

Mass-dependent isotopic fractionation of Sr in geochemical samples by MC-ICP-MS

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The study of naturally occurring isotopic fractionation of Sr has a potentially significant influence in geochemical research fields combined with traditional studies using radiogenic isotopes as a tracer, because information on isotopic fractionation may provide another constraint on a formation process of a sample.

In this study, we present a method to determine $^{88}\text{Sr}/^{86}\text{Sr}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ simultaneously. The former variation reflects the mass-dependent isotopic fractionation through the physico-chemical processes, and the latter originates from decay of the parent nuclide ^{87}Rb as well as the mass-dependent isotopic fractionation. In order to determine the mass-dependent isotopic fractionation, the mass-discrimination effect on $^{88}\text{Sr}/^{86}\text{Sr}$ was externally corrected by an exponential law using Zr. For the radiogenic growth of $^{87}\text{Sr}/^{86}\text{Sr}$, the mass-dependent isotopic fractionation effect on $^{87}\text{Sr}/^{86}\text{Sr}$ was corrected by a conventional correction technique using the $^{88}\text{Sr}/^{86}\text{Sr}$ ratio. The reproducibility of the $^{88}\text{Sr}/^{86}\text{Sr}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ measurements for a high-purity Sr chemical reagent was 0.06‰ (2SD, n = 20) and 0.07‰ (2SD, n = 20), respectively. Isobaric interferences and matrix elements were chemically eliminated by an extraction chromatography using Sr spec. resin. We examined Sr isotopic fractionation during the separation procedure. The cumulative Sr isotopic value of the eluent indicates that no detectable isotopic fractionation of Sr was found through a few percent loss of Sr during the chromatographic separation.

Strontium isotopic ratios ($^{88}\text{Sr}/^{86}\text{Sr}$ and $^{87}\text{Sr}/^{86}\text{Sr}$) were measured on six geochemical reference materials (igneous rock: JB-1a and JA-2; carbonate mineral: JLs-1, JDo-1, JCp-1 and JCt-1) and one seawater sample. The resulting $^{87}\text{Sr}/^{86}\text{Sr}$ ratios obtained here were consistent with previously published data within the analytical uncertainties. The resulting $^{88}\text{Sr}/^{86}\text{Sr}$ ratios for igneous rock samples did not vary significantly within the samples, whereas the carbonate samples showed enrichments of the lighter Sr isotopes over the seawater sample. The $^{88}\text{Sr}/^{86}\text{Sr}$ ratio of geochemical samples could reflect the physico-chemical processes for the sample formation. Also, a combined discussion of $^{88}\text{Sr}/^{86}\text{Sr}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ of samples will render multi-dimensional information on geochemical processes.

Interactions of Actinides with Microorganisms and Organic Ligands

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Trivalent actinides, such as Am(III) and Cm(III), are highly toxic because they emit high-energy alpha-particles and have long half-lives. Plans to dispose of HLW and TRU wastes in geological disposal repositories have raised a number of concerns about polluting the environment through dissolution and subsequent mobilization of actinides; thus, long-term assessments of safety are required. TRU wastes contain cellulosic materials, scintillation fluids, waste oils, decontamination reagents, and chemical reagents. Among them, organic acids, such as citric acid, EDTA, and NTA form stable complexes with multivalent radionuclides, enhancing their mobility by increasing their solubility. However, little is known of the interaction of actinides with microorganisms and organic ligands. In this paper, we summarize our findings on the interactions of actinides with microorganism and organic ligands. Malic acid formed complexes with Eu(III), analogues of Am(III) and Cm(III), but degradation of malic acid by *Pseudomonas fluorescens* was observed when the ratio of malic acid to Eu(III) was higher than 100. One of the metabolites associated with Eu(III), that were produced by the degradation of malic acid, was determined as pyruvic acid by ESI-MS. The effect of bacterial organic exudates on the sorption of Eu(III) and Cm(III) by *Chlorella vulgaris* was studied. The pH dependence of $\log K_d$ of Eu(III) and Cm(III) for cellulose, major component of *C. vulgaris* cell, differed from that for *C. vulgaris*. However, the $\log K_d$ of Eu(III) and Cm(III) for cellulose in the solution containing exudates from *C. vulgaris* cells in a 0.5% NaCl solution showed a similar pH dependence to that by *C. vulgaris*. These findings strongly suggest that interaction of microorganisms with the actinide organic complexes affect the migration of actinides.