

Investigating the metal sources of the Early Nordic Bronze Age through a multi-proxy approach

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The Early Nordic Bronze Age (NBA Period IB, 1600–1500 BC) is characterized by huge amounts of metal products reaching northern Germany and Scandinavia for the first time, demonstrated by the appearance of a refined repertoire of bronze products (Nørgaard et al, 2019). Examples for these products are the blades of swords and daggers of the Sögel and Wohlde district, which suddenly appear as highly sophisticated metal artefacts without local precursors. Both blade types have hilt-plates with four or five rivets, while Sögel blades have a rounded and Wohlde plates have a trapezoidal formed hilt-plate. One of the great desiderates of archaeologists is determining the origin of archaeological bronzes and their metal sources (copper and tin). To reconstruct the provenance of the source materials isotope and elemental compositions of metals have since become important tools. This work pursues a multi-isotope approach combining Pb, Cu and Sn isotopes with trace element composition (Berger et al. 2022) of about 300 blades of the Sögel and Wohlde type from the Early NBA to investigate the origin of the raw material sources and of the blades. Additionally, we search for evidence of source mixing and/or recycling to gain a better insight into the manufacturing practices and to validate the provenance analysis. For this, the blades are isotopically and chemically analysed and compared with ores and typologically related blades from other regions in Central and Southern Europe. This may help to reconstruct relationships between artefacts of different origins and to reveal cultural and trade networks. Moreover, a critical evaluation of the data will be undertaken against the background of potential metal/ore mixing and recycling.

First results of 49 blades from the Early NBA indicate the Alpine Mitterberg as a potential source region for the copper based on Pb and Cu isotope composition, and trace element patterns. The majority of the blades consists of low-impurity copper of chalcopyrite quality typical for the Mitterberg. However, some blades were likely produced from Slovakian copper ores and there could even be indications of mixing both copper sources. Regarding tin, the Erzgebirge would be a very likely supplier, but some regions of Cornwall are also possible because of matching Sn isotope values. Based on the isotopic data of a single blade (Pb, Cu, Sn), we are able to comprehend the manufacturing steps of the object and their meaning for the choice of source materials. In future research, more artefacts from the NBA and Central and Southern Europe, as well as copper ores of the Mitterberg and the Slovakian Ore Mountains will be studied to conduct statistical analysis and to check for mixing practices.

Berger D, Brüggemann G, Bunnefeld J-H, Pernicka E (2022): Identifying mixtures of metals by multi-isotope analysis: Disentangling the relationships of the Early Bronze Age swords of the Apa–Hajdúsámson type and associated objects. - *Archaeometry* 64, 44–74, <https://doi.org/10.1111/arcm.12714>

Nørgaard HW, Pernicka E, Vandkilde H (2019): On the trail of Scandinavia's early metallurgy: Provenance, transfer and mixing. *PLoS ONE* 14, 1–32, <https://doi.org/10.1371/journal.pone.0219574>