COLOR AND SPECTRAL SLOPE MAPS OF ASTEROID RYUGU FROM HAYABUSA2 OPTICAL NAVIGATION CAMERA IMAGES. L. Le Corre[1], V. Reddy[2], K. J. Becker[2], J.-Y. Li[1], E. Tatsumi[3], R. Honda[4], S. Sugita[3], N. Hirata[5], and the *Hayabusa2* ONC team, [1]Planetary Science Institute, Tucson, AZ, USA (lecorre@psi.edu), [2]University of Arizona/Lunar and Planetary Lab, Tucson, AZ, [3]University of Tokyo, Japan, [3]JAXA/ISAS, Japan, [4]University of Aizu, Japan.

Introduction: JAXA's *Hayabusa2* spacecraft arrived at its target, the near-Earth asteroid (NEA) Ryugu, on June 27, 2018. The Optical Navigation Camera - Telescopic (ONC-T) acquired images of Ryugu in seven color filters during the approach phase and after arrival to characterize the surface composition, the photometric properties, and map the color units. The ONC-T color filters span the wavelength range between 0.4-1.0 microns.

We will present the results of our image processing and analysis using the color data of Ryugu from the Optical Navigation Camera (ONC), one of the scientific instruments onboard the *Hayabusa2* spacecraft. Using color image sets and image mosaics, we attempt to constrain the spectral properties and the surface composition of Ryugu, a C-type NEA, thought to be rich in carbonaceous material and hydrated silicates. We studied the correlations between color units identified in our maps and geologic features such as impact craters, boulders and ridges.

Data Processing: For the creation of image products such as color sets and image mosaics, we used ONC images generated with the latest calibration (flat field, distortion coefficients, etc.) in reflectance provided by the ONC team. We implemented the ONC camera model (for ONC-T, -W1, and -W2) and a specific ingestion routine for ONC images in USGS's Integrated Software for Imagers and Spectrometers (ISIS) to retrieve precise geometry information for each pixel in the images, and also for map projection. Images were processed to produce color sets with seven bands and we derived image mosaics using those sets.

Image registration: Part of our processing includes checking for alignment between geometric backplanes and images. This is a critical step to be able to generate color image sets and image mosaics. A byproduct of the shape modeling is improved pointing and trajectory information for the images (Fig. 1). Therefore, images used for shape reconstruction (such as stereophotoclinometry or SPC) can be used without further adjustments to create controlled image mosaics. However, pointing and trajectory updates are not available for all images and different methods have been tested to correct the backplanes in this case.

Image mosaics: Color maps of Ryugu are generated using the latest ray-tracing engine available in ISIS and are based on the best resolution shape model of Ryugu at the time of our processing in DSK (Digital Shape Kernel) format. We discarded pixels that are not directly illuminated by the sun and applied a Lommel-Seeliger photometric correction using the geometric backplanes. All pixels included in the color mosaic are sorted by best spatial resolution so that the end product retains the best information available from the ONC dataset. Our preliminary global image mosaics included images from the proximity phase acquired in July 2018 (figure 2).

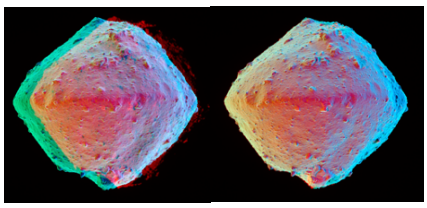

Fig. 1: RGB images of Ryugu with Red as I/F, Green as local incidence angles and Blue as local emission angles. The left image has been generated using the predicted CK and SPK kernels (from JAXA team) whereas the image on the right was created based on the pointing information from the SUMFILEs generated by the shape modeling process also done by the *Hayabusa2* team at JAXA.

Spectral properties: Most color differences on Ryugu are found in mosaics of color ratios and spectral slope. In the visible-IR spectral slope map (figure 3), the equatorial ridge presents a bluer slope relative to the average surface material. Perhaps the equatorial ridge is made of fresher material with slightly brighter reflectance (albedo of ~0.022 at 550 nm compared to the global average value of ~0.020), and was less affected by space weathering (SPWE). This trend would be consistent with changes in spectral slope observed when irradiating some CM2 meteorites in the lab to simulate SPWE. The biggest boulder, Otohime, has the bluest slope and might represent the most pristine material from Ryugu. Interestingly, only the fractured faces of the boulder have this blue slope while the rest of the boulder, appearing darker and more eroded, has a spectral slope similar to the background terrain. Other terrains at the south pole and around Otohime also have a bluer spectral slope. We did not find strong absorption features in the ONC data.

