COMPOSITION OF ULTRACARBONACEOUS ANTARCTIC MICROMETEORITES (UCAMMS). COMPARISON WITH ROSETTA/COSIMA ANALYSES.

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Introduction: Ultracarbonaceous Antarctic Micrometeorites (UCAMMs) are dominated by a polyaromatic organic matter globally N-enriched showing bulk D enrichments, with heterogeneous distributions of the D/H and $^{15}N/^{14}N$ isotopic ratios [1-6]. The abundant organic matter of UCAMMs contains amorphous and crystalline mineral components [7-9]. This high abundance of organic matter is reminiscent of the CHON particles detected in comet 1P/Halley [10, 11], although the size of CHONs was estimated to be on the micrometer to sub-micrometer size, while UCAMMs from the Concordia collection range in size from ~ 30 µm to ~ 200 µm [12]. They most probably originate from the outer regions of the protoplanetary disk, from the cometary reservoir [1, 3, 4], thus we aim at comparing their composition with that of dust particles from comet 67P/Churyumov-Gerasimenko (hereafter 67P) measured by Rosetta/COSIMA [13-15]. A recent summary of the general UCAMM characteristics can be found in [12].

Methods: UCAMMs from the Concordia collection were identified by SEM/EDX, and complementary UCAMM fragments were analyzed by synchrotron-based Fourier transform infrared (FTIR) microscopy at SOLEIL/SMIS, electron microprobe analysis (EMPA) at the CAMPARIS facility (Paris), transmission electron microscopy (TEM) at UMET (Lille), STXM-XANES analyses at synchrotron facilities (ALS Berkeley and SOLEIL/HERMES), NanoSIMS at MNHN Paris and Institut Curie Orsay [1, 3-6, 12, 16, 17]. Recent STXM-XANES analyses were performed at the SOLEIL/HERMES beamline on 4 additional UCAMMs.

Results and discussion: The additional STXM-XANES measurements of 4 UCAMM fragments in FIB-sections confirmed the presence of 3 organic phases in UCAMMs : i) an extended (up to tens of µm) smooth N-rich organic phase with a low O content, which is devoid of crystalline phases but can occasionnaly contain Glass Embedded with Metal and Sulfides (GEMS) inclusions; ii) an organic phase similar to the insoluble organic matter (IOM) extracted from carbonaceous chondrites (with a lower N/C ratio and a O content higher than for the smooth N-rich phase mentioned above), which contains minerals, including crystalline ones; iii) an organic phase associated with "dusty-patches", which also has a low N concentration, but contains less O and shows a higher aromaticity than the previous "IOM-like" organic phase.

UCAMMs analysed so far exibit various proportions of these 3 organic phases, thus showing variable bulk N contents [4, 12]. The N/C atomic ratios of individual UCAMMs varies from ~0.05 to ~ 0.20. The average N/C atomic ratio calculated from 5 UCAMMs is 2 to 3 times that of chondritic IOM. The N/C value calculated for dust particles from 67P is 0.035 ± 0.011 [14], i.e. lower than the average value of UCAMMs but still in the range of the UCAMMs with the lowest N/C atomic ratio.

The C/Si atomic ratio of 67P is compatible with that of Halley dust particles and with the solar value [15]. This may indicate that the dust particles from these comets have well preserved their initial composition in semi-volatile elements. The C/Si of UCAMMs is higher than that of 67P, Halley and the Sun [4, 12], suggesting a local accumulation process of organic matter in the formation process of UCAMMs, such as irradiation of volatile ices in the external and cold regions of the protoplanetary disk, as proposed for the formation of the N-rich organic matter in UCAMMs [18].

The O/Si atomic ratio in UCAMMs is variable, but the average value is a good match to the solar value. The O/Si measured in UCAMMs is generally dominated by the minerals embedded in its organic matter. This similarity in O/Si atomic ratios suggests that the UCAMM mineral component is representative of the composition of the inner solar nebula. Irradiation tracks observed in pyroxenes in one UCAMM (DC060443) [17], indeed supports an origin of these minerals from the inner solar nebula. UCAMMs thus contain materials formed in the inner regions of the solar system and transported outward, mixed with material likely formed in situ in the outer regions of the protoplanetary disk.

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