SPECTRAL PROPERTIES OF BRIGHT AND DARK AREAS ON RYUGU SURFACE.

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Introduction: The JAXA Hayabusa2 spacecraft approached the C-type Near-Earth asteroid 162173 Ryugu on 27th June 2018 [1] and acquired images and spectral data of surface until November 2019, when the spacecraft departed from Ryugu to return to Earth with collected samples. The payload of spacecraft included a Thermal Infrared Imager TIR [2], the NIRS3 spectrometer [3] and the Optical Navigation Camera-Telescopic, with a wideband and seven narrow band filters (ONC-T) [4]. Ryugu is a top-shaped asteroid and ONC images revealed a surface covered by boulders, and characterized by different roughness and albedo [5,6]. NIRS3 reflectance spectra, ranging from 1.8 to 3.1 µm, detected a narrow absorption feature at 2.72 µm across the entire observed surface, indicating the ubiquitous occurrence of hydroxyl (OH)-bearing minerals on Ryugu [7]. NIRS3 data also detected Ryugu as a very dark object with a globally-averaged reflectance at 2.0 µm of about 0.017 [7]. The aim of this work was to detect bright and dark areas on Ryugu surface by using NIRS3 data.

Dark and bright areas: We used calibrated, thermally and photometrically corrected data acquired on 10 and 11 July 2018 and on 19 July 2018, when NIRS3, operating in scanning mode, obtained a near-global coverage of Ryugu surface. The data acquired on 10 and 11 July are characterized by a spatial resolution of 40 m, whereas the data of 19 July have a spatial resolution of 20 m (spacecraft's altitude was 20 km, i.e. Home Position and 13 km, respectively).

We used a method already validated for Ceres and Vesta [8,9] to detect bright and dark areas on Ryugu surface. For each pixel, we obtained the reflectance factor at 1.9 µm and we estimated its mean value (0.017). Bright areas have been defined as regions with a 1.9 µm reflectance larger than the 5.5% than the mean value; dark areas are the regions with a reflectance factor lower than the 8% of the mean value and larger than 0.01 (to avoid false positive due to low S/N).

Results: A total of 36 Bright areas and 28 Dark areas have been detected. A longitudinal dichotomy is observed in the distribution of bright areas, mainly localized in the 240-360°E region, and a latitudinal variation characterizes the distribution of dark areas, mostly focused in the northern hemisphere. Dark areas show a more positive NIR spectral slope (estimated between 1.9 and 2.5 µm) than bright areas (***Figure 1***). Spectra of both dark and bright areas show a weak absorption band at 2.72 µm and a secondary absorption at 2.8 µm. The two bands are moderately correlated and are stronger in brighter areas. NIRS3 and ONC data were compared to characterize the areas in NIR and VIS range. The spectral darkening/brightening observed in the NIR range (by using the 1.9 µm reflectance factor) reflects in the VIS range (by observing the 0.55 µm reflectance). The increasing strength of both the 2.7-µm and 2.8-µm band is related to a VIS spectral reddening (estimated in the 0.48-0.86 µm range). As a result, dark areas could reflect more altered and dehydroxylated material, spectrally like heated Ivuna at 500°C, revealing the thermal metamorphism experienced by Ryugu as a consequence of the fragmentation of its parent body.

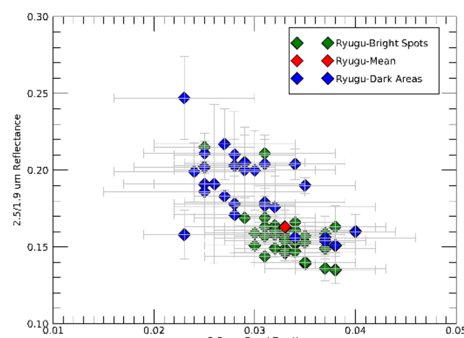

Figure 1: NIR spectral slope vs 2.8 um band depth for dark (blue diamonds) and bright (green diamonds) areas and for Mean Ryugu (red diamond).

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