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Barium isotopic composition of Ryugu samples by the Hayabusa2 mission

HIROSHI HIDAKA[1], SHIGEKAZU YONEDA[2], IKSHU GAUTAM[3] AND TETSUYA YOKOYAMA[3]

[1]Nagoya University

[2]National Museum of Nature and Science

[3]Tokyo Institute of Technology

Presenting Author: hidaka@eps.nagoya-u.ac.jp

The petrological and geochemical compositions of the Ryugu samples returned by JAXA's Hayabusa2 mission are close to those of the CI (Ivuna-like) carbonaceous chondrites (CCs) [1-3]. Here we present the Ba isotopic compositions of two Ryugu samples (A0106-A0107 and C0108) together with six CCs, Alais (CI), Allende (CV3), Murchison (CM2), Orgueil (CI), Tagish Lake (C2-ungrouped) and Tarda (C2-ungrouped), to help understand the nucleosynthetic heritage of the parent body and their relationship to CI and other CCs.

After initial sample processing [3], further Ba purification was performed at Nagoya University. The recovered Ba amounts were ~50 ng for both Ryugu samples and 30-80 ng for the CCs. The Ba isotopes were measured by TIMS (TRITON Plus) at National Museum of Nature and Science. Barium has seven isotopes synthesized by three distinct nucleosynthetic processes: ^{130}Ba and ^{132}Ba are p-process isotopes, ^{134}Ba and ^{136}Ba are s-process isotopes, and ^{135}Ba, ^{137}Ba and ^{138}Ba are both s- and r-process isotopes. The Ba isotope ratios normalized to ^{134}Ba/^{136}Ba in the Ryugu samples have small excesses of ^{135}Ba and ^{137}Ba (A0106-A0107: μ^{135}Ba = +27 ± 22, μ^{137}Ba = +24 ± 27; C0108: μ^{135}Ba = +27 ± 24, μ^{137}Ba = +29 ± 27), suggesting depletion of s-process Ba isotopes [4] that complements the s-process-enriched signature with deficits in ^{135}Ba and ^{137}Ba for samples including acid residues from CCs [5]. The isotopic anomalies in ^{135}Ba and ^{137}Ba could be created by the loss or gain of an amount of presolar SiC in the samples [4,5]. The result from Ryugu samples is consistent with those from the CCs having isotopic excesses of ^{135}Ba ($+21<\mu^{135}$Ba$<+38$) and ^{137}Ba ($+18<\mu^{137}$Ba$<+27$) in this study, although the linkage between Ryugu samples and chemical groups of CCs is not constrained from the Ba isotope signatures alone.

This research was conducted in collaboration with the Hayabusa2 initial analysis chemistry team and the Hayabusa2 initial analysis core.

References

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