MICROMEGA DETECTIONS OF CARBONATES IN RUYGU RETURNED SAMPLES WITHIN THE HAYABUSA 2 JAXA EXTRATERRESTRIAL CURATION CENTER

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Introduction: The Ryugu samples brought back by the Hayabusa2 spacecraft in December 2020 have been delivered to the JAXA Extraterrestrial Curation Center [1]. Bulk samples and then individual grains have been picked up and stored into sapphire dishes, weighted, and analyzed with an optical microscope, FTIR spectroscopy, and MicrOmega hyperspectral imaging [2-4] for initial description. The MicrOmega instrument used in the JAXA Extraterrestrial Curation Center is a near-infrared (NIR) hyperspectral microscope [5]. It has a total field of view of ~5 mm x 5 mm, with a resolution of ~22 µm/pixel in the focal plane. It covers the spectral domain from 0.99 µm to ~3.6 µm, enabling the identification of most candidate minerals and molecules of relevance (e.g. mafic minerals, altered phases, salts, ices, aliphatic/aromatic CH, NH-rich compounds) [6]. In particular, in the spectral domain of MicrOmega, carbonates have a strong characteristic double absorption band in the 3.3-3.5 µm range, accompanied by two other weaker bands around 2.5 and 2.3 µm. The exact position of these bands varies with the cation content of the carbonate [7]. Iron-bearing carbonates also show a strong Fe^{2+} absorption below 1.5 µm.

Initial analyses with MicrOmega were first made on the bulk samples from chambers A and C of the Hayabusa 2 returned capsule, and then on individual grains stored in their sapphire dishes (by the end of 2021, ~180 individual grains have been analyzed), as well as 14 sub-bulks. Such extensive characterization provides a unique opportunity to assess the different processes that shaped Ryugu's material. Here, we focus on the MicrOmega analyses of Ryugu carbonate-rich grains and inclusions which record the alteration processes encountered on Ryugu parent body.

Results: Spectra of the Ryugu samples at the mm-scale share common features: a very low reflectance (2-3%), an absorption band centered around 2.715 µm attributed to OH, and a weak absorption centered around 3.4 µm attributed to a variety of CH-rich compounds and carbonates [2]. Only at a sub-millimeter scale do heterogeneities clearly show up, either or both at grain level or as inclusions within grains. In total, more than 200 carbonate-rich areas larger than ~45 µm (2x2 MicrOmega pixels) have been detected among the grains and bulks/sub-bulks observed with MicrOmega by the end of 2021 (which does not preclude the presence of carbonates at finer scale). While most of the detections are smaller than ~100 µm in size, the largest carbonate-rich areas can reach several hundreds of µm, displaying various kinds of morphologies.

The analysis of the position of the absorption features enabled the identification of various types of carbonates, similar to dolomite and breunnerite for the large majority of them. These various detections and the context in which they are made will be presented. Implications for the alteration processes encountered on Ryugu's parent body will also be discussed.

References: [1] Yada, T., et al., *Nature Astronomy*, 2021, Volume 6, p. 214-220, [2] Pilorget, C., et al., *Nature Astronomy*, 2021, Volume 6, p. 221-225, [3] Pilorget et al. (2022) this conference. [4] Yogata K. et al. (2022) LPSC, [5] Bibring, J.-P., et al. *Astrobiology*, 2017, Volume 17, Issue 6-7, 2017, pp.621-626., [6] Pilorget C. and Bibring J.-P., PSS, 2014, 99, 7-18. [7] Hunt, G.R. and Salisbury J.W., *Modern Geology*, 1971, 2, 23–30.