

LA-CE CHRONOMETRY OF EUCRITES AND DIOGENITES. H. Hidaka¹, S. Yoneda² and S.-G. Lee³,
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Introduction: We have established the systematic chemical separation techniques of Sr, Ba, Nd, Sm, and Gd from single-source fragments of geological samples for their isotopic measurements, and used this technique for the isotopic studies of meteorites and lunar samples [1,2]. In our recent study, La and Ce isotopic measurements were newly added into the same sequential analytical scheme for the chemical separation of the other REE, and used for the chronological applications [3,4].

Ce has four stable isotopes with mass number 136, 138, 140 and 142. Of the four isotopes, ¹³⁸Ce isotope includes radiogenic component decayed from ¹³⁸La with a half-life of 1.05×10^{11} years. The Ce isotopic studies once developed for the application of ¹³⁸La-¹³⁸Ce geochronometry [5-7]. ¹³⁸La-¹³⁸Ce decay system can be one of geochronometers for understanding the formation and the evolution processes of solar planetary materials.

In this study, the results from ¹³⁸La-¹³⁸Ce systematics for eucrites and diogenites are reported.

Experiments: Eight basaltic eucrites (Dar al Gani 380, Dar al Gani 391, Dar al Gani 411, Dar al Gani 443, Dar al Gani 480, Juvinas, Stannern, and Millbillillie), one cumulate eucrite (Yamato 980433) and seven diogenites (Bilanga, Northwest Africa 2629, Northwest Africa 5480, Tatahouine, Yamato 002857, Yamato 74013, and Yamato 74097) were used in this study. Each sample weighed 0.3 to 0.4 g for the basaltic eucrites and 1.0 g for the cumulate eucrite and diogenites was powdered and then decomposed completely by HF-HClO₄ with heating. The sample was evaporated to dryness, and redissolved in 2 M HCl of 5 to 10 mL. The sample solution is divided into two portions for the determination of elemental abundances by an inductively coupled plasma mass spectrometer (ICP-MS), and for the isotopic analyses of individual elements by a thermal ionization mass spectrometer (TIMS). Minor portions (5-10 % of the total amount) of the sample solution is evaporated to dryness once and redissolved into 5 mL of 2 % HNO₃ for the ICP-MS analyses. Major portions (> 90 % of the total amount) used for the isotopic works need chemical separations of the elements that are isolated from the isobaric interferences on the mass spectra. We have established a two-step of resin chemistry. Prior to mutual separation of rare earth elements (REE), the sample solution is loaded onto a

cation exchange resin column (Bio-Rad AG50WX8, 200-400 mesh, H⁺ form, 50 mm length, 4.0 mm i.d.) and washed with 3.5 mL of 2 M HCl, and then washed with 2 mL of 3 M HCl for the elution of the Sr fraction. Successively, the column was washed with 2 mL of 3 M HNO₃ for the elution of the Ba fraction, and successively washed with 3.5 mL of 6 M HCl for the elution of total REE fraction. The REE fraction collected through the 1st step of resin chemistry is evaporated to dryness and redissolved in a drop of 0.1 M HCl. This drop is loaded onto a second column packed with Ln-resin (particle size of 100-150 μm, 100 mm length, 2.5 mm i.d.) to separate La, Ce, Nd, Sm, Gd using various concentrations of HCl from 0.15 M to 0.5 M HCl as eluents.

In this study, isotopic analyses of Ce for individual meteorite samples were performed using two Triton TIMS at KIGAM (Daejeon) and at NMNS (Tsukuba), and an Isoprobe-T TIMS at Nagoya University (Nagoya). Ce was measured on double Re filaments without any activators. ¹⁴⁰Ce/¹⁴²Ce = 7.941 was used as the normalization factors for the correction of instrumental isotopic mass fractionation [8]. Cerium was measured as oxide ions (CeO⁺). All analyses were performed in static mode with the amplifier rotation system.

Results and Discussion: CI chondrite-normalized REE abundance patterns of all 16 samples used in this study are shown in Fig. 1. The eight basaltic eucrites show relatively flat REE patterns and high abundances (CI × 10-25), while the cumulate eucrite and the diogenites show significant depletions of lighter REE (LREE) and low abundances (CI × 0.01-0.3 for LREE). The REE contents data of basaltic eucrites are quite consistent with those of previous studies [9-11]. However, some of diogenites data such as Bilanga and Tatahouine show significant differences from previous data [12,13], which is suggested by diversity of the diogenite parent melts.

Since ¹³⁸Ce isotopic excesses of eucrites correlate with their La/Ce elemental ratios, these excesses are identified to be the decay product from ¹³⁸La. However, the La/Ce elemental ratios of eucrites and diogenites show in a narrow range (¹³⁸La/¹⁴²Ce = 0.00317 to 0.00322), and it is difficult to make a whole rock isochron of eucrites and diogenites only from our data. In this study, our data are compared with previous

studies to confirm the consistency between our results and previous results.

The primordial $^{138}\text{Ce}/^{142}\text{Ce}$ ratio in the solar system is an essential parameters to understand the evolution of the planetary materials in the early solar system. Since ^{138}Ce isotopic excesses of eucrites correlate with their La/Ce elemental ratios, these excesses are identified to be decay product from ^{138}La . There is a pioneering study to determine the primordial $^{138}\text{Ce}/^{142}\text{Ce}$ ratio in the solar system [6,9]. Our data are consistent with the results from previous study on the eucritic parent body evolution of Ce isotope, showing the La-Ce isochron of 4.56 Ga with the initial Ce isotopic ratio of $^{138}\text{Ce}/^{142}\text{Ce}=0.0225321$.

Ce isotopic measurements of cumulate eucrite and diogenites are still in progress.

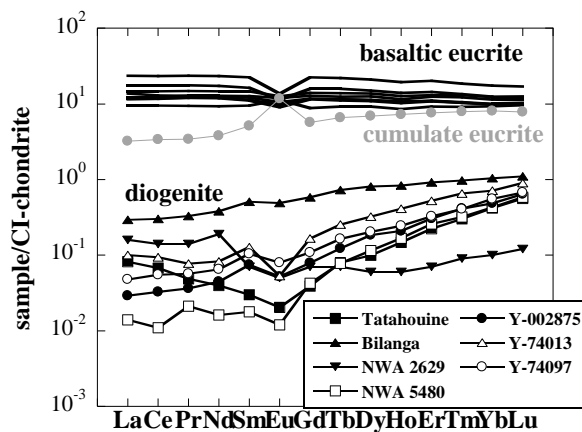


Figure 1. CI chondrite-normalized REE abundance patterns of eight basaltic eucrites (Juvinas, Millbillillie, Stannern, DaG 380, DaG 391, DaG 411, DaG 443, and DaG 480), one cumulate eucrite (Y-980433), and seven diogenites (Bilanga, NWA 2629, NWA 5480, Tatahouine, Y-002875, Y-74013, and Y-74097) used in this study.

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