Stable isotope geochemistry of strontium using 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 have developed a novel method of precise isotopic analyses to investigate both mass dependent isotopic fractionation and radiogenic isotopic variation of Sr. 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 result of the test demonstrated that Sr isotopes were measurably fractionated on the separation process. The cumulative Sr isotopic value of the eluent indicate that no detectable isotopic fractionation of Sr was found through a few percent loss of Sr during the chromatographic separation.

The ^{88}Sr/^{86}Sr and radiogenic ^{87}Sr/^{86}Sr data were expressed as the relative deviations from the same ratios for isotopic standard reference material (NBS987 Sr) in terms of delta notations (δ) and epsilon notations (ε), respectively.

$\delta\,^{88}\mathrm{Sr} = [(^{88}\mathrm{Sr}\,/^{86}\mathrm{Sr})_{\mathrm{sample}}/(^{88}\mathrm{Sr}\,/^{86}\mathrm{Sr})_{\mathrm{standard}} -1]*1{,}000$

$\varepsilon\,^{87}\mathrm{Sr} = [(^{87}\mathrm{Sr}\,/^{86}\mathrm{Sr})_{\mathrm{sample}}/(^{87}\mathrm{Sr}\,/^{86}\mathrm{Sr})_{\mathrm{standard}} -1]*10{,}000$

Reproducibility of measurements was evaluated by repeated analyses of a high purity reagent Sr solution (Kanto Chemicals). The resulting $\delta\,^{88}$Sr was 0.29 ± 0.06 (2SD, n=20), suggesting that the reagent Sr was isotopically fractionated during formation processes of the source material in nature or manufacturing processes. The resulting $\varepsilon\,^{87}$Sr was -23.0±0.7 (2SD, n=20), indicating that the source of the reagent Sr solution (Kanto Chemicals) should be different from that of NBS987 Sr.

In order to examine the possible isotopic fractionation of Sr in nature, we analyzed Sr isotopic compositions of GSJ igneous rock standards (Basalt, JB-1a; Andesite, JA-2; Rhyolite, JR-1), GSJ carbonate mineral standards (limestone, JLs-1; Dolomite, JDo-1; Coral, JCp-1; Giant clam, JCt-1) and seawater samples. No Sr isotopic variation was found among the igneous rock standards, whereas the resulting $\delta\,^{88}$Sr of carbonate mineral standards showed lighter Sr isotopic composition than that of the seawater, suggesting that lighter Sr isotopes could preferentially co-precipitate with Ca as a carbonate mineral. The resulting $\varepsilon\,^{87}$Sr of recent carbonate samples (JCp-1, JCt-1) were identical with that of seawater samples. These results imply that the study of Sr isotopic fractionation can be used as a potential proxy for reconstructing seawater chemistry.