MARTIAN ANALOGUE SAMPLES, THEIR SPECTROSCOPIC BIOSIGNATURES, AND DEGRADATION BY THE COSMIC RADIATION ENVIRONMENT

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Introduction: The success of an astrobiological search campaign on Mars, or other planetary bodies in the solar system, relies upon the reliable detection of evidence of past or present microbial life, or so-called biosignatures. While conclusive proof of life may depend on discovery of isotopic fractionation or enantiomer bias, these methods require sample preparation and consumable resources (such as solvent for extraction or sample wells in the instrument). Spectroscopic methods, on the other hand, require little or no sample preparation, can be repeated essentially endlessly, and may be performed in contact or even remotely. Such methods are therefore ideally suited for triaging for targets containing biosignatures, which can be confirmed by supporting instrumentation.

Here we discuss the use of Raman and FTIR (Fourier Transform Infra Red) spectroscopy, both vibrational spectroscopy methods that are complementary to each other, for the detection and characterisation of biosignatures of microbial life colonising a diverse sample set. This sample set includes both hypolithic and endolithic extremophile colonisation of rocks and minerals from martian analogue sites around the world, including the Mojave desert, the Atacama desert and the Antarctic Dry Valleys [1].

Results are presented on the Raman and FTIR spectroscopic characterization of these martian analogue samples, both in terms of the mineralogical context and the detectable biosignatures. Raman spectroscopy is sensitive to specific biological pigments including carotenoids, chlorophyll and scytonemin, and FTIR reveals the presence of more generic cellular organic molecules including fatty acids, polysaccharides and proteins.

A further key consideration in the detectability of past or present microbial life on Mars by lander probe instrumentation is the degree to which these characteristic biomolecules will have been degraded by the long-term bombardment of the martian surface (and penetrating into the subsurface) by the energetic particle radiation of the unshielded cosmic ray flux [2,3,4]. Exposure to this complex ionizing radiation field over geological time scales will not only sterilize microbial life [5] but also act to erase biosignatures detectable by spectroscoptic techniques [6,7].

Modelling results on this martian cosmic radiation field, and on-going experimentation on the effects on detectable biosignatures, will also be presented.

References:

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