

LEAD ISOTOPE ANALYSIS OF THE BRONZE AGE METAL FROM THE STEPPE CIS- AND TRANS-URALS

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Lead isotope analysis (LIA) has been rapidly approved by archaeologists as a method for provenance studies of metal artefacts as well as glass, pottery, pigments, etc. [1, 2]. The major advantage of LIA application for provenance studies is that lead isotope ratios do not change during metallurgical processes, which means that the isotope pattern remains constant independent on the temperature of ore roasting or Red-Ox conditions of metal smelting. The pattern is therefore characteristic of a particular deposit and allows a secure assignment of the finished product to the initial raw material [1]. The modern instrumental methods of isotope analysis, in particular, mass-spectrometry, are characterized by high sensitivity and precision. Lead mass of 10^{-9} - 10^{-7} g is sufficient for a routine isotope measurement resulting in the sample mass of only tens of mg, which can be very important when working with unique and valuable archaeological artefacts.

Lead isotope measurements of a number of bronze and copper artefacts and ingots of the Bronze Age steppe Cis- and Trans-Urals of were carried out on a Neptune Plus multicollector ICP-mass spectrometer (Thermo Fisher Scientific, Germany) using Tl-normalization technique [3] after the chromatographic lead isolation. A conventional ion-exchange chromatography technique using Bio-Rad AG 1x8 resin (100–200 mesh) proposed by [4] was applied for lead isolation [5]. The calculated U(k=2) method expanded uncertainty was $U(^{208}\text{Pb}/^{204}\text{Pb})=0.3\%$, $U(^{207}\text{Pb}/^{204}\text{Pb})=0.1\%$ and $U(^{206}\text{Pb}/^{204}\text{Pb})=0.1\%$. All works were performed in clean-rooms (ISO 6, 7) of the Zavaritsky Institute of Geology and Geochemistry, UB RAS.

The obtained data for bronze and copper artefacts and ingots of the steppe Cis- and Trans-Urals of the Bronze Age indicate their fairly clear assignment to the ores of the Trans-Urals and Ural-Mugodzharsky or Cis-Urals ancient mining and metallurgical centers. For a number of samples studied, the interpretation is complicated. More correct comparisons will become possible only after the implementation of a large-scale program of isotopic analyzes of ore deposits and occurrences of all mining and metallurgical centers of the Bronze Age of the Southern Urals.

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