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Free and bound carboxylic acids in carbonaceous chondrites.

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Geological processing has long-since obliterated the Earth-based record of pre-biotic chemical evolution. However, remains of the materials that were involved in the construction of the Earth are preserved in ancient asteroids, fragments of which are naturally-delivered to the Earth as meteorites. Carbonaceous chondrites are a particularly primitive class of meteorite that contain 2 to 5 wt. % carbon, most of which is present as organic matter (Sephton, 2002). There have been relatively few studies of polar moieties in the macromolecular organic matter in carbonaceous chondrites (e.g. Hayatsu et al., 1980). NMR data suggests that there are various oxygen-containing functionalities in Murchison (e.g. Cody et al., 2002).

A HF/HCl residue from a sample of Murchison meteorite was subjected to thermochemolysis followed by analysis by GC-MS and GC-IRMS. The most abundant compound released by thermochemolysis was benzoic acid and other abundant compounds include methyl and dimethyl benzoic acids. Short chain α,ω-dicarboxylic acids (C_{4-8}) were also released from the macromolecule similar to those observed in solvent extracts of the same meteorite. Other compounds detected include fluoranone, dimethylsulfone and aromatic hydrocarbons. The distribution of the C_1 and C_2 benzoic acids (BA) contain all possible structural isomers (except the ethyl BA; see Fig 1). The most abundant isomers include 3,4-dimethylbenzoic acid (DMBA), 3,5-DMBA, 2,6-DMBA and phenylacetic acid. By contrast the most abundant organic acids in the free fraction are the aliphatic C_4-C_9 α,ω-dicarboxylic acids with all structural isomers present. Aromatic acids detected include benzoic acid, C_1

benzoic acids and phthalic acids; no C_2 benzoic acids or naphthoic acids were detected unlike the bound fraction.

There are two possible mechanisms for the formation of meteoritic organic acids; firstly irradiation of cosmic ices by UV or cosmic particle radiation and secondly and more likely, oxidation of free hydrocarbons or of macromolecular material. Bound acids will be formed from free acids being transesterfied into the macromolecule. The aliphatic acids will probably be destroyed by further oxidation whereas the aromatic acids require ring cleavage for complete oxidation and are therefore more resistant to complete mineralisation. The origin and significance of bound organic acids within meteorites and their relationship with the free carboxylic acids within carbonaceous chondrites will be discussed.

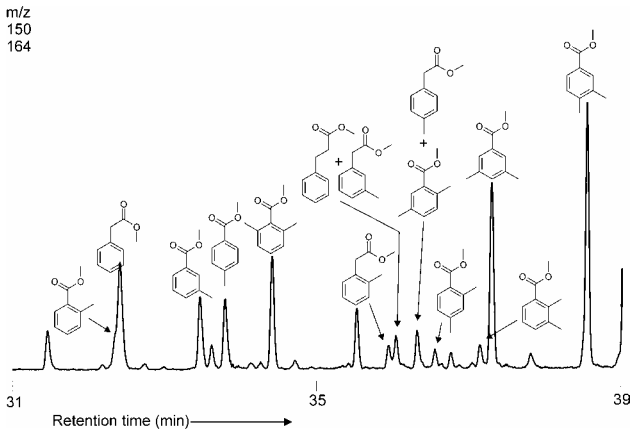

Fig 1: Partially reconstructed mass chromatogram (*m/z* 150 + 164) displaying the C_1 and C_2 benzoic acids (as methyl esters) released upon thermochemolysis of HF/HCl residue from Murchison.

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