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What if the insoluble organic matter of meteorites showed unexpected molecular diversity?

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Abstract

We developed a new strategy to analyze the insoluble organic matter (IOM) of meteorites. Using laser desorption ionization (LDI) coupled to a high-resolution mass spectrometer (FT-ICR-MS), we demonstrate for the first time that an important molecular diversity with low masses form these IOMs. These results complete the general view of IOM being a set of hydrophobic macromolecules.

1. Introduction

Carbonaceous chondrites (CCs) are fragments of primitive asteroids that are known to contain up to 6 wt.% of organic matter (OM). The insoluble organic matter (IOM) represents 75 to 95 wt.% of the total recovered organic matter. It is therefore the major organic carbon component of CCs. Its Analyses revealed that the IOM is constituted of aromatic units with aliphatic structures bridging aromatic units. Heteroatoms also compose the IOM with mostly oxygen next to nitrogen and sulfur. As a result, the IOM is schematically represented as a cross-linked structure of aromatic and aliphatic units with some heteroatoms, constituting macromolecules. Here, we used a new analytical method to analyse an IOM fraction of Paris meteorite: Laser desorption ionization (LDI) coupled to an ultra-high-resolution mass spectrometer (FT-ICR-MS) on a Paris IOM, which demonstrate that an important molecular diversity with low masses also forms IOM of meteorites.

2. Results

The coupling of LDI with a high-resolution mass spectrometer allows obtaining information on the molecular diversity present in this IOM. We indeed reveal new and original information on the molecular composition, diversity and aromaticity of the Paris IOM that can be related to synthesis environments during the early ages of the solar system.

An unprecedented molecular diversity (Figure 1A) is observed with a wide range of molecular family (Figure 1B).

Molecules observed present low masses with a high aromaticity and the presence of low amounts of heteroatom such as N, O and S.

The molecular cores are based on aromatic rings with various aliphatic branching depending on the molecular family.

Pure PAH are also observed, and fullerenes are observed at higher laser energy, suggesting a formation from high PAH structures that could correspond to a part of the IOM macromolecular structure.

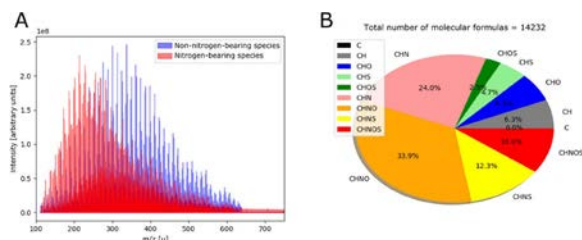


Figure 1: (A) Mass Spectrum of the Paris IOM analyzed by LDI FT-ICR-MS and (B) the repartition of the different molecular families.

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