Laboratory investigation of the origin of nitrogen in the insoluble organic matter of carbonaceous meteorites

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Carbonaceous meteorites contain up to 4% of carbon, mainly occurring as insoluble organic matter (IOM), the origin of which remains an unsolved issue despite major achievements in the knowledge of its chemical structure. We recently proposed a model for its molecular structure and suggested that the IOM formation took place in the gas phase of the disk surrounding the Sun in its early T-Tauri phase and that organic radicals played a central role in this organo-synthesis. This was further supported by laboratory syntheses which produced IOM sharing molecular and isotope (D/H) similarities.

However, these experiments experiments were focused on the hydrocarbon backbone of the IOM whereas the meteorite IOM is known to comprise heteroelements such as N, the origin of which remains unclear. To go a step further in the investigation of the potential formation of the meteorite IOM from organic radicals, we performed syntheses with various N-containing precursors to induce reactions between in situ produced CH_x radicals and N_2, NH_3 or NH_y radicals. Synthesized materials were thoroughly extracted to isolate IOM. The latter was then analyzed using the same methods as those previously used to decipher the chemical structure of the meteorite IOM, i.e. through a combination of spectroscopic methods (FTIR and solid state ^{13}C NMR) and pyrolysis coupled with GC-MS so as to achieve a comparison at the molecular level.

All the syntheses led to the formation of IOM and the latter showed some N incorporation (N/C between 0.02 and 0.08). Its N speciation (heterocycles and nitriles) is similar to that observed in meteorites. ^{15}N NanoSIMS analyses are in progress but preliminary results suggest that they allow distinguishing the IOMs produced with the different N sources, thus favoring some N incorporation pathway in the meteorite IOM.