at different points (= 3×200 sec. live time; c. 2500 cps.). A determination of the percentage of detected elements was then made by means of standardless quantification using the PGT integrated micro-analyser for image and X-ray (IMIX).

Results

X-ray micro-analysis shows that the rivet-material in almost all cases is non-alloyed copper (table 1).

The original surface structure has been destroyed by corrosion on most of the samples. On some samples it is, however, possible to verify directly that the wire was drawn, either by marks that the draw-plate has made on the wire (fig. 4), or by the visible seam of the drawn strip (fig. 5).

Lab #27 (table 1) is the only sample that cannot be defined as copper. The material is lead-tin-bronze with inhomogeneities that resulted in a great variance in the analytical results. It is interesting to note that this specific rivet comes from a comb with a trapeze-shaped section which is a form that mainly has its parallels south of the Baltic (Arbman 1940: pl. 165.12; cf. Jankuhn 1943:158 & Tempel 1969:100).

Conclusion

The analyses show that the wire used in making rivets was of an even quality. A possible interpretation of this is that the wire was manufactured at Birka, following a

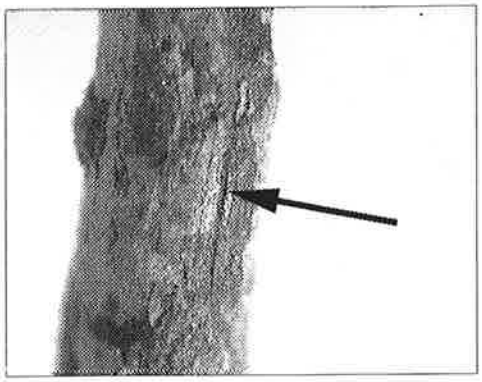

Figure 4. Lab #4. SHM Inv. 21064:300. Structure interpreted as draw marks on wire. Photo by the author.

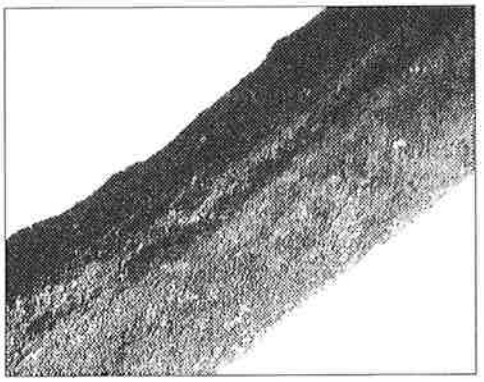

Figure 5. Lab #27. Grave Bj 1040. Structure interpreted as seam of strip, still visible on wire. Photo by the author.

Table 1. Results of the X-ray microanalysis. The tabulated values for the different metals denote WT% and variance.

Lab #	SHM Inv #	Structure	Cu	Sn	Pb	Zn	Fe	Ni	Ag
1	21064:227	n.v.	99 (0.0)	–	trace	–	–	–	trace
2	21064:227	Draw-marks	99 (0.6)	trace	–	–	trace	–	trace
3	21064:300	Draw-marks	98 (0.6)	trace	trace	–	trace	–	–
4	21064:300	Draw-marks	97 (0.1)	–	trace	–	trace	–	–
5	21064:300	Draw-marks?	99 (0.0)	trace	–	–	trace	–	trace
6	21064:300	n.v.	98 (1.3)	–	trace	–	trace	–	–
7	21064:300	n.v.	98 (0.1)	trace	trace	–	trace	–	–
8	21064:300	n.v.	99 (0.0)	–	trace	–	–	–	–
9	21064:300	n.v.	99 (1.0)	trace	trace	–	trace	–	–
10	21064:134	Draw-marks	99 (0.4)	–	trace	–	trace	–	–
11	21064:226	Draw-marks	99 (0.5)	–	trace	–	–	–	–
12	21064:300	Draw-marks	99 (0.0)	–	trace	–	–	–	–
13	21064:300	n.v.	99 (0.0)	trace	–	–	trace	–	0
14	21064:300	n.v.	98 (0.2)	–	trace	–	trace	–	0
15	21064:320	n.v.	87 (2.0)	–	–	–	trace	–	–
16	Bj 596	n.v.	95 (2.6)	–	trace	–	trace	–	–
17	Bj 596	n.v.	99 (1.0)	–	trace	–	trace	–	–
18	Bj 115	n.v.	99 (0.1)	trace	trace	–	–	–	–
19	Bj 359	n.v.	91 (6.6)	–	trace	–	trace	–	–
20	Bj 359	n.v.	98 (0.0)	–	–	–	trace	–	–
21	Bj 359	n.v.	98 (1.4)	trace	–	–	trace	–	–
22	Bj 376B	n.v.	97 (2.3)	trace	trace	–	trace	–	trace
23	Bj 376B	n.v.	93 (9.7)	trace	2 (1.3)	–	2 (0.9)	–	–
24	Bj 793	Draw-marks?	91 (2.8)	trace	–	3 (0.4)	1 (0.0)	1 (0.1)	–
25	Bj 900	n.v.	98 (0.5)	trace	trace	–	trace	–	trace
26	Bj 1040	n.v.	95 (0.3)	–	trace	–	trace	–	–
27	Bj 1040	Draw-marks	74 (57.6)	10 (2.6)	10 (39.2)	–	–	–	–
28	Bj 1052	n.v.	97 (0.7)	–	–	–	trace	–	–

– = Not sought; 0 = Not detected; n.v. = Not visible; trace = <1 WT%.

well established process in which refinement of copper was a standard procedure. The fact that the material in almost all cases is non-alloyed copper suggests that the wire was drawn by specialized craftsmen rather than by the comb-makers themselves. Considering other analyses that have been made of similar material, the manufacture of non-alloyed copper-wire in general may not have been the normal praxis during the 10th century, and for this reason local differences should be expected.

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