First characterizations of Bennu samples by the NIR hyperspectral microscope MicrOmega at the ISAS Curation Center and comparison with Ryugu samples

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Introduction: On December 2020, the JAXA Hayabusa2 mission successfully returned to Earth ~ 5.4 g of samples collected at the surface of the C-type asteroid Ryugu [1]. The samples are now stored at ISAS Curation Center (Sagamihara, Japan), in a pure N_2-purged controlled chamber, where they were first characterized with different non-destructive techniques, including MicrOmega, a NIR hyperspectral microscope developed at Institut d'Astrophysique Spatiale (Université Paris-Saclay/CNRS, Orsay, France) [2-4]. Hayabusa2 was followed on September 2023 by the NASA OSIRIS-REx mission that returned to Earth ~120 g of samples collected from the B-type asteroid Bennu.Thanks to an agreement between NASA and JAXA, a fraction of Ryugu and Bennu samples was exchanged between both agencies. As a result, ~0.6 g of Bennu samples were extracted from the collection as five different "bulk samples" and delivered in August 2024 to ISAS Curation Center. Similar to Ryugu samples, they are now stored in a pure N_2-purged controled chamber, where they are submitted to a first round of preliminary examination with a suite of instruments, including MicrOmega, which was transfered from the Hayabusa2 facility.

Uniquely, both Ryugu and Bennu samples are now accessible to analyses at the same location, using similar techniques, and in particular the same MicrOmega instrument, enabling rigorous comparison and unique cross-analysis. This will be key as preliminary results on the NASA collection have shown that Bennu samples present some similarities with that of Ryugu [5]: the capability to identify possible differences in their composition will thus be critical to establish the possible different origin and/or evolution of these two objects, and the respective role of their parent bodies regarding the delivery of specific compounds to the terrestrial planets.

Methods: The MicrOmega instrument sequentially illuminates the sample at different wavelengths with an incidence angle of ~35°. For each illuminated wavelength, an image is acquired in a "nadir" configuration. The hyperspectral (x,y,λ) cube is built by scanning the different monochromatic channels in the 0.99-3.65 µm wavelength range. Thanks to the use of an Acousto Optic Tunable Filter (AOTF) as dispersive system, with a Full Width at Half Maximum of ~20 cm^{-1}, the wavelengths can be selected and repeated in any order with minimum sampling steps of ~2 cm^{-1}. For the baselined operations, the typical number of spectral channels per cube varies between ~200 and ~400.

Similar to Ryugu samples, each of the five Bennu "bulk samples" was deposited on a dedicated sapphire sample holder (15 mm diameter at the base, 23 mm diameter at the top) set on a polished gold-coated mirror. The sample holder was set on a (x,y,z,θ,Δ) moving stage, remotely controlled, enabling to locate the entire surface of the sample within the MicrOmega Field of View (256x256 pixels of 22.5x22.5 $µm^2$) and to illuminate the grains with different geometries.

A first campaign of analyses, performed in September 2024, was dedicated to the characterization of the five "bulk samples". Each bulk was fully covered by a mosaic of 10-15 MicrOmega acquisitions, some with different focus to account for irregularities of the top surface of the grains. Such analyzes were repeated for a couple of different orientations to avoid the effect of shadowing. Additional acquisitions were also performed on specific regions of interest.

For each "bulk sample", complementary optical images were obtained with a LEICA visible microscope, set next to the MicrOmega instrument. Importantly, the MicrOmega data were also used to identify and locate regions of interest, that were then targeted by a FTIR point spectrometer with a 2-12 µm spectral range (footprint of a few tens to a few hundreds of microns), providing access to complementary spectral signatures, while still within the Curation Facility.

Results: Preliminary results of the analyses performed on Bennu "bulk samples" with MicrOmega will be presented. In particular, a first comparison between the Bennu and Ryugu samples will be adressed.

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