

BA ISOTOPIC HETEROGENEITY IN CM CHONDRITES

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Introduction: Ba has seven stable isotopes and consists of s-, r- and p-process nucleosynthetic components. In addition, isotopic abundance of ¹³⁵Ba may be affected by radiogenic components decayed from the presently extinct ¹³⁵Cs ($t_{1/2} = 2.3$ Ma). Therefore, Ba isotopic studies in primitive planetary materials provide information of the presences of several additional nucleosynthetic components in the early solar system and the chronological application using ¹³⁵Cs-¹³⁵Ba decay system [1, 2, 3, 4]. The Ba isotopic data of primitive planetary materials are important to understand the evolution processes of the early solar system. In this study, isotopic analysis of Ba and quantitative analyses of Rb, Sr, Cs, Ba and REE abundances from the acid leachates of four CM2 chondrites, Cold Bokkveeld, Murray, Nogoya and NWA 4428, were performed to discuss the origin of Ba isotopic variations.

Sample and Experiment: Each powdered sample (600~900 mg) was leached using 10 mL of 0.1M acetic acid-ammonium acetate, 0.1M HCl, 2M HCl and aqua regia, successively. The acid residue was finally decomposed by HF-HClO₄ about 150°C for 5 days. Separately from the above leaching treatment, about 100 mg of powdered sample was decomposed by HF-HClO₄, and treated as a whole rock for analysis. Each solution was divided into two portions; a major portion for Ba isotopic analysis by TIMS and another minor portion for the determination of Rb, Sr, Cs, Ba and REE abundances by ICP-MS. For the isotopic analysis, each major portion was treated with conventional resin chemistry to purify the Sr and Ba fractions. The sample solution was loaded onto cation exchange resin packed column (AG50WX8, 200–400 mesh, H⁺ form, 50 mm length × 4.0 mm diameter). The column was washed with 3.5 mL of 2 M HCl for the elution of major elements, and then it was washed with 3.5 mL of 2 M HCl for the elution of the Sr fraction. Finally, the column was washed with 3 mL of 2 M HNO₃ for the elution of the Ba fraction. For further purification, Ba fraction was loaded onto a Sr resin packed column (Eichrom, Sr resin, particle size of 100–150 μm, 50 mm length × 4.0 mm diameter). The column was washed with 3.5 mL of 3 M HNO₃, and was washed with 6.5 mL of 7.5 M HNO₃ for the elution of Ba.

Results and Discussion: The Ba isotopic data of the whole rock show small ($-0.58 < \epsilon < 0.24$) or no isotopic variations within the analytical errors. On the other hand, the Ba isotopic data from most of the acid leachates show variable isotopic excesses of ¹³⁵Ba, ¹³⁷Ba and ¹³⁸Ba. Furthermore, the Ba isotopic data of the acid residues show variable isotopic deficits of ¹³⁰Ba, ¹³²Ba, ¹³⁵Ba, ¹³⁷Ba and ¹³⁸Ba. These isotopic data set suggest a heterogeneous distribution of s- and r- process nucleosynthetic components of Ba isotopes in the early solar system. In previous studies [2, 3, 4], the Ba isotopic data of the acid residue in CI and CM chondrites and Tagish Lake (C2-ungrouped) meteorite showed large isotopic anomalies because of the enrichment of a carrier of s-process isotopes such as presolar SiC grains [5, 6]. However, some Ba isotopic data cannot be explained only from the contribution of s- and r-process nucleosynthetic components. As one of the possibilities, there is a contribution of X-type SiC grains, which are thought to come from type II supernovae (n-process components) [7, 8]. Assuming that the isotopic compositions of s-, r- and n-process nucleosynthetic components in individual samples are constant, we propose a model to estimate the ¹³⁵Cs isotopic abundances from the subtraction of the additional components.

References: [1] Hidaka H. et al. (2001) *Earth Planet. Sci. Lett* 193: 459-466. [2] Sakuma K. et al. (2018) *The Astrophysical Journal* 853: 92. [3] Hidaka H. et al. (2003) *Earth Planet. Sci. Lett* 214: 455-466. [4] Hidaka H. and Yoneda S. (2011) *Geochimica et Cosmochimica Acta* 75: 3687-3697. [5] Ott U. and Begemann F. (1990) *The Astrophysical Journal* 353: L57-L60. [6] Prombo C. A. et al. (1993) *The Astrophysical Journal* 410: 393-399. [7] Pellin M. J. et al. (2000) *LPS* 31: 1934. [8] Stephan T. et al. (2018) *Geochimica et Cosmochimica Acta* 221: 109-126.