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ストロンチウムの安定同位体地球化学
Stable isotope geochemistry of strontium

大野 剛 [1*], 平田 岳史 [2]
OHNO, Takeshi[1*], HIRATA, Takafumi[2]

[1] 学習院大学, [2] 京都大学
[1]Gakushuin University, [2]University of Kyoto

Strontium has four naturally occurring isotopes (84Sr, 86Sr, 87Sr and 88Sr). Among them, 87Sr is a daughter nuclide of radiogenic 87Rb, and its abundance changes due to the contribution of the radiogenic growth of 87Sr produced by the beta-decay of 87Rb; the radiogenic growth of 87Sr has provided important constraints of the age and sources in cosmochemical and geochemical materials. Moreover, the isotopic composition of other Sr isotopes, such as 84Sr, 86Sr and 88Sr may also vary due to mass-dependent isotopic fractionation through various physicochemical reactions in nature. This mass-dependent isotopic fractionation can provide key information about the sequence and/or mechanism of sample formation. The field of science that deals with them is widely known as stable isotope geochemistry. However, the application of stable isotopes of Sr has been retarded, mainly due to difficulty in obtaining an accurate and precise 88Sr/86Sr isotopic ratio. In the conventional isotopic analysis of 87Sr/86Sr, the 88Sr/86Sr isotopic ratio has been normalized to 1/0.1194 to correct the 87Sr/86Sr ratio for the mass-discrimination effect; the natural variation in the 88Sr/86Sr ratio has been neglected.

In this study, we present a method to determine 88Sr/86Sr and 87Sr/86Sr 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 87Rb as well as the mass-dependent isotopic fractionation. In order to determine the mass-dependent isotopic fractionation, the mass-discrimination effect on 88Sr/86Sr was externally corrected by an exponential law using Zr. For the radiogenic growth of 87Sr/86Sr, the mass-dependent isotopic fractionation effect on 87Sr/86Sr was corrected by a conventional correction technique using the 88Sr/86Sr ratio. The reproducibility of the 88Sr/86Sr and 87Sr/86Sr measurements for a high-purity Sr chemical reagent was 0.006% (2SD, n = 20) and 0.007% (2SD, n = 20), respectively. Strontium isotopic ratios (88Sr/86Sr and 87Sr/86Sr) were measured on geochemical reference materials (igneous rock: JB-1a, JA-2 and JG-2; carbonate mineral: JLs-1, JDo-1, JCp-1 and JCt-1) and one seawater sample. The resulting 87Sr/86Sr ratios obtained here were consistent with previously published data within the analytical uncertainties. The resulting 88Sr/86Sr ratios for igneous rocks and carbonate minerals showed enrichments of the lighter Sr isotopes over the seawater sample. The 88Sr/86Sr ratio of geochemical samples could reflect the physico-chemical processes for the sample formation. Also, a combined discussion of 88Sr/86Sr and 87Sr/86Sr of samples will render multi-dimensional information on geochemical processes.

キーワード: 安定同位体地球化学, ストロンチウム, 同位体分別
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