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Is icy grains of dense molecular clouds at the origin of a fraction of the organic content of meteorites?

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Abstract

Using laboratory experiments, we test the hypothesis of dense molecular cloud icy grains as a possible source of organic matter observed in current meteorites on Earth. These experimental simulations allow to trace the evolution of organics during their evolution all along the solar nebula evolution up to their incorporation and evolution on parent bodies of meteorites. A multi-technic analytical methodology is used to analyze volatile and solid organics fractions at various stages of their evolution, providing information on the different steps that could have led to current organics observed in carbonaceous chondrites.

1. Introduction

Carbonaceous chondrites are sources of information witness on the origin of the solar system. Their organic content is conventionally classified as soluble (SOM) and insoluble organic matter (IOM), where the latter represents the majority of their organic content. Relationships between SOM and IOM are still unknown, and their possible link is still debated. Using laboratory experiments, processes possibly at the origin of SOM and IOM are investigated, by assuming that dense molecular ices is one of the sources of organic matter of the solar system. Each organic fraction is analyzed by different analytical technics providing a complete information on their composition and evolution.

2. Results

Laboratory experiments are used to simulate the organic matter that could be formed at the surface of grains of dense molecular clouds during the formation and evolution of the solar nebula evolution. Organics formed in laboratory are then considered as analogues to the ones present in protoplanetary grains that could be then incorporated in the forthcoming asteroids and comets. In these interplanetary bodies, they could endure secondary alteration such as

aqueous alteration or metamorphism. These simulations from dense molecular clouds to asteroids provide the formation of soluble and insoluble organic matter, which compositions differ depending on local environments.

Results on laboratory are then compared to organic content of natural objects that are SOM and IOM of meteorites. This approach provide information on the scenario in which icy grains of dense molecular clouds could have been at the origin of the organic content of interplanetary bodies of the solar systems.

Dense molecular ices are a source of a high molecular diversity.

Organics generated from icy grains differ from the ones observed in the SOM of meteorites.

Aqueous alteration of organics generated from icy grains simulating secondary alteration inside asteroids present an important evolution that gives molecular similarities with meteorite SOM.

The soluble organics formed from icy grains can be a source of insoluble organic matter at the surface of grains.

The insoluble organics formed from the soluble organic processing present similarities with the IOM of meteorites.

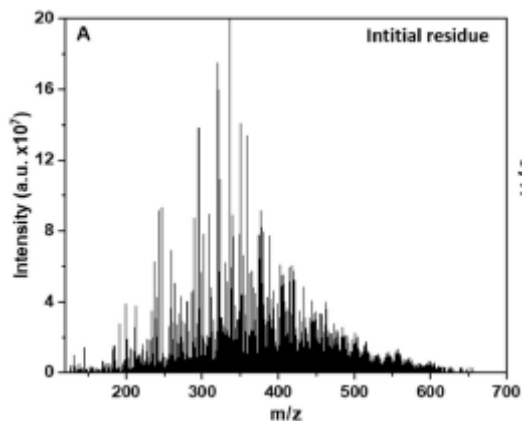


Figure: Mass spectrum of an organic residue analogue to what could be observed on grains of protoplanetary grains.

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