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Conference or Workshop Item

DID ORGANIC COMPOUNDS IN THE TAGISH LAKE METEORITE FORM VIA CATALYTIC PROCESSES IN THE SOLAR NEBULA AND WITHIN PARENT BODIES?

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Introduction: Dust-catalyzed reactions of the Fischer-Tropsch-type (FTT) and Haber-Bosch-type (HBT) almost certainly contributed to the production of gaseous organic and N-containing compounds in the warm, inner Solar nebula [1,2]. In addition, the surfaces of these nebular dust grains (amorphous silicates, oxides, etc.) were probably rich in high molecular weight organics [2,3]. However, the link between such catalytic processes and the organic content of chondrites is poorly understood [1,2]. Here, we compare the organic composition of the Tagish Lake meteorite with likely FTT and HBT catalysis products in the Solar nebula and in parent bodies in an attempt to ascertain whether the apparently restricted distribution of organic compounds in Tagish Lake is consistent with catalytic synthesis.

Analytical Methods and Results: The samples studied were silicate smokes ("synthetic nebular dust") following catalytic experiments [1-3] and fragments of the Tagish Lake meteorite. The organic analyses were performed using pyrolysis-gas chromatography mass spectrometry (Py-GCMS) and the methods have been summarized elsewhere [3,4]. The predominant compounds observed in the catalysis products were homologous series of aliphatic hydrocarbons, aromatic hydrocarbons and nitrile-aromatic hydrocarbons [3]. Tagish Lake macromolecular material is highly aromatic in character – the dominant pyrolysis products are parental PAHs, alkyl-substituted PAHs being scarce by comparison. Pyrolysis also revealed the presence of several heteroatom species such as O-containing phenols, S-containing thiopphenes and benzonthiophenes and N-containing species such as benzonitrile [4].

Implications: Meteoritic organic matter in CM2 chondrites such as Murchison is characterized by structural diversity and a general decrease in abundance with increasing molecular weight. The more restricted distribution observed in the free aromatic inventory of Tagish Lake has led to the suggestion [5] that it may reflect a contribution from processes involving catalytic synthesis since these tend to be more selective in the classes of compounds they produce than other synthetic pathways. FTT synthesis typically produces relatively aliphatic-rich products. However re-processing of these products leads to progressive aromatization and the production of more complex molecules, as we noted in the course of our catalytic experiments [2]. Tagish Lake macromolecular organic matter is extremely aromatic in nature, although the free organic inventory does contain aliphatic material in the form of carboxylic and dicarboxylic acids [5]. It would appear, therefore, that FTT/HBT products formed in the inner Solar nebula could have contributed to the Tagish Lake meteorite's parent body. However, if so, they were likely subjected to extensive secondary processing in this environment.

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