Isotope features of alkaline intrusions for different geodynamical settings: an example from the Central Siberia

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Alkaline intrusions of the Central Siberia have a different age and were formed in different tectonic setting. The establishment of Neoproterozoic (610-725 Ma) plutons of alkaline ultrabasites and syenites in folded belts of the Enisei Range and Eastern Sayan was probably connected with the superplume activity caused a rifting breakup of the Laurasia paleocontinent and opening of the Paleoasian Ocean. Paleozoic complexes of alkaline basic rocks (475-510 Ma) located in the Gornyi Altai and Kuznetsk Alatau was formed in the active continental margin setting corresponding to the late collision rifting during the Caledonian stage of the Central Asian Fold Belt history. The Mesozoic plume activity (~ 250 Ma) was corresponded to the tectonic destruction of the Siberian Craton and a forming of some alkaline ultrabasic massifs in the Maimecha-Kotui Province.

Sources of the Precambrian alkaline magmas according to isotopic data (εNd +2,5…+5,2; εSr –10… –19) corresponds to the HIMU- and PREMA- or E-MORB-type of mantle sources that can be mixing with a material of EMI. The feature of the Early Paleozoic magmatism is an enrichment by radiogenic ^{87}Sr (εSr –10…+30) in the rock composition correlated to Sm-Nd characteristics of the PREMA (εNd +5.0… +6,4). It is deviated from the mantle array and explained as an effect of crustal contamination of primary magmas. Their evolution was in upper parts of lithosphere with the higher thickness of crust that be confirmed by high values of the $\delta^{18}O$ (7-15 ‰, SMOW). Magma sources of Mesozoic alkaline complexes of the Siberian Craton (εNd +2,0…+5,4; εSr –2…–16) as well as Neoproterozoic are compositionally corresponded to moderate depleted reservoirs in the mantle. Their drainage was accompanied by the mixing with enriched domains of the lower lithosphere.

Finally, isotopic features of alkaline rocks are showed a relationship of mantle sources for primary magmas and some regularity of mantle composition under the Central Asia during the long time.

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A combined SIMS and TEM study of potential biosignals from Precambrian rocks

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Evidence for early life on Earth is extremely difficult to constrain. We now know that whilst morphology and geological context are vitally important tools, they are not always sufficient to establish biogenicity, because many inorganic processes can give rise to similar features. Geochemical data (e.g., micro- to nano-scale elemental distributions, elemental ratios, carbon- and sulfur-isotopes), provide an extra level of information that may indicate specific biological metabolisms on the early Earth. Until recently, however, a major stumbling block was the inability to obtain the spatial resolution required to accurately characterise individual micron-sized features.

Here we demonstrate the use of two complimentary techniques [Nano-scale secondary ion mass spectrometry (NanoSIMS) and Transmission electron microscopy (TEM)] for investigating the biogenicity of Precambrian micro-fossils, trace fossils, putative biominerals and stromatolites ranging in age from <600 Ma to almost 3,500 Ma. NanoSIMS data includes chemical maps and carbon and sulfur isotopic analyses measured *in situ* at the sub-micron scale, and we discuss the protocol for obtaining SIMS elemental ratios (e.g., N/C). TEM imaging and spectroscopy (EELS and EDS) data helps to elucidate the structure of carbonaceous material, in terms of aliphaticity and aromaticity, the functional groups present, and degree of ordering. TEM data also includes elemental distributions on the nano-scale across boundaries between the putative biological structures and their mineral hosts, and oxidation and co-ordination states of e.g. iron and sulphur in the vicinity of these structures. With respect to stromatolites, we will present data from modern analogues from Western Australia that help to constrain the preservation potential of biosignals in these structures.