Analysis of Tagish Lake macromolecular organic material

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ANALYSIS OF TAGISH LAKE MACROMOLECULAR ORGANIC MATERIAL. I. Gilmour, V.K. Pearson and M.A. Sephton, Planetary and Space Sciences Research Institute, The Open University, Milton Keynes MK7 6AA, United Kingdom (I.Gilmour@open.ac.uk).

Introduction: The fall and recovery of the Tagish Lake meteorite [1] has provided a unique opportunity to study the organic composition of what is possibly a new type of carbonaceous chondrite. The bulk element abundances of Tagish Lake have led to the suggestion [1] that it is more primitive than type 1 CI chondrites. Preliminary analysis indicated that it contains around 3.6 – 5.4 wt % C of which some 3.7 wt % is carbonate [1], much of the remainder being organic carbon. The majority of this organic matter occurs as a complex macromolecular material. We have undertaken a flash pyrolysis-gas chromatography-mass spectrometry study of Tagish Lake to examine the chemical composition of this macromolecular material and have compared the results with those obtained from the type 2 CM chondrite Murchison.

Experimental: Around 30 mg of whole-rock meteorite that had been kept cold since its fall (at ca. -20°C) was loaded into a pre-cleaned quartz glass tube. The sample was flash pyrolysed at 610°C using a CDS 1000 pyroprobe (CDS Analytical, Oxford, PA), within 15 s after insertion into the interface, for 15 s in a flow of helium. The heating rate of pyrolysis was 20°C ms⁻¹. The interface was held at 260°C and the GC injector maintained at 250°C. The GC oven was operated under the following conditions: initial isothermal hold for 2 min at 50°C; temperature programmed at 5°C/min to 300°C and final isothermal hold for 8 min. The pyrolysate was analysed on an Agilent Technologies 5973 GCMS operated in fullscan electron ionization mode (50-500 Da, 1.8 scan s⁻¹, 70 eV electron energy).

Following the initial pyrolysis at 610°C, the sample was pyrolysed a second time at 1000°C, all other conditions were the same as for the first run. A similar-sized sample of whole-rock Murchison meteorite was also pyrolysed under identical conditions for comparison.

Results: The total ion chromatogram for the 610°C pyrolysis is shown in Figure 1a. In general, the pyrolysate is dominated by aromatic compounds, however, two compounds predominate: the C₁₆ polycyclic aromatic hydrocarbons fluoranthe and pyrene. Other polycyclic aromatic hydrocarbons are also present, though in much lower quantities. Figures 1b – 1e are reconstructed ion chromatograms that show the distribution of 1-ring to 4-ring aromatic hydrocarbons.

The pyrolysate of Tagish Lake is dominated by relatively high-molecular weight aromatic compounds; small quantities of the C₁₈ PAHs chrysene and benzanthracene were observed in the pyrolysate. Relatively small quantities of one and two-ring species were observed, although chromatographic resolution of one-ring aromatics was difficult due to the release of substantial quantities of sulfur which co-eluted with benzene and toluene.

Conclusions: Pyrolysates of the Tagish Lake meteorite are dominated by two high molecular weight PAHs suggesting that the macromolecular material in Tagish Lake consists of a highly condensed aromatic network.

Figure 1. Mass chromatograms of pyrolysates released from a 610 °C flash pyrolysis of Tagish Lake. (a) Total ion current chromatogram, (b) Mass chromatogram (m/z 128, 141, 142, 155, 156) showing C0-C3 alkyl naphthalenes, (c) Mass chromatogram (m/z 134, 147, 148, 161, 162) showing C0-C2 alkylbenzo[b]thiophenes, (d) Mass chromatogram (m/z 178, 192, 206) showing C0-C2 alkyl phenanthrenes, (e) Mass chromatogram (m/z 202, 216, 230) showing C0-C2 alkyl pyrenes/fluoranthenes.