HYDROGEN ISOTOPE FRACTIONATION IN HYDROCARBON PLASMA: COSMOCHEMICAL IMPLICATIONS.

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The deuterium-hydrogen isotope ratio (D/H) is commonly used to reconstruct the chemical processes at the origin of water and organic compounds in the early solar system(1). On the one hand, the large enrichments in deuterium of the insoluble organic matter (IOM) isolated from the carbonaceous meteorites are interpreted as a heritage of the interstellar medium(2,3) or resulting from ion-molecule reactions taking place in the diffuse part of the solar disk(4). On the other hand, the molecular structure of this IOM, suggests that organic radicals have played a central role in a gas phase organo-synthesis(5).

During the course of experiments aiming at reproducing this type of chemistry between organic radicals, we observed large variations at a sub-micrometric spatial resolution in the IOM isolated from the black organic residues deposited from a microwave plasma of CH_4. They likely reflect the differences in the D/H ratios of the CH_x radicals whose polymerization is at the origin of the IOM. A possible interpretation of this isotope effect may hinge on the differences between the probabilities accounting for the interaction between distinguishable and indistinguishable isotopes (i.e. H-D compared to H-H).

These isotopic heterogeneities are commensurable with those observed in meteorite IOM. As a consequence, the appearance of organic radicals in the ionized regions of the T-Tauri solar disk may have triggered the formation of organic compounds.

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ON THE ORIGIN OF ULTRACARBONACEOUS ANTARCTIC MICROMETEORITES.

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The central regions of Antarctica provide a unique opportunity to collect micrometeorites well preserved from terrestrial weathering [1, 2]. For more than a decade, we have developed a protocol to extract such grains from ultra-clean snow near the CONCORDIA station at Dome C. From such Antarctic collections, it is possible to recover Ultracarbonaceous Antarctic Micrometeorites (UCAMMs) characterized by a high concentration of organic matter (OM) (> 50 vol%) [3, 4]. The OM of UCAMMs exhibits extreme deuterium excesses and is nitrogen-rich, with N/C ratios significantly higher than those reported in IOM from carbonaceous chondrites [5-7].

We will present the latest results on isotopic analyses on UCAMM fragments obtained with the NanoSIMS-50 at Institut Curie. The isotopic compositions of light elements (H, C and N) were measured as C_2D^-/C_2H^-, $^{13}C^-/^{12}C^-$, $^{12}C^{13}C^-/^{12}C_2^-$ and $C^{15}N^-/C^{14}N^-$ using a high mass resolution (HMR) protocol and a dedicated series of standards to infer the D/H instrumental mass fractionation [8, 9]. Together with NanoSIMS data, XANES and TEM data reveal that the OM of UCAMMs contains various components exhibiting different concentration in minerals and a wide range of hydrogen and nitrogen isotopic compositions [10, 11]. Both the elemental and isotopic compositions of UCAMMs indicate that these samples most probably originate from a cometary reservoir. The main part of the UCAMM OM is depleted in minerals and exhibits an intimate mixing of various D-rich components. One mineral-rich OM phase significantly differs from the rest of the OM. We will present a scenario that can account for their high nitrogen concentration and high heterogeneous isotopic composition assuming that the precursors of their OM result from the irradiation by galactic cosmic rays of N-rich ices at the sub-surface of a parent body orbiting at large heliocentric distances.

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