

RB-SR AND CS-BA SYSTEMATICS OF THE TAGISH LAKE METEORITE

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Introduction: The chronological study of primitive solar-planet materials is important to put temporal constraints on the evolution processes of the early solar system. Aqueous alteration is one of the primitive activities on meteorite parent bodies in the early solar system. The presence of secondarily formed minerals such as serpentine, oxides and calcite in CI and CM chondrites provide the evidence for the occurrence of aqueous activity [1,2].

Chronological methods using short-lived nuclides (extinct nuclides) have been able to be applied for understanding of the evolution process in the early solar system. The ¹³⁵Cs-¹³⁵Ba decay system including a presently extinct nuclide ¹³⁵Cs ($t_{1/2} = 2.3$ Ma) in primitive materials is expected to work as a sensitive chronometer for aqueous process on the early planetary materials, because Cs is one of the elements that is highly reactive with water [3,4,5]. However, the Ba isotopic compositions in primitive materials are often affected by additional nucleosynthetic components of s- and r-process isotopes and hide isotopic evidence for the radiogenic ¹³⁵Ba [4,5,6].

The main purpose of this study is to examine the isotopic evidence of ¹³⁵Cs based on precise determination of Ba isotopic compositions in primitive solar materials. The Tagish Lake (TL) meteorite is one of primitive chondrites, and known to be experienced by aqueous alteration on the parent body [7]. Ba and Sr isotopic analyses and quantitative analyses of alkaline elements are performed on chemical separates of TL by sequential acid-leaching method to find specific phases that contain high abundance of alkaline elements compared to bulk sample.

Experiments: About 400 mg of powdered sample was leached by 5 mL of 0.1M CH₃COOH-CH₃COONH₄, 0.1M HCl, 2M HCl and aqua regia, successively. The acid residue was finally decomposed by HF-HClO₄ about 140°C for 2 days. This sequential acid-leaching procedure was based on the previous methods [3]. Separately from the above leaching treatment, about 40 mg of powdered sample was decomposed by HF-HClO₄, and treated as a whole rock for analysis. Each fraction was evaporated to dryness, and redissolved in 2M HCl of 1 mL. The solution was divided into two portions; major portion for Sr and Ba isotopic analyses by thermal ionization mass spectrometry (TIMS) and minor portion for the determination of Rb, Sr, Cs and Ba elemental abundance by inductively coupled plasma mass spectrometry (ICP-MS). For the isotopic analysis, each major portion was treated with conventional resin chemistry to purify the Sr and Ba fractions [8].

Results and Discussion: The leachates show various Rb/Sr and Cs/Ba ratios suggesting heterogeneous redistribution of alkaline elements associated with aqueous alteration on the TL parent body (Rb/Sr: 0.14 ~ 1.3, Cs/Ba: 0.0011 ~ 0.060). The Ba isotopic data of the leachates show variable isotopic excesses of ¹³⁰Ba, ¹³²Ba, ¹³⁵Ba, ¹³⁷Ba and ¹³⁸Ba, while those of the acid residue show isotopic deficits of ¹³⁰Ba, ¹³²Ba, ¹³⁵Ba, ¹³⁷Ba and ¹³⁸Ba. These Ba isotopic negative anomalies can be simply explained by two-component mixing model between average of solar component and additional nucleosynthetic s-process component derived from presolar SiC grains. The calculation of Ba isotopic data to remove additional nucleosynthetic components cannot show correlation between ¹³⁵Ba excess due to decay of ¹³⁵Cs and Cs/Ba ratio. From the chronological view point, ¹³⁵Cs-¹³⁵Ba decay system based on the calculated Ba isotopic data after subtraction of additional nucleosynthetic components, and ⁸⁷Rb-⁸⁷Sr decay system do not provide any chronological information, which suggest significant disturbance of these two chronometers on the TL parent body.

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