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The association between organic matter and clay minerals in carbonaceous chondrites

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THE ASSOCIATION BETWEEN ORGANIC MATTER AND CLAY MINERALS IN CARBONACEOUS CHONDRITES. V. K. Pearson, M. A. Sephton, P. A. Bland, I. A. Franchi and I. Gilmour. Planetary and Space Sciences Research Institute, The Open University, Milton Keynes MK7 6AA, United Kingdom. (v.k.pearson@open.ac.uk)

Introduction: There is an established relationship between organic matter content and aqueous alteration processes [1,2]. However, the relationship between meteoritic organic matter and individual aqueously generated mineral matrix phases is poorly understood.

Meteoritic organic matter is primarily composed of C, H and N and therefore their bulk abundances in chondrites are strongly controlled by the organic matter content. Mössbauer Spectroscopy can characterise the ferric iron bearing matrix minerals associated with aqueous alteration, such as Fe-bearing clays and magnetite. A combination of these two parameters may indicate the presence of any organic-mineral interactions.

Experimental: 22 whole-rock samples representing types CI, CM, CR, CO, CV and CK carbonaceous chondrites, in powder or chip form were analysed. C, N and H concentrations were determined using an Elemental Analyser-Isotope Ratio Mass Spectrometer (Europa ANCA-SL). Sample size varied between 2.09-19.92 mg. ^{57}Fe Mössbauer spectra were recorded at 298K with a microprocessor-controlled spectrometer using a $^{57}\text{Co/Rh}$ source. Sample size varied between 0.2-0.3mg.

Results and discussion: Combining Mössbauer and elemental abundance data indicates that there is a general correlation between C, H and N abundances and established extent of pre-terrestrial aqueous alteration as quantified by total oxidation of Fe-bearing mineral phases [3]. This has been supported by Spearman's Correlation Coefficients (r_s). The data also indicates there are strong relationships between C, H and N and the paramagnetic iron within hydrothermally produced clay minerals (Fig. 1A). Surprisingly, no correlation is seen with magnetite alone (Fig. 1B).

Within terrestrial systems, it has been suggested that clay surfaces may adsorb labile organic compounds allowing them to accumulate, condense and polymerise [4,5]. However, the amount of organic matter associated with clays is greater than that which can be accommodated through adsorption processes. It has been proposed that the trapping of organic matter within the inter-layer spacings of clays [6] combined with adsorption may offer an improved mechanism. This sorptive protection mechanism has been proposed as a means for the sequestration and protection of organic material.

Within chondrites, this is supported by the observation that the majority of carbonaceous material is located within clay rich, aqueously altered rims around

anhydrous precursors [2]. Furthermore, it has been noted that significant amounts of organic molecules are liberated from solvent extracted carbonaceous chondrites following demineralisation procedures [7].

Conclusion: Elemental abundances indicative of organic matter correlate with the abundance of hydrothermally produced clay minerals but not magnetite. This association may be due to the adsorption and trapping of the organic molecules between clay interlayer spacings. These interactions may explain the preservation of macromolecular organic material within carbonaceous chondrites.

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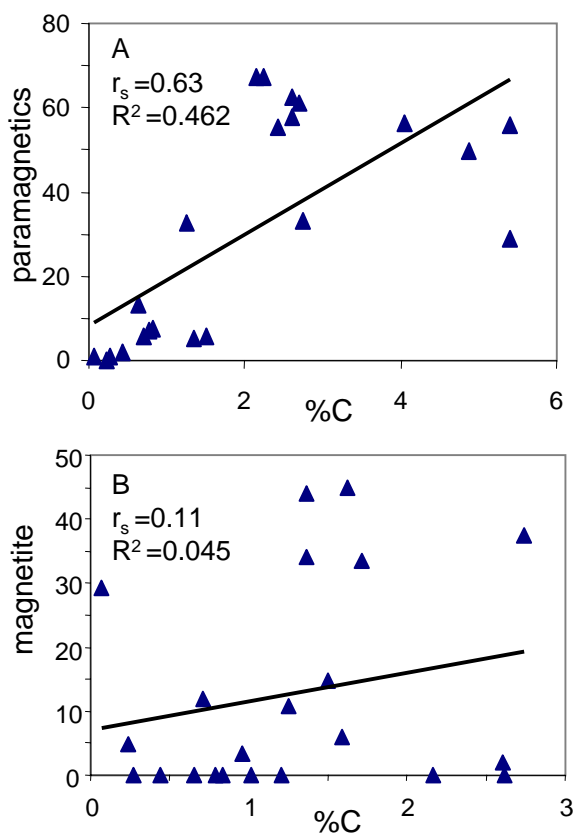


Figure 1 Relationship between whole rock carbon abundance and A. paramagnetic iron and B. magnetite