

HYDROPYROLYSIS OF INSOLUBLE CARBONACEOUS MATTER IN THE MURCHISON METEORITE

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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 (Septon, 2002).

Much of our current understanding of meteoritic organic matter has come from investigations of the Murchison carbonaceous chondrite, approximately 100 kg of which fell in Australia in 1969. Over the last three decades Murchison has been the focus of intensive research using the most modern techniques and, consequently, the Murchison organic inventory has become a valuable reference to which all other meteoritic organic matter may be compared. The major organic component in Murchison is a solvent-insoluble, high molecular weight macromolecular material that constitutes at least 70% of the total organic content in the meteorite. As the dominant organic entity, this component is key to understanding the origin of meteoritic organic matter. The macromolecular material consists of an aromatic framework linked and surrounded by short functional groups.

Analytical pyrolysis is often used to thermally decompose macromolecular organic matter in an inert atmosphere into lower molecular weight fragments that are more amenable to conventional organic analytical techniques. Hydropyrolysis refers to pyrolysis assisted by continuous flow high hydrogen gas pressures and a dispersed sulphided molybdenum catalyst. This method retains structures and stereochemistries. Hydropyrolysis of the Murchison macromolecular material successfully releases significant amounts of high molecular weight PAH (Fig. 1). The majority of the carbon in the Murchison hydropyrolysate appears to be present as three- to seven-ring polyaromatic hydrocarbons (PAH) including phenanthrene, fluoranthene, pyrene, chrysene, perylene, benzoperylene and coronene units with varying degrees of alkylation. The absence of long-chain alkyl substituents indicates that these moieties exist within or around the aromatic network as hydroaromatic rings and short alkyl substituents or bridging groups. The higher molecular weight PAH within the pyrolysable macromolecular material extend up to coronene. Carbazole is a dominant nitrogen heterocyclic compound in the hydropyrolysate.

Although hydropyrolysis liberates substantial amounts of organic matter from the macromolecular material, over 50% of macromolecular carbon remains unconverted. Hence, the meteoritic organic network contains both labile (pyrolysable) and refractory (non-pyrolysable) fractions. Comparisons with experimental yields from bituminous coals (over

85%) indicate that this refractory residue probably consists of a network dominated by at least five- or six-ring PAH moieties cross-linked together.

Current work is extending the data set to include the hydropyrolysates of several carbonaceous chondrites that have been subjected to different levels of alteration on their parent body to assess if there is any discernible macromolecular record of secondary processing.

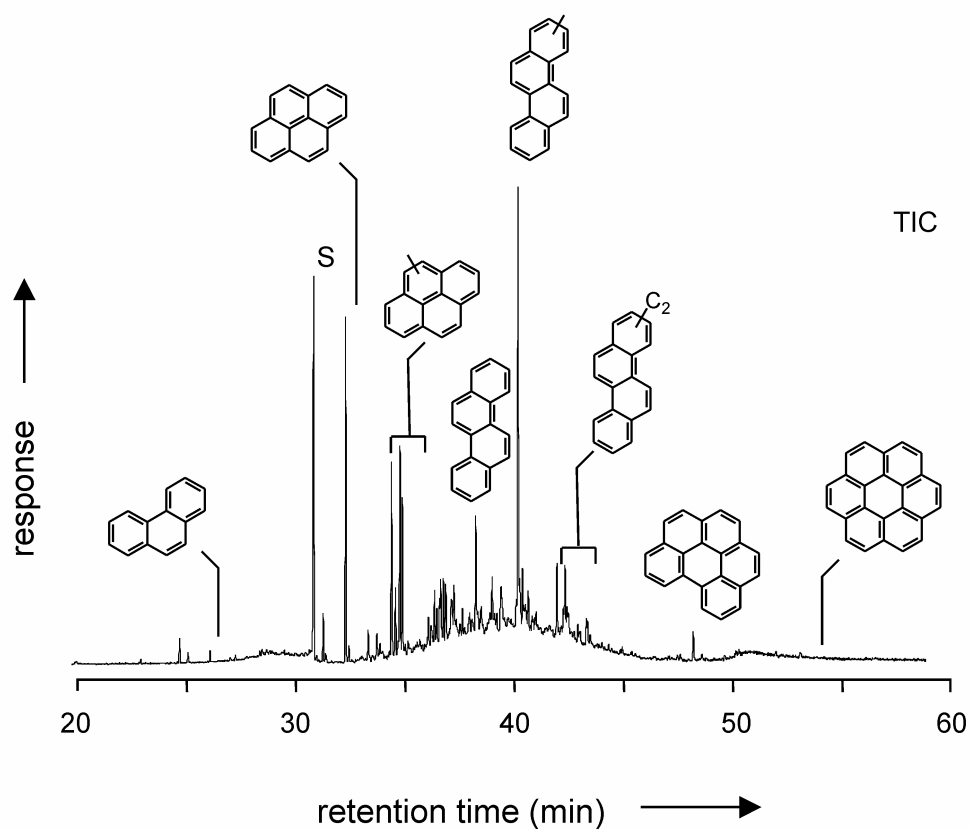


Figure 1. Total ion chromatogram (TIC) of the hydropyrolysate from the Murchison meteorite. (S) elemental sulphur

REFERENCES

Sephton, M.A., 2002. Organic compounds in carbonaceous meteorites. *Natural Product Reports* 19, 292-311.