Preliminary investigation into the use of surface modification techniques to detect organic materials in meteorites

Conference or Workshop Item

PRELIMINARY INVESTIGATION INTO THE USE OF SURFACE MODIFICATION TECHNIQUES TO DETECT ORGANIC MATERIALS IN METEORITES.

M. D Goodyear[1,2], I. Gilmour[1] and V.K. Pearson[1,2]. [1]Planetary and Space Sciences Research Institute and [2]Department of Chemical and Analytical Sciences, The Open University, Milton Keynes, MK7 6AA, UK (m.d.goodyear@open.ac.uk).

Introduction: Many carbonaceous chondrites (CCs) display evidence of aqueous and/or thermal alteration of their component minerals [1]. In addition, CCs also contain up to *ca*. 5% carbon [2], much of which is organic, insoluble, involatile and unreactive, and known as insoluble organic material (IOM). It is not known if there is a causal connection between the mineral alteration, and formation or modification of organic materials [3]; however by understanding the relationships between them, any connections (chemical or physical) could be established.

Analytical constraints: Organic analysis of CCs generally requires extraction or demineralisation; mineralogy is often studied in polished surfaces or thin section. None of these methods is suitable for this study, as all spatial information would either be lost, or compromised (e.g. by mechanical redistribution). Scanning Electron Microscopy (SEM), and Raman Spectroscopy are useful complementary techniques, requiring minimal surface preparation and yielding information *in situ*, on both the mineralogy (from SEM) and organic content (from Raman) of a region under study. It is essential the sample be accurately aligned and imaged, so the same area is studied using both methods.

Experimental: We present preliminary work directed towards the application of molecular tags, whereby more-easily detectable atoms or functional groups (i.e. those not typically present in untreated meteorites) are attached to the IOM.

Ozonolysis. To increase its reactivity to tagging, IOM is pretreated with ozone, to introduce oxygen-containing functional groups, such as carboxylic acids or ketones. The resulting compounds can then be converted into a range of derivatives containing the chosen tag. Conditions for ozonolysis were developed by following the reaction of polycyclic aromatic hydrocarbon (PAH) standards, typical of those believed to make up the IOM backbone [4], on inert mineral supports, e.g. silica or sandstone. Samples of Murchison were ozonised and examined by SEM and Raman spectroscopy, the latter incorporating image processing to ensure in each case, the same sample region was being studied.

Molecular tagging. Reaction conditions have been developed to enable the introduction of a range of molecular tags into ozonolysis-generated oxygen-containing functional groups, initially using model compounds again supported on inert minerals. Using these methods, standard acids (carboxylic and amino-), alcohols, phenols, aldehydes and ketones have been tagged with fragments containing fluorine or chlorine; work to apply this methodology to meteorites is ongoing.

Results: Good-quality, aligned and focused images were obtained using both SEM and Raman, allowing mapping of elemental abundance and organic content. The derivatisation of IOM by ozonolysis, (indicated by the changes observed in the Raman signal), shows that the IOM can next be subjected to molecular tagging.

References: [1] Brearley A. J. (2005) *Treatise on Geochemistry*, Vol 1, 1.09:247-268. [2] Sephton M. (2002) *Natural Product Reports*, 19:292-311. [3] Zega T. J. et al. (2010) *Geochimica et Cosmochimica Acta*, 74:5966-5983. [4] Derrene S. and Robert F. (2010) *Meteoritics and Planetary Science*, 45:1461-1475