Stable isotope geochemistry of Nd in various terrestrial rocks

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We have developed a method for high-precision Nd stable isotopic composition measurements by the combination of double spike and TIMS techniques to examine the possible Nd stable isotopic variations in terrestrial and extraterrestrial materials. Our method simultaneously allows the measurement of the variations in the radiogenic ^{143}Nd abundance caused by the radioactive decay of ^{147}Sm. 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 the epsilon^{146}Nd measurement was estimated from the repeated analyses of the standard (JNdi-1) and is +/- 0.2 (2SD, n=11).

The analyzed reagents are distinguished into 2 groups based on the Nd stable isotopic composition. Six reagents, including 3 high pure reagents, have similar isotopic compositions slightly depleted in heavy isotopes(epsilon^{146}Nd = -0.5) with respect to those of JNdi-1(epsilon^{146}Nd = 0). Two high pure reagents are slightly enriched in heavy isotopes (epsilon^{146}Nd = 0.5, 0.8). Isotopic composition of JNdi-1 is intermediate between these two groups. The difference of the epsilon^{146}Nd either originated from the isotope fractionation occurred during the purification of the reagent Nd or inherited from the different source materials of the different reagents.

Six igneous rock samples analyzed so far show no variation in Nd stable isotopic compositions instead of the variations in their REE abundance pattern. The average epsilon^{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 sample analyzed so far (epsilon^{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.