# Multi-scale variations of the ~2.7µm feature in Ryugu samples, observed by MicrOmega

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Hayabusa2 is the first space mission to study and collect samples from a C-type asteroid. In December 2020, the spacecraft brought back to Earth ~5.4g of materials from the surface of asteroid (162173) Ryugu. The samples were collected from two different sites TD1 and TD2 [1] at the surface of the asteroid. The second touchdown was performed near the artificial crater created by the small carry-on impactor [2] to collect both surface and subsurface materials. The samples were delivered to JAXA (Japan Aerospace eXploration Agency) Extraterrestrial Curation Center for preliminary analyses. They were extracted from chambers A and C, corresponding to TD1 and TD2 respectively, weighed and analyzed in a controlled $N_2$ environment by an optical microscope, a FTIR, and MicrOmega, a near-infrared (0.99-3.65 µm) hyperspectral microscope. MicrOmega acquires images of 256x250 pixels with a spatial resolution of 22.5 µm. The total field of view covers ~5.7x5.7mm² [3]. The first spectral characterization of the bulk samples within the Curation Facility [4,5] showed that the grains are extremely dark and exhibit absorption features at 2.72 µm, 3.1 µm and 3.4 µm due to phyllosilicates, NH-rich compounds, and organics and/or carbonates respectively. The ~2.7 µm feature was also observed on the asteroid's surface by the NIRS3 spectrometer [6]. In addition to the bulk samples, observations of individual grains, extracted from the bulks, were performed with MicrOmega. We investigate here the variations of the ~2.7 µm feature at different scales, from the millimeter scale to the hundred microns scale, on 177 grains (typical size 1-7 mm) from chambers A and C.

In order to extract an average spectrum of each grain but also to delimit the region of interest to study the spectral heterogeneities inside the grains, we developed a procedure using thermal emission maps measured by MicrOmega. First, each grain was isolated from the rest of the field of view (the sample holder) thanks to their difference in terms of thermal emission. Then, we performed a study of the ~2.7µm band at two different scales. On one hand, all pixels within the mask where averaged to obtain the millimeter scale spectrum of each grain. On the other hand, to better understand the variations at millimeter scale, we looked at smaller scales (<200 µm) to highlight possible heterogeneities within the grains. Two spectral parameters were calculated to characterize the ~2.7 µm OH feature: the peak position was estimated using a gaussian fit, and the band depth was calculated between the minimum of reflectance and a linear continuum.

At millimeter scale, the position of the ~2.7 µm OH feature is consistent with the position found in highly aqueously altered carbonaceous chondrites [7]. Contrary to the bulk spectra where the ~2.7 µm OH feature was very similar between the two chambers [5], the position of the band varies within an interval of 10 nm at individual grain scale and the peak position distribution varies between the two chambers: there is an excess of grains from chamber A with a position at longer wavelength. Another difference is that the band depth of the grains varies within a larger range in chamber A than in chamber C. The analysis at smaller scales (<200 µm) is still ongoing and will be presented at the time of the conference.

We will discuss the spectral differences between the collected grains, in particular between chambers A and C, and what information they carry about the composition of phyllosilicates and the space weathering processes affecting Ryugu's surface materials. Indeed, the OH feature position can change with the Mg/Fe ratio in phyllosilicates [8]. Moreover, space weathering experiments on carbonaceous chondrites [9] have shown that the band position was shifted towards longer wavelength after irradiation. The slight variation of band position we observe at the grain scale is consistent with the shift observed on Ryugu's surface spectra, between the artificial crater and the surrounding surface [10]. We expect that the smaller scale analysis will give hints on the involved processes.

**References**

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