Progress report of initial description of the C-type asteroid Ryugu samples returned by Hayabusa2

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The Hayabusa2 spacecraft reached the C-type near-Earth asteroid 162173 Ryugu in June 2018 and observed the asteroid with onboard instruments and from the landers [1-8], and accomplished two touchdown samplings on 22 Feb. and 12 Jul. 2019 [9]. After the 2nd touchdown, the sample catcher which contains samples was transferred into its reentry capsule. The spacecraft left the asteroid in Nov. 2019 and returned the capsule to the Woomera Prohibited Area in South Australia on 6 Dec. 2020. The handling processes for the capsule and the sample container in it after its landing have been detailed in a previous report [10].

The clean chambers in the Extraterrestrial Sample Curation Center of JAXA Sagamihara campus are composed of five chambers; CC3-1~3 and CC4-1~2 [12]. The container was installed into CC3-1 on 11 Dec. 2020 and opened after evacuated to high vacuum. The sample catcher was extracted from the container, and transported to CC3-2. The catcher is composed of three small chambers A, B and C. The chambers A and C contain sample obtained by the 1st and 2nd touchdowns, respectively. As the cover of the chamber A was opened in vacuum in CC3-2, a large number of black particles were observed inside the chamber A, as shown in the Fig. 1. Two particles inside the chamber A were picked up and placed on a quartz glass dish for future science. The catcher with the greater part of samples was transferred to CC3-3, and the gate valve between CC3-2 and CC3-3 was closed. Then, CC3-3 was slowly purged with purified nitrogen gas to the atmospheric pressure, in which the catcher was handled with Viton-coated butyl gloves.

The catcher containing samples was transferred to CC4-2 and its bulk weight was measured with an electronic balance. The total weight of the samples inside the catcher is 5.4g, subtracting the designed weight of the catcher and a tare weight of an attached jig. The catcher was then dismantled to extract samples from the chambers A, B and C to sapphire glass dishes in CC4-1. The bulk samples held in the dishes were photographed with an optical microscope installed above CC4-2. The same microscope was used to take images of the samples with illumination through five filters (0.40 μm (ul), 0.48 μm (b), 0.55 μm (v), 0.59 μm (Na), and 0.70 μm (w)) matched to the ONC-T camera of Hayabusa2 [2]. The weight of each dish was measured with the balance in CC4-2. The bulk samples in the dishes were measured with the FT-IR (JASCO VIR-300) installed to CC4-2 for their average spectra from 1 to 5 μm and were also measured with MicrOmega installed to CC3-3, a noncontact version of the hyperspectral microscope onboard the MASCOT lander [11], to investigate spectral features from 0.99 to 3.65 μm of the samples. After the bulk initial description, individual particles >1mm in size are handpicked one by one with a vacuum tweezer to be enclosed into individual particle containers. They are to be characterized in the

same manner as the bulk samples.

The sample distribution plan was detailed in [12]. JAXA plans to release the announcement of opportunity for the Hayabusa2 samples to the international science community with the sample catalog after 18 months from their return to the Earth.

References: [1] Watanabe S. et al. (2019) Science 364, 268. [2] Sugita S. et al. (2019) Science 364, 252. [3] Kitazato K. et al. (2019) Science 364, 272. [4] Jaumann R. et al. (2019) Science 365, 817. [5] Grott M. et al. (2019) Nat. Astron. [6] Okada T. et al. (2020) Nature 579, 518. [7] Morota T. et al. (2020) Science 368, 654. [8] Arakawa M. (2020) Science 368, 67. [9] Tachibana S. et al. (2020) 51st LPSC, #2027. [10] Tachibana S. et al. (2021) 52nd LPSC, #1289. [11] Bibring J.-P. et al. (2017) Space Sci. Rev. 208, 401. [12] Yada T. et al. (2021) 52nd LPSC, #2008.

Figure 1. A photograph of the sample catcher of Hayabusa2 after opening its chamber A in CC3-2. A large number of black particles are observed inside the chamber. An outer diameter of the catcher is 48mm.

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