

ACQUEOUS ALTERATION PROBED BY MUTLI-ASSEMBLY AND 3D HETEROGENEITY IN SMALL RYUGU FRAGMENTS.

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Introduction: In December 2020, the Hayabusa2 reentry capsule returned 5.4 g of material from the asteroid Ryugu. A fraction of the collected material was then examined by Initial Analysis Teams. As a part of the Mineralogy / Petrology STONE team, we received ~30 small fragments to study the 3D heterogeneity and the assembly of the different phases.

Material and methods: In this study, we will present the results of a multi-analytical sequence applied to nine micrometric Ryugu fragments (ranging from 30 to 80 μm in size), coming from 3 bigger millimetric grains (A0064, C0046, and C0002). These fragments were welded with platinum on metallic needles using FIB (Focus Ion Beam) microscopes in Saclay and Lille [1]. Then, we analyzed these fragments using an IR micro-tomography setup available at the SMIS beamline of the SOLEIL synchrotron (France). Multiple configurations were used: analyses in transmission by Infrared Computed Tomography [2] (IR-CT) and analyses in reflectance by Infrared Surface Imaging [3] (IR-SI). Regions of interest with peculiar spectral signatures were identified on the 3D volume and 3- μm thin-slices (~ 15 x 20 x 3 μm^3) around these regions were extracted using FIB. They were finally analyzed in 2D with high-resolution IR imaging and SEM-EDX.

Average composition: We will present the average IR spectra in the 2.5 – 12.5 μm range both in reflectance and transmission of the 9 small studied fragments. Several grains showed IR signatures at ~ 2.7 μm , 3.0-3.1 μm , 3.4 μm , and 3.9 μm , in a good agreement with the bands identified by NIRS3 or by MicrOmega in the JAXA curation facility [4,5], plus several mid-IR signatures of great interest, such as bands attributed to Si-O stretching in phyllosilicates, and C=O stretching in organics and carbonates. In general, the 2.7 μm feature observed in our data exhibits similar maximum position but is deeper to the one observed with NIRS3. However, we notice a variability of the composition between the 9 fragments, for instance in the intensity of the 2.7 and 3.4 μm features.

Study of heterogeneity: The small fragment C0002-FO019, exhibits two regions with very different IR signatures. The difference in the position and the shape of the SiO feature could sign different lithologies affected by various degrees of aqueous alteration. In particular, some spectra show a shoulder at ~ 998 cm^{-1} which could be due to anhydrous silicate related to a less-altered lithology [6]. The origin of the variation of the 10 μm band (chemical composition, or structural diversity of the mineral) will be discussed. A correlation with the 2.7 μm band will also be presented. Complementary measurements performed with SEM-EDX to better constrain the mineralogy of the surface of the extracted thin-slices will be presented and we will discuss the structural diversity at the scale of ~100 nm.

References: [1] Aléon-Toppani A. et al. (2021) *Meteoritics & Planetary Science* 56: 1151–1172. [2] Dionnet Z. et al. (2020) *Meteoritics & Planetary Science* 55: 1645-1664. [3] Dionnet Z. et al. (2022) *Meteoritics & Planetary Science* Early view. [4] Pilorget C. et al. (2021) *Nat. Astron.* 6: 221-225. [5] Kitazato K. et al. (2019) *Science* 364: 272-275. [6] Nakamura T. et al. (2022) LPSC abstract #1753.

Acknowledgement: We thank Moe Matsuoka for her precious help in preparing and sending Ryugu's particles from Sendai-Japan all the way to Orsay-France. This work is part of the multi-analytical sequence of the Hayabusa2 "Stone" MIN-PET group, led by Tomoki Nakamura. Zélia Dionnet was supported by a CNES postdoctoral allocation, and this work was supported by the Centre National d'Etudes Spatiales (CNES-France, Hayabusa2 mission). The micro-spectroscopy measurements were supported by grants from Region Ile-de-France (DIM-ACAV) and SOLEIL.