SYSTEMATIC REE ISOTOPIC STUDIES OF EUCRITES.

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Introduction: Most eucrites have basaltic composition and several of them represent lavas or shallow intrusions from a differentiated parent body, possibly asteroid 4 Vesta. Many isotopic studies have been conducted using long- and short lived geochronometers to understand accretion, core formation, mantle differentiation, and the formation of primary basalts on the eucritic parent body (EPB). In our previous study, Sr and Ba isotopic analyses were applied mainly for chronometric purposes of eight basaltic eucrites, but Rb-Sr and Cs-Ba decay systems did not provide any chronological information because of the significant contamination of terrestrial Sr and Ba found in five DaG desert eucrites [1]. In this study, Ce, Nd, Sm and Gd isotopic compositions of the eight eucrites were further determined for better understanding of differentiation on the parent body.

Samples and Experiments: Eight basaltic eucrites, Juvinas, Millbillillie, Stannern, DaG 380, Dag 391, DaG 411, DaG 443, and DaG 480, were used in this study. To remove the terrestrial weathering products from the original components of five DaG eucrites, each fragment of the five DaG eucrites weighing about 0.2 g was newly powderized and put into 5 mL of 0.2 M HNO_3 for 10 min. of ultrasonification. Then, each residual sample was decomposed by treatment with HF-$HClO_4$ with heating. The decomposed samples were taken to dryness and redissolved in 5 mL of 2M HCl. The solution was divided into two portions: the main portion for isotopic measurements by TIMS and the rest for the determination of elemental abundances by ICP-MS. For the isotopic work, conventional techniques using two kinds of ion exchange resin were carried out to separate Ce, Nd, Sm and Gd from each sample solution [2,3]. A TRITON TIMS equipped with nine Faraday Cup collectors was used for the isotopic measurements of Ce, Nd, Sm and Gd [3].

Results and Discussion: The data points from eight eucrites including five desert eucrites lie on a single isochron of ^{147}Sm-^{143}Nd isotopic systematic with a slope of 4.56 Ga. Their isotopic deviations of ^{142}Nd show slightly negative to zero values relative to terrestrial standard materials ($\varepsilon^{142}Nd$=-0.2 to 0), and no positive values which are observed in typical non-cumulate eucrites having high Sm/Nd elemental ratios. These results are consistent with previous studies [4,5].

Since ^{138}Ce isotopic excesses of eucrites correlate with their La/Ce elemental ratios, these excesses are identified to be the decay product from ^{138}La with a half life of 105 Ga [6]. Our data are consistent with the results from previous study on the EPB evolution of Ce isotope [7], showing the La-Ce isochron of 4.56 Ga with the initial Ce isotopic ratio of $^{138}Ce/^{142}Ce$=0.0225321 .

Sm isotopic compositions of the eucrites show the depletions of ^{149}Sm and excesses of ^{150}Sm caused by neutron capture reactions of $^{149}Sm(n, \gamma)^{150}Sm$ due to cosmic rays irradiation. These Sm isotopic shifts correspond to the neutron fluences ranging from 3.2 to 6.1×10^{15} n cm^{-2}. The estimated neutron fluences are almost consistent with their cosmic-ray exposure ages as 4π irradiation, suggesting no strong evidence of initial cosmic-ray exposure as 2π irradiation on the surface of EPB. The isotopic shifts of Sm are caused by the cosmic-ray irradiation after release from the EPB. The variation of ^{157}Gd-^{158}Gd isotopic shifts caused by neutron capture reactions of $^{157}Gd(n, \gamma)^{158}Gd$ also show the consistency with that of ^{149}Sm-^{150}Sm isotopic shifts.

Considering the REE isotopic results, the acid treatment used for the removal of terrestrial weathering products in the DaG eucrites seems to be enough for the REE analyses, although it is not sufficient to reduce the terrestrial Sr contamination [1]. Systematic isotopic data of Ce, Nd, Sm and Gd obtained in this study provide a hint to understand the differentiation processes of HEDs. We are now applying this technique for the analyses of cumulate eucrites and diogenites.

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