SPECTRAL ANALYSIS OF (162173) RYUGU RETURNED SAMPLE UNDER SIMULATED SPACE VACUUM CONDITIONS

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Introduction: JAXA's Hayabusa2 mission has successfully returned to Earth ~5 g of pebbles and sand from asteroid (162173) Ryugu, a near-Earth carbonaceous asteroid [1]. Preliminary analyses of Ryugu's returned samples revealed they have diverse sizes and contain rugged and smooth particles [2]. Additionally, near-infrared reflectance spectra of Ryugu samples showed the presence of absorption features at ~2.7 µm and ~3.4 µm, attributed to OH- and carbon-bearing materials, including organics and carbonates, respectively [2, 3]. Here, as part of the Hayabusa2 Initial Analysis Stone Team we acquired more spectra of Ryugu samples for further study of the asteroid mineralogy and chemistry. The studied sample (C0002) was retrieved during the mission second touchdown. Ultraviloet (UV), visible and near-infrared (NIR) spectra of the sample were measured in simulated space vacuum conditions.

Instrumentation and Procedure: Bidirectional reflectance spectra (incidence=15°, emission=45°, phase angle=60°) of parts of a large Ryugu sample of C0002 (C0002-003 and 004) (< 500 µm in grain size) were collected at the Laboratory for Spectroscopy under Planetary Environmental Conditions (LabSPEC) at the Johns Hopkins University Applied Physics Laboratory (JHU APL). All spectra were collected under space simulated vacuum conditions using a Bruker Vertex 70 FTIR with a spectral range between ~1 µm to 8 µm and spectral resolution of 0.5 cm^{-1}, a McPherson vacuum UV/vis monochromator spectrometer that covers the spectral range between 0.13 µm and 0.57 µm, and a SVC HR-1024i spectrometer with a spectral range between 0.3 µm and 2.4 µm. The spectrometers were mounted to an ultra-high vacuum (UHV) chamber. Because of the very small quantity of the received sample, we had to design and build a new and custom sample holder (~2 mm in diameter) that we filled with Ryugu sample and loaded into the sealed vacuum chamber. Ryugu sample spectra were collected under ambient conditions and periodically as the chamber pumps down and after the sample was left to pump down overnight. Final sample spectra were measured after the chamber reached its base pressure (~10^{-8} Torr). Because some of our sample was mixed with glycol phthalate glue, we were not able to slightly heat the sample (to drive off the remaining adsorbed terrestrial water) to avoid altering the physical properties of the sample.

Results: Here we present our preliminary spectral measurements and analysis of Ryugu sample C0002. Figure 1 shows a UV/Visible spectrum of the sample, measured under space simulated vacuum conditions. The shown UV/Visible spectrum is characterized by a red slope in the ~0.25-0.57 µm spectral range with no apparent and strong absorption features. In this work, the measured UV, Visible, and NIR spectra of Ryugu sample will also be compared to Ryugu samples that were measured by other teams.

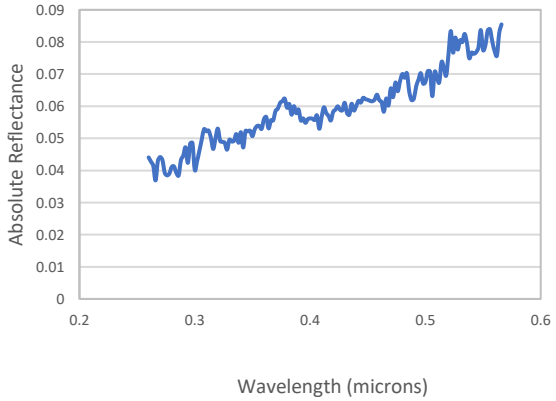

Fig. 1. Reflectance spectrum of Ryugu sample C0002 measured under simulated space vacuum conditions, using a McPherson vacuum UV/vis monochromator spectrometer.

References: [1] Tachibana S. et al. 2022. Science 375, 1011-1016. [2] Yada T. et al. 2021. Nature Astronomy 6, 214-220. [3] Pilorget C. et al. 2022. Nature Astronomy 6, 221-225.

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