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Evolution of the insoluble organic matter of the CI chondrites under reducing conditions

LAURENT REMUSAT[1], KANA AMANO[2], ERIC QUIRICO[3], SYLVAIN BERNARD[4], LYDIE BONAL[5], PIERRE BECK[6], VAN PHAN[7], LAURÈNE FLANDINET[3], YURI FUJIOKA[8] AND TOMOKI NAKAMURA[8]

[1]CNRS - Muséum National d'Histoire Naturelle (MNHN)
[2]IMPMC, Muséum National d'Histoire Naturelle, Sorbonne Université, CNRS UMR 7590 (Paris)
[3]Université Grenoble Alpes, IPAG, Grenoble, France
[4]Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie, Sorbonne Université - CNRS - MNHN
[5]Institut de Planétologie et d'Astrophysique de Grenoble – Université Grenoble Alpes, CNRS (Grenoble - France)
[6]Institut de Planétologie et d'Astrophysique de Grenoble – Université Grenoble Alpes - CNRS
[7]Université Paris Saclay
[8]Tohoku University

The Insoluble Organic Matter (IOM) isolated from the Ryugu samples shows striking differences in its stable isotope distributions compared to the Orgueil IOM. The D/H ratio appears lower in Ryugu IOM, despite the occurrence of numerous D-rich hotspots, compared to Orgueil IOM whereas the N-isotope distribution is consistent in both IOMs [1]. Ryugu grains returned by the Hayabusa 2 spacecraft were sampled at the surface of the asteroid. They were exposed to the molecular hydrogen of the solar nebula and the hydrogen contained in the solar wind that could modify local redox conditions. We have tested the hypothesis that the differences of the IOM in Orgueil and Ryugu, notably in H-isotope composition, were related to reduction processes.

A sample of the Orgueil CI chondrite was experimentally set to evolve in reducing conditions at 300°C for 50h, 300°C-500h and 500°C-50h. Fe L-edge XANES analysis confirmed the reduction of Fe in the phyllosilicate-rich matrix [2]. The IOM of experimental samples was recovered by HF/HCl demineralization. NanoSIMS imaging shows that the experiment induces a depletion in D of the IOM (that still exhibits D-rich hotspots for the lower temperature experiments), whereas N-isotopic composition is unchanged. This is consistent with the difference observed between Orgueil and Ryugu. Further investigations using FTIR and C K-edge XANES indicate a clear reduction of C=O contribution over aromatic C=C. Similar evolution was observed after experiments on the Orgueil IOM at temperatures up to 500°C under inert atmosphere [3], with the caveat that aromatic structures were shown to grow in the later experiment, whereas in the present study, we rather evidence the formation of new aromatic structures at the expense of aliphatic C. Depletion in C=O contributions is also stronger in experiments conducted in reducing conditions. Interestingly, the IOM in Ryugu was shown to contain less C=O moieties than in Orgueil [4].

[1] Yabuta H. et al. 2023. Science 379, eabn9057. [2] Amano K. et al. 2023. Sci. Adv. 9, eadi3789. [3] Remusat L. et al. 2019. Geochim. Cosmochim. Acta 263, 235–247. [4] Quirico E. et al. 2024. MAPS 59, 1907–1924.