EPSC Abstracts
Vol. 13, EPSC-DPS2019-1198-2, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Processing and analysis of color maps of asteroid Ryugu from ONC-T onboard *Hayabusa2*

Lucille Le Corre (1), Jian-Yang Li (1), Eri Tatsumi (2), Rie Honda (3), Seiji Sugita (2), Naru Hirata (4) and the *Hayabusa2* ONC team;
(1) Planetary Science Institute, Tucson, AZ, USA (lecorre@psi.edu), (2) University of Tokyo, Japan (3) JAXA/ISAS, Japan (4) University of Aizu, Japan.

Abstract

We will present the results of our image processing work using panchromatic and color data of near-Earth asteroid (NEA) 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 surface composition of Ryugu, a C-type NEA, thought to be rich in carbonaceous material and hydrated silicates. Correlations between color units identified in our maps and surface features are investigated.

1. Introduction

JAXA's *Hayabusa2* spacecraft revealed the surface of asteroid Ryugu in great detail after arriving at the target 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 composition of the surface and map the different color units. The ONC-T color filters span the wavelength range between 0.4-1.0 microns.

2. Data processing

2.1 Calibration and camera model

Our processing and analysis are based on images processed with the latest calibration (flat field, distortion coefficients, etc.) provided by the ONC team. In some cases, mostly for the most recent images, conversion from radiance to reflectance needs to be computed.

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 be able to retrieve precise geometric information for each pixel in the images, and also for map projection.

2.2 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.

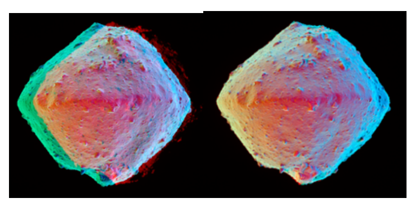

Fig. 1: RGB images of Ryugu with Red as I/F, Green as local incidence angles and Blue as local emission angles. The left image has been generated using the predicted CK and SPK kernels (from JAXA team) whereas the image on the right was created based on the pointing information from the SUMFILEs generated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

2.3 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 as a DSK (Digital Shape Kernel) at the time of our processing. Our preliminary global image mosaics included images from the approach phase and images from the proximity phase acquired in July 2018. Seams visible at image boundaries could be minimized after normalizing viewing conditions using simple photometric models such as Lommel-Seeliger.

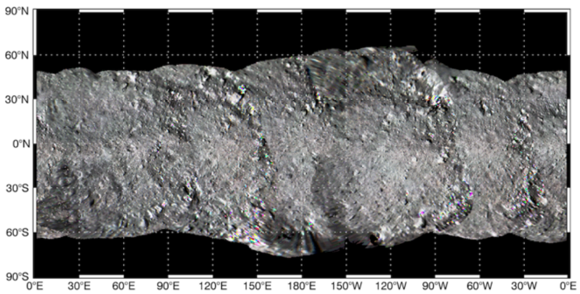

Fig. 2: RGB color composite using filters w, x, and p after photometric correction using modified Lommel-Seeliger model with images at 2 m/pixel.

2.4 Topography

In order to understand the geologic settings for color units, local terrain models were produced using the highest resolution images acquired during several descent operations (descent rehearsals and landers releases). These were also useful for assessing potential sampling and landing sites regarding the presence of hazardous boulders that could put the spacecraft at risk during sampling. Both clear and color images from ONC-T, as well as ONC-W1 images, were employed for DEM computation.

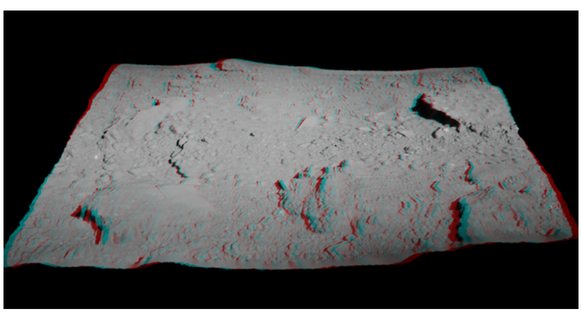

Fig. 3: Example of a DEM generated with ONC-T images from TD1-R1A descent event shown here as an anaglyph (red-blue glasses needed).

3. Color units in global maps

Both color mosaics and color stations we generated were used to perform analysis of the ONC-T images to search for distinct color units and space weathering effects. The advantage of color stations is that the data is not distorted for pixels that are far off the image center because all six color images are reprojected in camera space to the seventh reference color image (Fig. 3). We created color stations with seven filters and use the resulting cubes to build image mosaics. Within a color station, images are acquired <20s apart. The observed color variations across the surface are very small (few %). Only subtle changes in spectral slope and albedo are creating color diversity. The equatorial ridge is slightly brighter in albedo with a bluer spectral slope than the background terrain.

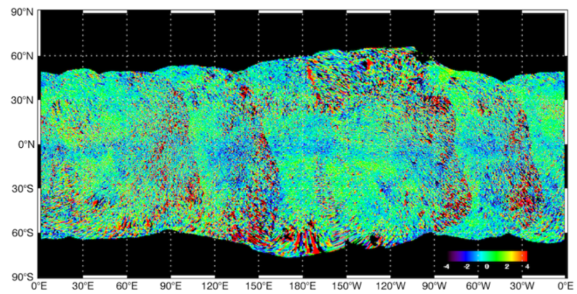

Fig. 5: Spectral slope between the V (550 nm) and P (950 nm) bands relative to average value on Ryugu. The equatorial ridge has a more negative slope in the visible compare to the global average value (bluer).

4. Spectral properties

Most color differences are seen in color ratios/spectral slope for Ryugu: bluer slope at the equatorial ridge relative to the average surface material that exhibits a red slope. Perhaps the fresher material with slightly brighter reflectance and less space weathering effects (bluer slope) is found at the equatorial ridge. The biggest boulder, Otohime, has the bluest slope and might represent the most pristine material from Ryugu. We did not find strong absorption features in the ONC data. No 700 nm absorption feature indicative of hydrated minerals was detected in multiband images.

Acknowledgements

L.L. would like to thank the NASA *Hayabusa2* Participating Scientist program for funding this work.