

OXYGEN ISOTOPIC MAPPING OF A CLAST IN FRAGMENT C0002 FROM ASTEROID RYUGUA. N. Nguyen¹, P. Mane^{1,2}, L. Piani³, The Hayabusa2-initial-analysis chemistry team, The Hayabusa2-initial-analysis core¹Astromaterials Research and Exploration Science, NASA Johnson Space Center, 2101 NASA Parkway, Houston, TX 77058, USA (lan-anh.n.nguyen@nasa.gov), ²LPI, USRA, Houston, TX, USA, ³CRPG, CNRS-Université de Lorraine, Vandoeuvre-les-Nancy, France

Introduction: The samples of Ryugu returned by the Hayabusa2 spacecraft have mineralogy similar to CI chondrites and are dominated by secondary phases (e.g., phyllosilicates, carbonates, magnetite, sulfides) from extensive parent body aqueous alteration [1,2]. Anhydrous minerals such as olivine, pyroxene, and spinel are rare and exist in phyllosilicate-rich clasts [2-4]. Oxygen isotopic studies of these minerals have shown a bimodal distribution with both ¹⁶O-rich and ¹⁶O-poor grains [3,4]. In this study, we conducted NanoSIMS isotopic mapping of a clast found in a fragment of a C0002 grain from Chamber C, which may have derived from the asteroid sub-surface, to characterize small primary minerals.

Methods: The fragment of C0002 was prepared by pressing into In. A 5 nm Pt coating was deposited on the sample mount and SEM-EDX maps were acquired using a JEOL 7600F field emission SEM at NASA JSC. The clast was identified in one fragment that was more Fe- and S-rich, and Mg- and Si-poor than the surrounding matrix. We mapped the clast for C and O isotopes, ²⁸Si, and ²⁴Mg¹⁶O using the CAMECA NanoSIMS 50L at NASA JSC. A ~1 pA Cs⁺ primary beam focused to ~100 nm was rastered over 20 μm fields of view. Data were corrected for instrumental mass fractionation using San Carlos olivine. Only grains having δ¹⁸O error < 10 ‰ are considered here.

Results and Discussion: The clast had an irregular shape and was ~50 μm in size. EDX mapping showed Mg-rich grains that were smaller than ~2 μm. One region contained a cluster of five Mg-rich silicates that had varying O isotopic compositions, with δ¹⁸O ranging from 0 to -16 ‰. Collectively, the grains have a composition of δ¹⁷O = -17 ± 12 ‰, δ¹⁸O = -11 ± 4 ‰ (2σ). Other Mg-rich silicates had δ¹⁸O values ranging from -38 to 0 ‰. Some of these grains plot along the terrestrial fractionation line (TFL), though they are within error of the slope-1 line reflecting mass-independent fractionation. The analysis of larger primary minerals (~10-30 μm) by [3] and [4] revealed a bimodal distribution of O isotopic compositions, which is not discerned in our study due to the larger analytical errors.

Two silicates had compositions similar to bulk Ryugu C0002 [5] and lie on the TFL (δ¹⁷O = 11 ± 38 ‰, δ¹⁸O = 23 ± 16 ‰; δ¹⁷O = 14 ± 20 ‰, δ¹⁸O = 29 ± 8 ‰). These grains have slightly lower ²⁸Si/¹⁶O than the other silicates analyzed, and could be hydrous. Additionally, a ~1.5 μm ¹⁶O-poor grain was identified having δ¹⁷O = 37 ± 28 ‰, δ¹⁸O = 58 ± 12 ‰ (2σ). The NanoSIMS analysis showed the grain to be Mg-bearing, devoid of C, and with much lower ²⁸Si/¹⁶O than the ¹⁶O-rich Mg-rich silicates and bulk clast. The O isotopic composition is within 2σ of both the TFL and the slope-1 line, and could reflect either mass-dependent fractionation effects, or mixing with an isotopically heavy reservoir. The O isotopic compositions of secondary dolomite in Ryugu samples showed δ¹⁸O values up to ~30 ‰ [6]. The grain in this study has heavier isotopic composition and is likely not a carbonate. A clast of probable cometary origin within LaPaz Icefield 02342 was found to contain ¹⁶O-poor (δ¹⁸O ~150 ‰) Na-rich sulfate that formed by reaction with isotopically heavy water and a higher abundance of presolar grains than surrounding chondrite matrix [7]. We also found the Ryugu clast to contain a higher abundance of presolar grains than the matrix [8]. It is possible that the ¹⁶O-poor grain is a sulfate that formed through alteration of its precursor by heavy water. However, sulfates have not been observed in Ryugu samples [9]. Alternatively, the grain could be brucite (Mg(OH)₂), which can form by serpentinization of forsterite.

References: [1] Yurimoto H. et al. (2022) *53rd LPSC*, 1377. [2] Yamaguchi A. et al. (2022) *53rd LPSC*, 1822. [3] Liu M.-C. et al. (2022) *53rd LPSC*, 2276. [4] Kawasaki N. et al. (2022) *in preparation*. [5] Young E.D. et al. (2022) *53rd LPSC*, 1290. [6] Nagashima K. et al. (2022) *53rd LPSC*, 1689. [7] Nittler L.R. et al. (2019) *Nat. Astron.* 3, 659. [8] Nguyen A.N. et al. (2022) this meeting. [9] Yokoyama T. et al. (2022) *in preparation*.

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