**ULTRAVIOLET/VISIBLE REFLECTANCE SPECTRA OF RETURNED SAMPLES OF (162173) RYUGU UNEXPOSED TO EARTH'S ATMOSPHERE.** F. Vilas[1], A. R. Hendrix[1], C. Jaramillo[2], N. Pearson[1], M. E. Zolensky[3], D. L. Domingue[1], E. Cloutis[4], R. Clark[1], G. Holsclaw[5], J. P. Allain[2], T. Nakamura[6], M. Matsuoka[7], K. Amano[6], T. Morita[6], M. Kikuiri[6], E. Kagawa[6], H. Yurimoto[8], T. Noguchi[9], R. Okazaki[10], H. Yabuta[11], H. Naraoka[10], K. Sakamoto[12], S. Tachibana[12,13], S. Watanabe[14], Y. Tsuda[12], [1]Planetary Science Institute (1700 E. Fort Lowell Rd., Suite 106, Tucson, AZ, 85710, USA, fvilas@psi.edu), [2]Pennsylvania State University (State College, PA, USA), [3]NASA Johnson Space Center (Houston, TX, USA), [4]University of Winnipeg (Winnipeg, Manitoba, Canada), [5]University of Colorado (Boulder, CO, USA), [6]Tohoku University (Sendai 980-8578, Japan), [7]LESIA, Observatoire de Paris (Paris, France), [8]Hokkaido University (Sapporo 060-0810, Japan), [9]Kyoto University (Kyoto 606-8502, Japan), [10]Kyushu University (Fukuoka 812-8581, Japan), [11]Hiroshima University (Higashi-Hiroshima 739-8526, Japan), [12]ISAS/JAXA (Sagamihara 252-5210, Japan), [13]The University of Tokyo (Tokyo 113-0033, Japan), [14]Nagoya University (Nagoya 464-8601, Japan).

**Introduction:** Following the successful return of JAXA's Hayabusa2 sample capsule, the material from asteroid (162173) Ryugu retrieved from the spacecraft retrieval container has been the subject of multi-pronged analyses [e.g., 1]. Here, we undertook an effort to acquire reflectance spectra covering 200- to-1100 nm of individual particles from Ryugu (Table I). This spectral region probes the middle ultraviolet (MUV) to acquire reflectance spectra that cover the 250-nm Fresnel peak that can result from increased graphitization (reduced H content) of carbon-bearing materials. Laboratory tests show that increased graphitization could result from the impacts of increased temperature, one of the space weathering processes affecting materials closer to the Sun. Some ground-based reflectance spectra and space-based photometry of Ryugu show that reflectance is increasing with decreasing wavelength, suggesting the beginning of a UV upturn [2]. We sought evidence for space weathering (graphitization) of the sampled Ryugu material at MUV wavelengths, by acquiring reflectance spectra of these surface samples.

**Instrumentation and Procedure:** Five particles of Ryugu's surface material were sent from Japan to the University of Illinois, Champaign-Urbana. These pristine samples from Ryugu were unexposed to ambient air. They were packed in a glove box purged with $N_2$ gas in separate sealed plastic containers at Tohoku University, Japan. Upon receipt, the package was transferred to a glove box also filled with $N_2$ gas (oxygen <0.90 ppm, water <0.40 ppm). We chose to not mix the particles, as they potentially had different compositions. For each particle, separate spectra were acquired.

Each particle was first removed from the sealed plastic container and placed in a compact sample capsule. The sample capsule has the capability to hold small volumes of a sample in a controlled environment (Ar or $N_2$) at ambient pressure; it can preserve an air-sensitive sample for 3 weeks with no visible sample reaction [3]. The sample capsule was then removed from the glove box and positioned with the rest of the spectral apparatus. Adjustments were made to avoid measuring reflections from the chamber. Several spectra of each grain were obtained to ensure repeatability.

The experimental equipment consisted of a light source (AvaLight-DH-S-BAL, Avantes) and spectrometer (AvaSpec-ULS2048XL-EVO, Avantes), fiber optic probes mounted on a goniometer, and the compact sample capsule [3]. Both tungsten and deuterium lamps were used to illuminate the sample across the full spectral region, through a sapphire window in the sample capsule. Spectralon was used as reference material for the measurements.

