An overview of initial descriptions for samples returned from C-type asteroid Ryugu.

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Introduction: Hayaubsa2 spacecraft operated by JAXA explored a near-Earth asteroid 162173 Ryugu from Jun 2017 to Nov 2019 [1]. During the exploration, the spacecraft accomplished touchdown sampling on the asteroid's surface in Feb and Jul of 2019 [2]. The samples recovered by the first touchdown were stored in the Chamber A of a sample catcher and those by the second one were in the Chamber C [2]. The sample catcher was sealed in a sample container, which was set in a reentry capsule of the spacecraft, and the capsule was returned to the Earth, the Woomera Prohibited Area in South Australia, on 6 Dec 2020 [2, 3].

Extraction Procedures for Ryugu samples: As the container was transported from Australia to Japan by air and arrived at cleanrooms of the Extraterrestrial Sample Curation Center (ESCuC), it was disassembled to remove unnecessary parts and cleaned on its surface in the cleanrooms and introduced into the clean chamber (CC) 3-1 to be evacuated to high vacuum [2, 3]. In the static vacuum condition, the container was opened and the sample catcher was extracted from the container. The catcher was transported to the next chamber, CC3-2, and a lid of the Chamber A of the catcher was removed from the catcher and a few mm-size particles were recovered from the Chamber A to a quartz glass container in vacuo. Then the catcher with rest of samples was transported to the next chamber, CC3-3, then the catcher handling environment have changed from vacuum to purified nitrogen condition. Hereafter, all the extraction works and initial descriptions have been done in this purified nitrogen condition in the clean chambers. The catcher was firstly measured with a balance equipped in the chamber CC4-2 to confirm the bulk samples' weight in it, to be 5.4 grams [3]. Then it was dismantled with catcher handling tools in the chamber CC4-1 to recover samples from each chamber of the catcher to sapphire dishes of 23mm in diameter.

Initial descriptions for bulk and individual Ryugu samples: Each of the bulk samples in the dishes were observed and photographed with a stereomicroscope equipped above the chamber CC4-2. Then they were also measured with the balance for their bulk weights to be 3.2 grams and 2.0 grams from the from the Chamber A and C, respectively [4]. They were then analyzed with a Fourier Transmission Infrared spectrometer (FT-IR) for their near infrared reflectance spectra in wavelength ranging from 2.0 to 4.0 μm [4]. They were also analyzed with a MicrOmega, infrared imager comparable to that onboard instrument of MASCOT lander released from Hayabusa2 spacecraft, for obtaining overall and local infrared spectra in the bulk Ryugu samples [1, 5-7]. Finally, they were analyzed with an optical microscopic imaging through six filters (ul: 0.39 μm, b: 0.48μm, v: 0.55 μm, Na: 0.59 μm, w: 0.70 μm, x: 0.85 μm), compatible with the ONC-T camera of Hayabusa2, onboard instrument of Hayabusa2 [8]. After the series of initial descriptions for bulk Ryugu samples, individual particles have been handpicked from the bulk samples to sapphire dishes for individual samples with a vacuum tweezer, and described in the same manner as the bulk samples experienced [9-11]. The results of initial descriptions for bulk Ryugu samples are presented in [4]. Their small bulk densities and dark visible and infrared spectral features indicates that obtained samples are representative of surface materials of Ryugu. Together with absence of high temperature components like a chondrule and a Calcium-Aluminum rich Inclusion (CAI) and presence of 2.7 μm absorption band in infrared spectra, which corresponds to hydroxyls (-OH) absorption implying abundant phyllosilicate, they are most similar to CI chondrites among known planetary materials.

Data archive and sample distributions: All the obtained data by the initial descriptions have been archived in Hayabusa2 sample data catalog [12]. This catalog will be in public soon as a reference of Announcement of Opportunity (AO) for Ryugu samples, which will start in early 2022. Any researcher can apply for the AO, and Ryugu samples will be distributed to Principle Investigators (PIs) of selected proposals in the middle of 2022.

References: [1] Tsuda Y. et al. (2020) *Acta Astron.* 171, 42-54. [2] Tachibana S. et al. (2021) *LPS, XXXXXII*, Abstract #1289. [3] Yada T. et al. (2021) *LPS, XXXXXII*, Abstract #2008. [4] Yada T. et al., *submitted to Nature Astron.* [5] Pilorget C. et al., *submitted to Nature Astron.* [6] Bibring J.-P. et al., *this meeting.* [7] Yogata K. et al., *this meeting*. [8] Sugita S. et al. (2020) *Science* 364, eaaw0422. [9] Miyazaki A. et al., *this meeting*. [10] Hatakeda K. et al., *this meeting*. [11] Cho Y. et al., *this meeting*. [12] Nishimura M. et al., *this meeting*.