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The detection of biomarkers in sulphates on Mars. I. Lipid biomarker signatures extracted from sulphates

J. Parnell (1), S. A. Bowden (1), R. Wilson (2), J. M. Cooper (2)

(1) Department of Geology & Petroleum Geology, University of Aberdeen, UK, (2) University of Glasgow, UK (j.parnell@abdn.ac.uk)

The analysis of biomarkers is an essential aspect of the search for life on Mars. The extreme oxidative nature of the Martian surface means that sampling should be undertaken either at depth or from material sealed within a mineral matrix. Sulphate minerals are relatively ubiquitous on the surface of Mars and Earth and form by precipitation from water. Sulphates can trap material that is present in their parent solution as they precipitate. This material forms micron-scale inclusions that are protected from the external chemical environment, i.e. they behave as sealed vessels. Inclusions may be liquid, i.e. the parent solution from which the mineral precipitated, but solid matter including biological matter can also be incorporated. Analysis of these minerals is therefore a potential source of biomarkers in solid or dissolved form.

Extraction of the intracrystalline material in sulphates from the Haughton Impact Crater, Canadian High Arctic has yielded 3 distinct components. A fossil fuel signature reflects naturally-generated oil-like components in the bedrock, unrelated to impact. One lipid component is derived from modern cyanobacteria living in the surface environment, and another probably originated from green non-sulphur bacteria that lived in an extinct hydrothermal system. These results give us confidence that surface mineral precipitates can yield signatures from both fossil and extant microbial life. Sulphate minerals are abundant on the surface of Mars and were present in the samples analysed by the Viking Landers. The quantities of intracrystalline lipids in samples of gypsum-rich soils from the Haughton Crater are sufficient to suggest that if a similar concentration of fossil lipids was present in the sulphate-rich samples analysed by the Viking Landers then they could have been detected. Possible reasons why they were not detected include a poor rate of conversion during pyrolysis, exposure of the lipids during oxidative weathering, and the level of biological productivity.