Micro-PIXE Studies on Copper Provenance of Some Romanian Bronze Age Artifacts

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INTRODUCTION

The problem of provenance for prehistoric copper and bronze objects (found in Romania) consists in their classification from the copper provenance Bronze Age regional mines point of view – North-East Bulgaria [Ai Bunar – “fingerprint” minor-trace elements As, Ag, Ni and Sb (hundreds of ppm), Se (tens of ppm)], Serbia [Rudna Glava and Majdanpek – “fingerprint” trace elements As, Sb, Ni, Ag, (thousands-hundreds ppm), Co (tens of ppm)] or Transylvania (e.g. Baia-Mare – “fingerprint” trace elements Sb and Ag – thousands of ppm). A special case is the Copper-Antimony alloys (e.g. those from Velem – St. Vid - Hungary) – and the possibility of their transport as ingots or tools for re-melting to Transylvania must be analyzed.

EXPERIMENTAL

It is already well-known that trace-elements are more significant for provenance assignment of archaeological metallic artifacts than the main components, both for gold, silver, obsidian and copper-bronze items [1-4]. As a consequence, micro-PIXE technique, sensitive at a μg/g level and also featuring excellent lateral resolution, being capable of micro-inclusions detection is one of the best methods capable to provide answers to provenance issues when dealing with archaeological artefacts [5].

RESULTS

We performed the analysis of 40 small fragments (approx 100 microns diameter) of some Late Bronze Age (1500-1000 B.C.) copper and bronze items – sickles (figure 1), celts (figure 2), axes (figure 3), daggers (figure 4), sampling performed on previously corrosion-cleaned areas on the items surface.

For the extra-Carpathian regions of Romania – Moldavia and Walachia – the results indicate the use of Serbia-origin copper (Co distinctive fingerprint) mainly in Walachia and the use of North-Bulgaria-origin copper (Se distinctive fingerprint) both in Walachia and Moldavia. For Transylvanian artifacts, we found Serbia-origin copper (but the possibility of using Banat copper – close to actual Serbia – must be also considered), Transylvanian copper and, in two cases, a copper-antimony alloy very probably from West Hungary. A very interesting aspect is the possibility to put in evidence micro-inclusions of minor and trace elements: Pb and Hg as provenance fingerprints for native copper (figures 5 and 6), and Pb, Ni, As, Sb, Ag as relevant indicators of the imperfect metallurgy used many times during the Bronze Age.

Fig. 1. Late Bronze Age sickle from Drajna deposits (Walachia).

Fig. 2. Late Bronze Age celt, Arad County (Banat).

Fig. 3. Late Bronze Age axe, Bacau County (Moldavia).

Fig. 4. Late Bronze Age dagger, from Ocnita deposit (Oltenia).
CONCLUSIONS

The present results encourage the future extension of this study both chronologically to different cultural periods (Copper Age, Early Bronze Age and Middle Bronze Age), and also targeted-geographically to the most important archaeological sites.

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