

COMPARISON OF MINERALOGICAL COMPOSITION OF ASTEROID RYUGU SAMPLES RETURNED BY THE HAYABUSA2 MISSION AND ANTARCTIC MICROMETEORITES (AMMs).

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Introduction: Micrometeorites have preserved pristine material that shed light on primitive conditions of the Solar System. They constitute the dominant extraterrestrial material accreted by the Earth nowadays, and are most efficiently collected in Antarctica (Antarctic micrometeorites – AMMs [1, 2]). Mineralogical composition of micrometeorites allows to retrace their primitive formation conditions and degree of alteration. Primitive carbonaceous (Cb-type) asteroid *Ryugu* samples were returned by the Japanese mission Hayabusa2 in December 2020. Both surface (Chamber A) and potential sub-surface (Chamber C) of *Ryugu* were sampled [3]. The textures and mineralogical compositions of AMMs and *Ryugu* samples are studied to investigate a potential link between these objects.

Materials and methods: Twelve sample from *Ryugu* were prepared and analyzed by analytical scanning electron microscopy (SEM-EDX), electron probe microanalysis (EPMA), or Fourier-transform IR microscopy (μ -FTIR) and far-infrared microscopy (FIR). Among these twelve samples, 5 originate from chamber A (A0064-FO013-17, A0064-FO0020, A0106-13, A0108-15, A0108-19) and 7 were extracted from chamber C samples (C0002-FC016, C0002-FC017, C0040-FC025, C0046-FO004-010, C0057-5, C109-04, C109-10). For SEM & EPMA analysis, they were moved with a quartz needle from their quartz holder to a carbon tape disk and were carbon-coated on 4 stubs. After SEM examination, these stubs were embedded in epoxy and polished with diamond pads down to 0.25 μ m. The AMMs selected for this study were collected in Antarctica from melted ice (Cap Prud'homme) and snow (Concordia collection). AMMs showing magnetite framboids and platelets in a phyllosilicate matrix ("C1-like AMMs") were selected to be compared with *Ryugu* samples. Polished sections of *Ryugu* and AMMs samples were analyzed by EPMA at 15 kV and 10 nA at CAMPARIS University Paris Sorbonne (Jussieu). For μ -FTIR/FIR analyses, the *Ryugu* samples and 4 AMMs samples (DC16-14-315, DC16-11-429, DC16-11-430, DC16-11-436) were flattened in custom-made diamond cells and were analyzed on the SMIS line at synchrotron SOLEIL (France) in July, October 2021 and April 2022. The synchrotron beam was coupled to a Nicolet continuum IR microscope. Hyperspectral maps with a beam aperture of 6 x 6 μ m, and 3 μ m step have been produced, and IR nanospectroscopy (AFM-IR) was also performed on some samples ([4, 5]). Furthermore, 5 AMM FIB-sections were analysed by synchrotron-based STXM-XANES at the C, N and Fe K-edges in September 2021 and February 2022.

Results and discussion: SEM analyses showed that *Ryugu* samples are composed of a fine-grained hydrated matrix containing characteristic aggregates of magnetite framboids, platelets and "sprays", from 200 nm to 1 μ m. EPMA analysis of chamber A and chamber C *Ryugu* samples revealed a dominant phyllosilicate matrix, mostly saponite and Mg-serpentine, with magnetite, carbonates (mostly dolomite), Fe-Ni sulfides such as pyrrhotite or pentlandite, and rare phases such as apatite and a potential Mg-phosphate. The infrared (IR) analyses of *Ryugu* samples revealed widespread organics intimately linked to phyllosilicate matrix and the presence of carbonates and IR-opaque minerals in the matrix [4]. According to EPMA and μ -FTIR analysis of *Ryugu* samples, less and smaller carbonates are observed in chamber C than in chamber A samples. Magnetite framboids and platelets, in that proportion, are typical of C1 meteorites (especially CI1 and CR1), and these characteristic features are also found in ~5% of the AMMs from the Cap Prud'homme and Concordia collections, that we quote as "C1-like AMMs". *Ryugu* samples seem to be enriched in Ca and Mn, as measured by averaging the EPMA measurements, compared to C1-like AMMs, which are comparatively enriched in Al and K. The IR and STXM-XANES analyses of AMMs are being processed, but already confirmed the presence of phyllosilicates (although with a rare structural OH signature, as also seen in other types of hydrated AMMs [8, 9]), carbonates and ferric (Fe³⁺) iron within the matrix of AMMs.

Conclusion: The mineralogical components of *Ryugu* samples show similarities with C1 meteorites, except for the presence of sulfates and the lack of Fe sulfides in C1 meteorites, probably due to the terrestrial alteration of sulfides in C1 meteorites [7]. Around 5% of the Cap Prudhomme and Concordia AMMs show magnetite framboids or platelets ("C1-like AMMs") that show similarities with *Ryugu* samples. The comparison of C1-like AMMs with *Ryugu* samples is ongoing.

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