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Microbial Relics within Gypsum Crystals and their Astrobiological Implications

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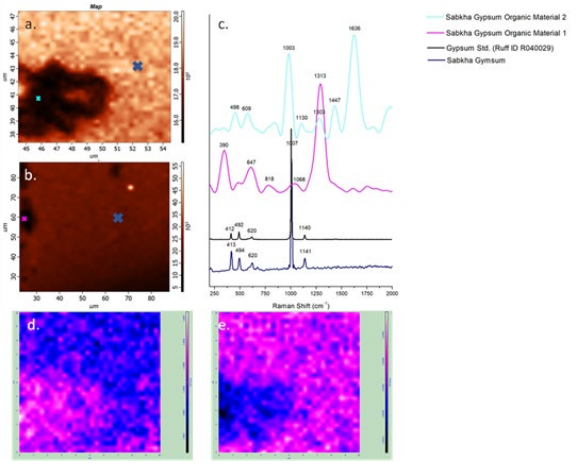

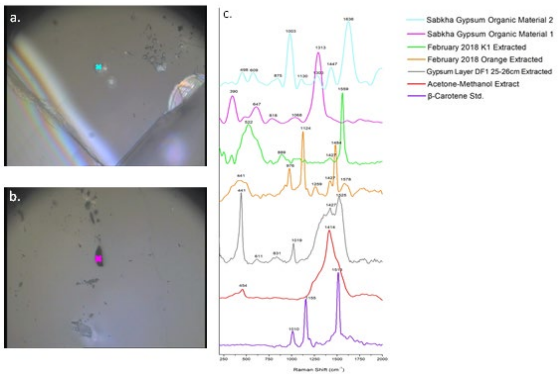

Questions pertaining to the existence of extinct or extant life on the Martian surface are at the forefront of every mission to the red planet (1). Over the years, scientific studies have fallen short of providing unambiguous evidence to answer to this question. Although it is believed that Mars may have once hosted life the disappearance of surface liquid water would have impaired its ability to develop. Volatilization processes caused by a weakening magnetic field due to Mars' single plate tectonic system is thought to be responsible(1,2). Nonetheless life may have been limited on Mars and the discovery of gypsum by NASA Mars Exploration Rover Opportunity has implications for the presence of this past life. Evaporitic minerals, for example gypsum, can act as a refuge for extremophilic microorganisms under extreme conditions. Gypsum can offer protection against desiccation, rapid temperature fluctuations, and exposure to UV-radiation, while still allowing the penetration of electromagnetic radiation needed for photosynthesis (3).

The aim of our work is to better understand the interactions of biomarkers, e.g., pigments, that may have been preserved within a gypsum matrix and to evaluate the potential of Raman microscopy to detect the biomarkers in gypsum crystals from extreme environments. In this study, gypsum samples associated with a hypersaline microbial mat were collected in Qatar sabkhas, and evaluated using a combination of microbial DNA analyses and Raman microscopy. It was observed that gypsum formed in a layer heavily dominated by halophilic archaea (>50% total ZOTUS). Furthermore, organic materials, including pigments and biomarkers, produced by microorganisms were encapsulated in gypsum. These were detected using Raman microscopy with little sample preparation **[Figure 1,2]**. Several types of organic material were identified in the Raman spectra including carotenoids, chlorophylls, scytonemin and phycobiliproteins suggesting complex signatures can persist in a gypsum matrix. These results imply that if extent life is present on Mars, there is a high likelihood that some evidence has remained within mineralogical reservoirs.

References:

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