

A rapid determination method for Re and Os isotopic compositions using ID-MC-ICP-MS with sparging method

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We present a rapid determination method for Re and Os isotope compositions using ID-MC-ICP-MS (NEPTUNE) combined with a sparging method. The sparging method allows us to measure Os isotope compositions just after acid sample digestion in a Carius tube without the most commonly used but time-consuming solvent extraction using CCl₄ and HBr. Remaining Os after isotope measurement can be perfectly/easily removed by only drying sample solution, and Re is subsequently separated on an anion exchange resin. Our NEPTUNE is equipped with the multi-ion counter (MIC) system, enabling simultaneous measurement of a maximum of four Os isotopes, leading to drastic reduction of the measurement time. Therefore, compared to negative thermal ionization mass spectrometry (N-TIMS) which is presently the most widely used for Re-Os analyses, sample throughput becomes several times higher.

Re-Os data of GSJ geochemical reference samples (JCh-1 and JMS-2; chert and pelagic clay, respectively) measured by NEPTUNE give similar concentrations and isotope compositions to those obtained by N-TIMS. The precision of Os isotope measurement by NEPTUNE with the sparging method is inferior to those by N-TIMS due to declining of the Os signal intensity and change of the efficiency of MIC over time. The total procedural blank for Os by the method using NEPTUNE are 0.69 ± 0.04 pg ($n = 9$), which is much lower than those by N-TIMS (ca. 2 pg). The detection and determination limits for Os amount by NEPTUNE are 0.12 and 0.39 pg, respectively. The typical sensitivity of Re by our NEPTUNE with a dissolvent nebulizer (Aridus II), Ni X-skimmer cone and external large interface pump is ca. 1100 V/ppm (1.1 mV/ppt). These analytical performances of our NEPTUNE are sufficient to analyze samples with very low Re and Os contents such as chert. Therefore, the Re and Os measurement of sedimentary rock samples by NEPTUNE combined with the sparging method is expected to be a powerful tool to reconstruct the secular change of the marine Os isotope compositions with high resolution, which unravels the cause of paleo-ocean global environmental change.

Investigating the effect of electro-active ion concentration on induced polarization signatures arising from biomineral formation

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Spectral induced polarization (SIP) is a proven geophysical method for detecting biomineral formation with promising applications for monitoring biogeochemical products during microbial induced sequestration of heavy metals and radionuclides in soils. SIP has been used to monitor the evolution of bioremediation-induced end-products at the uranium-contaminated U.S. Department of Energy RIFLE Integrated Field Research Challenge site in Colorado. Although a significant SIP response was detected, the quantitative interpretation is non-trivial as the polarization of metallic minerals depends both on the mineral surface properties and the electrolyte chemistry. In previous experiments SIP mechanisms were studied under complex environments and individual source mechanisms could not be evaluated. Here we examine the role of electrolyte chemistry by comparing the effect of redox active / inactive ions on metallic polarization. In these abiotic experiments magnetite was used as a proxy biomineral and dispersed within columns packed with sand. Parallel columns were saturated with solutions of different concentrations of active (Fe²⁺) and inactive (Ca²⁺) ions (0.01mM–10mM) and SIP measurements made (0.1–1000 Hz). Preliminary results suggest differences in the effect of active ion and inactive ion concentration on the SIP response are small, and that changes in the active ion concentration, in the presence of magnetite, alone are unlikely to explain recent SIP monitoring data from the RIFLE site.