Methodology of MicrOmega data acquisition/processing in initial description of Ryugu returned samples

Kasumi Yogata[1], Tatsuaki Okada[1,2], Kentaro Hatakeda[1,3], Toru Yada[1], Masahiro Nishimura[1], Aiko Nakato[1], Akiko Miyazaki[1], Kazuya Kumagai[1,3], Yuya Hitomi[1,3], Hiromichi Soejima[1,3], Kana Nagashima[1], Ritsuko Sawada[1,3], Shogo Tachibana[1,2], Masanao Abe[1,4], Tomohiro Usui[1], Jean-Pierre Bibring[5], Cedric Pilorget[5], Vincent Hamm[5], Rosario Brunetto[5], Damien Loizeau[5], Lucie Riu[1,5], Lionel Lourit[5], Guillaume Lequertier[5], and Hayabusa2 MicrOmega-Curation team[1,5]

[1]*Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency,* [2]*University of Tokyo,* [3]*Marine Works Japan, Ltd.,* [4]*The Graduate University for Advanced Studies (SOKENDAI),* [5]*Institut d'Astrophysique Spatiale, Université Paris-Saclay*

The Hayabusa2 spacecraft successfully brought samples back to Earth in December 2020, collected at two different locations on the surface of the C-type asteroid Ryugu. The samples, weighing about 5.4 g, have been transported to the Extraterrestrial Samples Curation Center of JAXA and have been installed in vacuum chambers or pure nitrogen-purged chambers. JAXA curation is currently in the progress of producing catalog data to be included in the database, which is planned to be open in early 2022 towards sample allocation for Announcement of Opportunity [2]. Within this work, basic properties of return samples, for both the aggregate and individually picked-up grains, are acquired using microscopy, weighing, and visible/near-infrared spectroscopy and imaging analyzer. One of the methods is near-infrared hyperspectral microscopy by MicrOmega, developed at IAS (Orsay, France) [3].

MicrOmega is installed in a class 1000 clean room, in contact with a sapphire viewport window of a nitrogen-purged clean chamber. By distant monochromatic light illumination of MicrOmega, it enables non-destructive ultraclean analysis without exposure of the samples to the atmosphere and protecting them from contamination such as water and human-derived organics. MicrOmega has a 5x5 mm Field of View (FOV) and 250x256 pixels with a resolution of 22.5 µm/pixel, and generates a hyperspectral (x,y,λ) cube within the 0.99 to 3.65 µm wavelength range. The performance above can mark the presence of absorption bands suggestive of hydrous minerals at 1.4, 1.9, and 2.7-3.0 µm, and of organics and carbonates at 3.4 µm. Also, its FOV can cover the entire body of a single grain, most of which are about a few mm in size, and the image resolution allows to distinguish interstitial materials such as meteoritic inclusions more than 50-100 µm in diameter.

In the production of data for the catalog, it is important to be careful about the shape-dependent signals of grains. The image often shows strong specular reflection and/or the shadow effect at a certain angle due to the instrument's light illumination incidence angle: 35 degrees. Therefore, for the catalog, two monochromatic images with different angles are generated for each single grain to show the effect of angular dependence. In addition, since the FOV usually includes signal from the sapphire sample dish where the grain sits, we extract the average spectra of the grain area only. Furthermore, if there are areas that show distinctive signatures different from most of the others, specific ROIs are also extracted. The database will contain images showing the ROIs and their spectral data, with comments on the inclusions and minerals they may imply.

In this presentation, we will introduce the MicrOmega data acquisition and data processing, including approaches in the presence of angle-dependent effects and sorting strategies for the curatorial initial description, and the characteristics of typical samples based on results obtained so far for each individual grain.

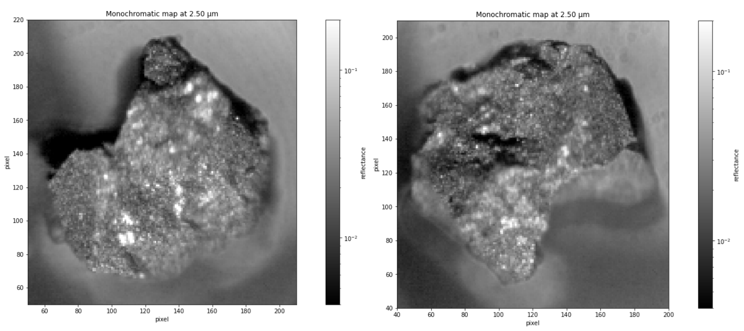

Figure 1. (a) Monochromatic image of A0015 grain at 2.50um at 0 deg, and (b) at 180 deg, showing angular dependence on the reflectance.

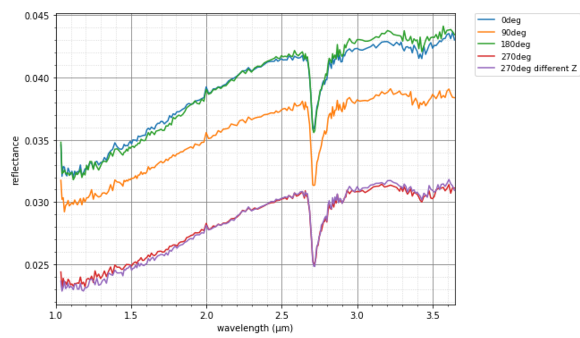

Figure 2. Average reflectance of A0015 at different angles and focal positions.

References: [1] Yada et al. submitted to Nature Astron., [2] Nishimura M. et al. (2021), Astromaterials Data Management in the Era of Sample-Return Missions Community Workshop, Abstract, [3] Pilorget et al. submitted to Nature Astron.