

**RYUGU PARTICLES FOUND OUTSIDE OF THE HAYABUSA2 SAMPLE CONTAINER.**

S. Inada<sup>1</sup>, A. Nakato<sup>2</sup>, S. Furuya<sup>1,2</sup>, M. Nishimura<sup>2</sup>, T. Yada<sup>2</sup>, M. Abe<sup>2</sup>, T. Usui<sup>2</sup>, H. Yoshida<sup>1</sup>, T. Mikouchi<sup>1</sup>, K. Sakamoto<sup>2</sup>, R. Okazaki<sup>3</sup>, H. Sawada<sup>2</sup> and S. Tachibana<sup>1,2</sup>, <sup>1</sup>The University of Tokyo, 7-3-1 Hongo, Tokyo 113-0033, Japan, <sup>2</sup>Institute of Space and Astronautical Science (ISAS), JAXA, Sagami-hara, Kanagawa 252-5210, Japan, <sup>3</sup>Kyushu University, Motooka, Fukuoka 819-0395, Japan.

**Introduction:** Samples returned from C-type near-Earth asteroid (162173) Ryugu by the Hayabusa2 spacecraft are reported to be in close relation to CI chondrites [1-6]. They were collected at two different touchdown sites and separately stored in the sample catcher, which was transported into the sample container inside the reentry capsule to seal with a metal-to-metal sealing system [7-9]. The reentry capsule was transported from the capsule landing site (the Woomera Prohibited Area in South Australia) to the curation facility in JAXA, where the sample container was opened by the container opening device. During this operation before installation of the sample container into the clean chamber [11], the sample container was cleaned to remove any particles present outside of the metal-to-metal sealing. In the cleaning operation, two millimeter-sized black particles (hereafter Q001 and Q002) were removed from the gap between the inner lid and the sample container (outside of the container sealing). In this study, we investigated mineralogical, petrographical, and chemical characteristics of Q001 and Q002 to relate them to Ryugu grains and/or potential contaminants [12].

**Methods:** Q001 and Q002 were both black in hue like low-albedo surface boulders and pebbles on Ryugu [13-14] or carbon-phenolic ablator of the reentry capsule. Both particles were first examined using stereo microscope (NIKON SMZ1270) followed by surface observation with FE-SEM (Hitachi SU6600) equipped with an EDS at ISAS, JAXA. The polished section of Q001 was also observed with FE-SEM (Hitachi NX2000 at ISAS, JAXA and JEOL JSM 7000F at University of Tokyo) and quantitatively analyzed with FE-EPMA (JEOL JXA-8530F) at University of Tokyo. The analytical condition with FE-EPMA was identical to that in [2].

**Results and discussion:** The surface observation with FE-SEM suggests that both Q001 and Q002 consist mainly of magnesian silicates and contain iron sulfide, iron oxide, carbonates and phosphates, implying their close relation to Ryugu particles [1, 2]. Characteristic morphology of iron sulfide and iron oxide also shows a good agreement with those typically observed in Ryugu particles [1, 2]. The two particles resemble neither the soil at the capsule landing site nor fragments of the ablator. Quantitative compositional analyses of minerals in the polished section of Q001 showed that both magnesian silicate matrix and coarse magnesian silicate have the total cation concentrations as oxides, lower than 100 wt% (70-90 wt%), suggesting that they are phyllosilicates. Other minerals in Q001 are found to be pyrrhotite, pentlandite, dolomite, breunnerite, magnetite, and hydroxyapatite. The elemental compositions and their variations in all the minerals in Q001 well match those in Ryugu particles [1, 2]. We here note that no sulfate, a common mineral phase in CI chondrites [15] formed through terrestrial weathering [16], is found in Q001 and Q002.

The mineralogical, petrographical, and chemical characteristics of Q001 and Q002 particles led us to conclude that they are grains originated from Ryugu, which were expelled from the sample catcher and placed outside the sample container before or during the container closing operation in space.

**References:** [1] Yurimoto H. et al. (2022) *LPSC LIII*, Abstract #1377. [2] Nakamura T. et al. (2022) *LPSC LIII*, Abstract #1753. [3] Noguchi T. et al. (2022) *LPSC LIII*, Abstract #1747. [4] Okazaki R. et al. (2022) *LPSC LIII*, Abstract #1348. [5] Yabuta H. et al. (2022) *LPSC LIII*, Abstract #2241. [6] Naraoka H. et al. (2022) *LPSC LIII*, Abstract #1781. [7] Tachibana S. et al. (2014) *Geochemical Journal* 48:571-587. [8] Sawada H. et al. (2017) *Space Science Reviews* 208:81-106. [9] Okazaki R. et al. (2017) *Space Science Reviews* 208:107-124. [10] Abe M. (2021) In *Sample Return Missions* (ed. A. Longobardo), 241-248. [11] Sakamoto K. et al. (2022) *Earth, Planets and Space*, in press. [12] Sugita S. et al. (2019) *Science* 364: eaaw0422. [13] Yada T. et al. (2021) *Nature Astronomy* 6:214-220. [14] Tachibana S. et al. (2022) *Science* 375:1011-1016. [15] Tomeoka K. and Buseck P. (1988) *Geochimica et Cosmochimica Acta* 52:1627-1640. [16] Gounelle N. and Zolensky M. E. (2001) *Meteoritics & Planetary Science* 36:1321-1329.