P-rich compounds within the Ryugu sample collection: a perspective from joint MicrOmega/Curation, the OU and Phase2 Kochi curation activities

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The JAXA Hayabusa2 mission has returned for the first time samples collected at the surface of a C-type asteroid, Ryugu [1,2]. They are now preserved at the Extraterrestrial Samples Curation Center of JAXA at ISAS in Sagamihara, Japan, where they are submitted to a first round of non-destructive and non-invasive analyses, while maintained in a purely non-altering environment since their collection [3]. Some of these grains have also been extracted to be further analyzed by - initially - 8 analytical teams, including Phase2 Kochi (Ph2K) curation [4,5], and later open to AOs.

The MicrOmega hyperspectral microscope operating in the near-infrared (NIR) range (0.99 – 3.65 µm) is performing the mineralogical and molecular characterization of the samples present in the Curation Center, down to the scale of a few tens of micrometers [6]. By the end of September 2022, >375 individual grains (a few mm in diameter) and 25 sub-bulks (a few tens of mg each) have been analyzed with MicrOmega, in addition to the 6 initial bulks from chamber A and C. It offers a global view on the Ryugu samples, preserved from any terrestrial contamination, and can be used to target specific grains and areas of interest with complementary techniques. In particular, while strong features at 2.7 µm – translating their OH-rich content - and 3.4 µm – diagnostic of the presence of organics – dominate at a global scale, key distinctive signatures have been identified at sub-mm scale [7,8,9,10]. Here we present the international collaborative curation work conducted with the Ph2K and the OU on Ryugu samples and focused on the P-rich compounds.

Specific grains of interest/inclusions have been identified with MicrOmega within the Curation Facility, for having a bright aspect (reflectance of ~10-20%) coupled to a very peculiar spectrum in the NIR: a broad and deep band at ~3 µm, with additional features, in particular a sharp band at ~2.7 µm shifted by ~10 nm compared to the one observed in the matrix [7]. Grains with such properties tend to occur as inclusions or loose grains with sizes up to a few hundreds of microns, similar to carbonates observed by MicrOmega [8] but with a much lower occurrence. Such signatures have been identified in the C0209 sub-bulk delivered to the Ph2K team in April 2022. Grains presenting these properties have been manually extracted and analyzed by SR-XRD at Spring-8 and then combined SEM/EDX at Kochi JAMSTEC, which revealed an enrichment in P, O and Mg elements, possibly pointing towards Mg-phosphates as suggested by other observations on a few samples [11,12]. These grains and the C0209 sub-bulk were then re-analyzed by a MicrOmega unit present at IAS [13]. The results confirmed the correlation between the IR signature and the P, O, Mg content detected by the EDX. Slight modifications of the IR spectra in the 2.7-3.0 µm range points towards a contact with the terrestrial atmosphere after the extraction of the grains from the Curation Center.

These results offer a new perspective on the characterization of the distribution and properties of such compounds over the entire collection. Further analysis of the grains is on-going to assess the possible couplings of the P-rich phases with other compounds (minerals and/or organics) and their origin by H, O isotopic ratios.

References

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