Table I lists the 5 particles of Ryugu we received. A0055 and A0064 are the particles collected at the first touchdown site, and C0040, C0061-a, and C0103 are those from the second touchdown site. We successfully obtained spectra of three of the particles. The two smallest particles were, however, too small to provide sufficient signal to measure successfully.

Table I. Ryugu particles identifiers and dimensions:

| Sample | Length (μm) | Width (μm) |
|---|---|---|
| A0055 | 1090 | 1037 |
| A0064 | 1242 | 936 |
| C0040 | 1475 | 688 |
| C0061-a | 503 | 426 |
| C0103 | 798 | 654 |

**Interim Results:** Because these particles had not been exposed to air, the best comparison sources for modeling their spectra are spectra of samples not exposed to air, or planetary objects themselves. Since a library of mineral spectra acquired under these conditions does not exist for the MUV, we have been acquiring spectra of terrestrial and meteoritic samples under inert gas conditions in the MUV, as part of a program to build such a spectral library. We have also been comparing the Ryugu laboratory spectra to the UV asteroid spectra we have from space-based observations. Figure 1 shows four spectra of Ryugu chip A0055, demonstrating rough repeatability in the spectra of the chip. The figure also compares these spectra to IUE spectra of B-class asteroids [2]. The similarities to the B-class asteroid spectra in the MUV lend support to the presence of absorption features in the MUV spectral region of the B-class asteroids [2], and provide additional information about the attributes of these asteroids. To date, we find no sign of graphitization. These are preliminary results; current results will be presented.

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**References:** [1] Nakamura T. et al. (2022) Submitted. *Science*. [2] Hendrix A. R. and Vilas F. (2019) *Geophys. Res. Lett., 46*. [3] Jaramillo C. *et al.* (2021) *AGUFM, P11A-06*.

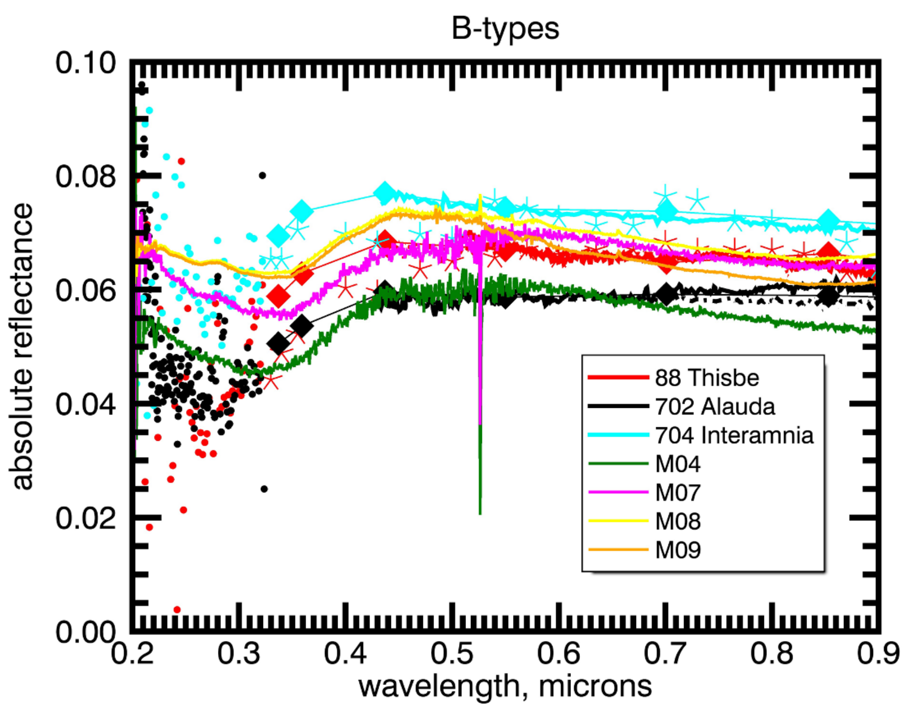


Fig. 1. Four reflectance spectra of Ryugu chip A0055 (M04, M07, M08, and M09) plotted with UV/VIS reflectance spectra of B-class asteroids (88) Thisbe, (702) Alauda, and (704) Interamnia.