ISOTOPIC STUDIES OF RADIOGENIC AND NEUTRON-CAPTURED REE OF LUNAR METEORITES

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Introduction: Geochemical characterization of lunar meteorites are expected to offer new information on the lunar mantle evolution that has not been known from the Apollo and Luna missions samples. Isotopic determination of Ce and Nd of lunar meteorites leads to ^{138}La-^{138}Ce, ^{147}Sm-^{143}Nd and ^{146}Sm-^{142}Nd chronometry to consider early differentiation of the samples from lunar mantle and their evolution history. Isotopic compositions of Sm and Gd can be used to characterize exposure history of the samples from isotopic shifts on ^{149}Sm-^{150}Sm and ^{157}Gd-^{158}Gd due to neutron capture effect, because lunar meteorites have more or less been affected by contribution of cosmic-ray irradiation on the moon [1,2]. In this study, we performed Ce, Nd, Sm and Gd isotopic measurements of four lunar meteorites, NWA 479, NWA 482, NWA 2995 and NWA 5000.

Samples and Experiments: NWA 479 is an unbrecciated mare basalt, and is considered to be a pair with NWA 032. NWA 482 is a crystalline impact melt polymict breccia with highland affinities. NWA 2995 is a feldspathic breccia containing highland lithologies. NWA 5000 is a feldspathic monomict breccia including Mg-suite olivine gabbro clasts. Individual powderized samples weighing 60-90 mg were completely decomposed by HF+$HClO_4$, and were finally redissolved in 1 mL of 2M HCl. The solutions were divided into two portions: the main portion for isotopic measurements by a thermal ionization mass spectrometer (TIMS) and the rest for the determination of elemental abundances of the rare earth elements (REE) including Ce, Nd, Sm and Gd by an inductively coupled plasma mass spectrometer (ICP-MS).

Results and Discussion: Sm and Gd isotopic shifts of individual samples provide neutron fluences of $(1.3\text{-}9.6)\times10^{16}$ ncm^{-2}. In particular, a very large isotopic shift of NWA 482 is nearly equivalent with that of a lunar regolith 70002 having the largest isotopic shifts among the Apollo regolith samples, corresponding to cosmic-ray exposure ages of 700-1000 Myr in the lunar surface [3]. The $\varepsilon_{Sm}/\varepsilon_{Gd}$ values, as a parameter for thermalization degree of neutron energy [4], reveal that neutrons in all of four samples were thermalized to the similar level with those of lunar regoliths. Previous Nd isotopic study shows that the bulk Moon has a chondritic ^{142}Nd/^{144}Nd ratio which is 20 ppm lower than those of terrestrial materials and equivalent with chondritic materials [5]. The ^{142}Nd/^{144}Nd ratios of the samples range from ε_{142Nd}=-0.13 to -0.58 before the correction of neutron capture effect. The isotopic excesses of ^{138}Ce in all of samples are variable and correlate with their La/Ce ratios, showing the addition of ^{138}Ce decayed from ^{138}La.

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