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# Mineral tissue $\delta^{66}$Zn and $\delta^{15}$N values of amino acids as complementary tracers of past diet: A case study from the Neolithic and Bronze Age of Cis-Baikal

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Stable isotope analysis is widely used in archaeology to reconstruct past diets and mobility. While traditional bulk $\delta^{13}$C and $\delta^{15}$N analyses on collagen have been extensively applied, their utility is limited by diagenesis, particularly in older samples where collagen degradation occurs. In contrast, zinc isotopes ($\delta^{66}$Zn) in tooth enamel offer a promising alternative, as enamel is highly resistant to diagenetic alteration, allowing dietary reconstruction in samples where collagen is no longer preserved.

Despite its potential, $\delta^{66}$Zn remains a promising tool that requires further validation, particularly through comparative studies across different ecosystems. To refine its interpretation, we systematically compared $\delta^{66}$Zn values with compound-specific $\delta^{15}$N in amino acids (CSIA-AA $\delta^{15}$N) from the same archaeological individuals and associated fauna. CSIA-AA is a powerful tool for studying trophic organization and comparing food chains, as it provides a more precise assessment of trophic level by differentiating baseline nitrogen sources (e.g., $\delta^{15}$N-Phe) from trophic fractionation effects (e.g., $\delta^{15}$N-Glx). This approach enables a more accurate distinction between trophic signatures and environmental baselines, a critical step for correctly interpreting Zn isotopic variations.

Our study focuses on human and faunal remains from the Neolithic and Bronze Age of Cis-Baikal, a region where populations relied on both terrestrial and aquatic resources. The comparison of $\delta^{66}$Zn and CSIA-AA $\delta^{15}$N across different populations and faunal remains helps clarify the sensitivity of Zn fractionation to trophic level differences by directly comparing it with a baseline-free CSIA-AA signature. Preliminary results suggest that $\delta^{66}$Zn effectively differentiates between dietary protein sources, but its variability may be influenced by environmental factors that must be accounted for in dietary reconstructions.

These findings advance our understanding of Zn as a powerful and effective dietary tracer, even in complex trophic webs. However, for now, they highlight the need for multi-isotopic frameworks that integrate Zn and CSIA-AA, alongside traditional Sr, bulk N and C isotopes, as well as archaeological and anthropological data, for robust paleo-dietary reconstructions. This study contributes to refining the applicability of Zn isotopes in archaeological contexts, particularly where traditional organic isotopic markers are unavailable due to diagenesis.