# Simultaneous determination of mass-dependent isotopic fractionation and ragiogenic isotope variation of Sr in geochemical samples

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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 using MC-ICP-MS. 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 was expressed as the relative deviations from the same ratios for isotopic standard reference material (NBS987 Sr) in terms of delta notations (δ).

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

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 $^{87}$Sr/$^{86}$Sr was 0.70861±0.00005 (2SD, n=20).

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 $^{87}$Sr/$^{86}$Sr of recent carbonate samples (JCp-1, JCt-1) were identical with that of seawater samples. These results imply that simultaneous determinations of mass-dependent isotopic fractionation and radiogenic isotope variation of Sr could become a new tool for geochemical research field.

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# Stable isotope geochemistry of Nd in various terestrial rocks

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We have developed a precise Nd stable isotope measurement technique by the combination of TIMS and double spike method to examine the possible Nd stable isotopic variations in terrestrial and extraterrestrial materials. We will report our preliminary results of Nd stable isotope variations on 9 reagents and 8 rock samples including basalt, granite, rhyolite, calcite and dolomite. All the results are expressed as the relative deviations from the isotopic standard reagent JNdi-1 in epsilon notation. The reproducibility of $\varepsilon^{146}$Nd was estimated from the repeated analyses of the standard and is ± 0.3 (2SD, n=11).

Six igneous rock samples analyzed so far show no variation in Nd stable isotopic compositions instead of variations in their REE abundance pattern. The average $\varepsilon^{146}$Nd is -0.2, which is slightly lower than that of JNdi-1 but within the external 2SD range. Since isotope fractionation effects can be neglected in high-temperature equilibrium reactions, the average isotopic composition of the igneous rocks probably represents the bulk earth Nd isotopic composition. The GSJ reference rock sample JLs-1 (calcite) also has Nd isotopic composition indistinguishable from the igneous rocks.

The isotopic composition of the GSJ reference rock sample JDo-1 (dolomite) is clearly different from the other samples $\varepsilon^{146}$Nd = 2.1). Our observation confirmed the previous report using MC-ICP-MS (Ohno and hirata, 2005). There are three possible scenarios to account for the heavy isotope enriched Nd in JDo-1 dolomite. The first is that the isotope fractionation took place during the re-crystallization reaction of calcite (dolomite precursor), when most of the REEs have included into the calcite from seawater. The second is that the heavy Nd is inherited from the ancient seawater and no isotope fractionation have occurred during the REE concentration by the calcite re-crystallization reactions. The third is that Nd isotopes are fractionated during the dolomitization reaction of the precursor calcite. Since JDo-1 and calcite from the same formation both have the seawater-like REE abundance pattern and similar REE concentrations indicating that the REEs of JDo-1 are not affected by the dolomitization reaction (Miura *et al.* 2004), the third scenario is unlikely.