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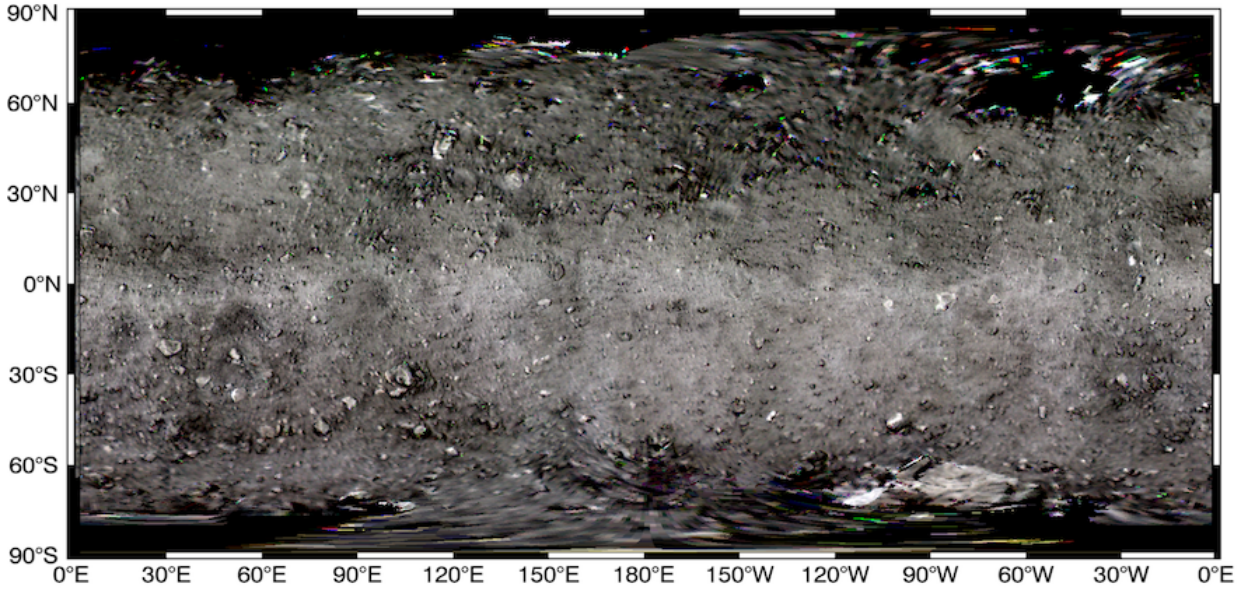

Fig. 2: RGB color composite map with images from July 2018 at 2 m/pixel after photometric correction using Lommel-Seeliger model. This RGB composite is close to true color using filters Na (589 nm), V(550 nm), and B (480 nm). Ryugu appears quite homogeneous in these colors with some terrains at the equator that have higher reflectance.

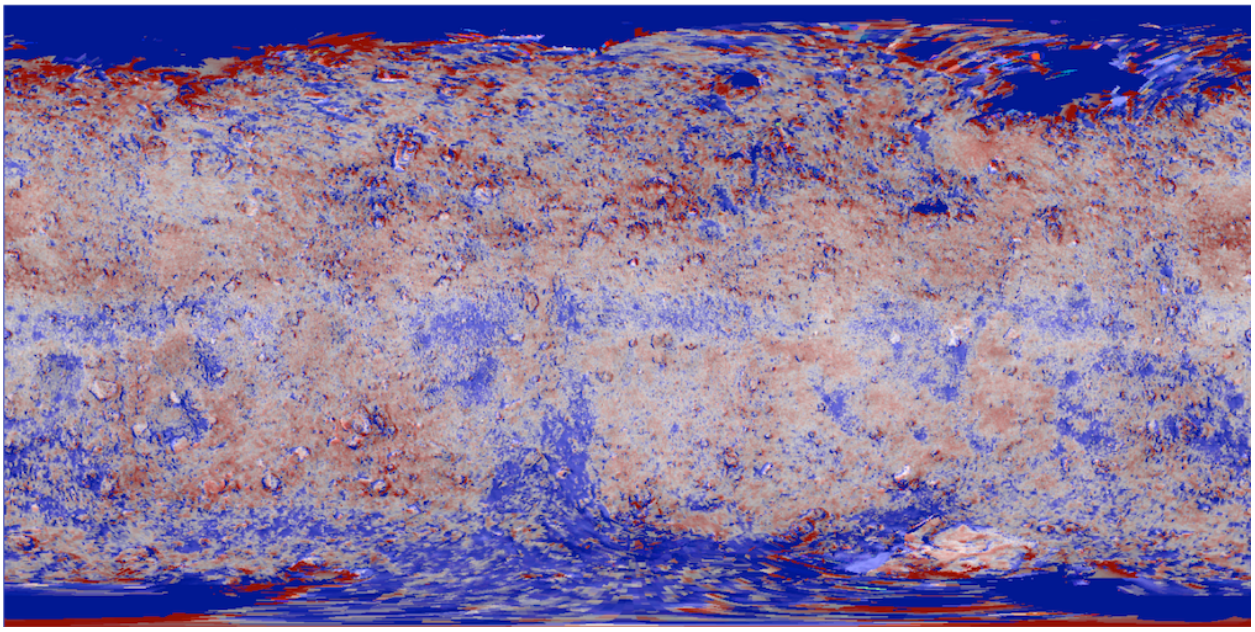

Fig. 3: Map of the slope between the V and P bands displayed as blue-red color scale overlaid on a 550 nm map. This map is derived from the same multi-band image mosaic as figure 2. The regolith material located at the equatorial ridge has a more negative slope in the visible compare to other surrounding terrains. This blue slope unit corresponds to the brighter reflectance unit found on the equatorial ridge on figure 2. At the south pole, other terrains and part of the Otohime boulder also exhibit a bluer spectral slope.