

## Overview of the features of returned samples from the C-type asteroid 162173 Ryugu based on optical microscope observations and their weights

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Hayabusa2 collected the surface and sub-surface material from the C-type near-Earth asteroid 162173 Ryugu and brought back 5.4 g of samples in total to the Earth [1]. The samples were collected during the two touch-down operations: the samples collected for the first touch-down (TD1) were stored in the Chamber A of the sample catcher, and those collected for the second touch-down (TD2), which was done near the artificial crater made by the SCI [2], were stored in the Chamber C [3]. In the clean chamber dedicated to Hayabusa2 samples [4], the samples in the Chambers A and C were first put in individual sapphire containers for the initial characterization of bulk properties. The samples were first observed with an optical microscope and it was found that the samples from both chambers were aggregation of black-colored mm-sized pebbles and sub-mm sized fine powder, with millimeter-scale particles being the most common [5]. A few centimeter-sized pebbles were also found in the samples recovered from the Chamber C [1]. Then, weight analysis, optical spectroscopy and visual multispectral imaging were performed for the initial characterization. We will present here the features of the individual returned samples based on the microscopic observations and weight analyses.

Pebbles of 1–10 mm in size were removed from the sapphire containers to individual small sapphire dishes. For the first six months after the sample receipt, 100 pebbles from the Chamber A and 105 from the Chamber C were hand-picked one-by-one with vacuum tweezers in the clean chamber under ultra-purified nitrogen atmosphere without exposing to terrestrial atmosphere [6]. The samples in the sapphire dishes are first photographed with an optical stereomicroscope equipped above the clean chamber through a glass window. The size of the individual samples is measured from the microscopic images. Then, the gross weight of the sample and the sapphire dish in the stainless steel capsule was measured with a microbalance equipped in the CC. The weight of an individual sample inside the dish is calculated based on the gross weight of the dish in the stainless steel capsule which was measured in advance.

The preliminary results were reported in [3] and [5]. The observed Ryugu samples have dark spectral features. Many bright and patchy fine inclusions are observed on the surface of some pebbles, but no apparent high temperature components like chondrules nor Calcium-Aluminum-rich-Inclusions (CAI) has been observed with optical microscope analyses [5]. These pebbles show significant morphological variations; grains with rugged surface and with smooth surfaces are observed [3]. These two types of features were also found on the surface textures on Ryugu boulders [7]. Many pebbles are also found to feature curved and straight cracks and some pebbles show elongated block-like morphologies [3]. Densities of individual grains are estimated from the grain weight and the volume of approximated spheroid evaluated from the optical observation, leading to the average density of  $1282 \pm 231 \text{ kg m}^{-3}$ . This density is much lower than the typical grain density of CI chondrites [5]. We will present more detailed features of the returned individual samples.

### References

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