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Characterization of the craters' surface at Ryugu using NIR spectroscopy

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Asteroid Ryugu was observed up close for almost a year and a half by the instruments on-board the Japanese Aerospace eXploration Agency (JAXA) Hayabusa2 spacecraft. It has been shown that in the near-infrared wavelength ranges, the asteroid exhibits relatively homogeneous spectral characteristics: including a very low reflectance factor, a slight red slope towards longer wavelengths, and a narrow and weak absorption feature centered at 2.72 μm. Numerous craters have been identified at the surface of Ryugu. These features provide good candidates for studying more recently exposed near-surface material to further assess potential spectral/compositional heterogeneities of Ryugu. We present here the results of a spectral survey of all previously identified and referenced craters (Hirata et al. 2020) based on reflectance data acquired by the NIRS3 spectrometer. Globally, we find that the spectral properties inside and outside of craters are very similar, indicating that subsurface material is either compositionally similar to material at the surface that has a longer exposure age or that material at Ryugu's optical surface is spectrally altered over relatively short timescales by external factors such as space weathering. The 2.72 μm band depth, present on the overall surface, exhibits a slight anti-correlation with the reflectance factor selected at 2 μm, which could indicate different surface properties (*e.g.*, grain size and/or porosity) or different alteration processes (*e.g.*, space weathering, shock metamorphism and/or solar heating). We identified four different spectral classes based on their reflectance factor at 2 μm and 2.72 μm absorption strength. The most commonly spectral behavior associated with crater floors, is defined by a slightly lower reflectance at 2 μm and deeper band depth. These spectral characteristics are similar to those of subsurface material excavated by the Hayabusa2

small carry-on impactor (SCI) experiment, suggesting these spectral characteristics may represent materials with a younger surface exposure age. Conversely, these materials may have experienced significant solar heating and desiccation to form finer grains that subsequently migrated towards and preferentially accumulated in areas of low geopotential, such as craters floors. Detailed analyses of the returned samples of Ryugu that are now being investigated at the curation facility in ISAS will allow for further testing of these formation and alteration hypotheses.