MODEL CRYSTALS TO TEST TECHNIQUES IN ASTROBIOLOGICAL EXPLORATION OF EVAPORITES ON MARS. *A. D. Wilkins[1], J. Parnell[1], A. J. Wright[1] and R. R. E. Artz[2]* [1]*Department of Geology and Petroleum Geology, University of Aberdeen, Aberdeen AB24 3UE, U.K e-mail: a.d.wilkins@abdn.ac.uk.* [2]*Department of Plant and Soil Science, Cruickshank Building, St. Machar Drive, Aberdeen, UK*

Introduction: The search for life on Mars involves many potential strategies for the analysis in situ of surface samples or the analysis of returned samples in a controlled environment, in particular analyses seek evidence of tangible life and/or biomolecules. It is important to develop mineralogical standards suitable for testing the techniques that will be used for these analyses.

Evaporites have been previously suggested as potential hosts to microbial life on Mars [1]. In particular much interest has recently been focused upon evaporite deposits that are associated with impact crater lakes [2]. For example, the feature on Mars known as White Rock is believed to be a potential evaporite deposit contained within an impact crater site as it appears as a significant albedo feature within orbital camera images.

Within Martian evaporite basins the mineralogy may include epsomite (hydrated magnesium sulphate), gypsum (hydrated calcium sulphate) and halite (sodium chloride). Halite and epsomite are therefore of particular relevance to astrobiology. They both occur in Martian meteorites [3] and are thought to be a significant component of Martian soils [4]. It is important to investigate the astrobiological potential of such evaporite minerals and we have undertaken an experimental study of halite and epsomite. These minerals are ideal candidates for laboratory experiments as they have a high solubility and can be readily precipitated. The study was particularly concerned with the entrapment of organic materials within fluid inclusions.

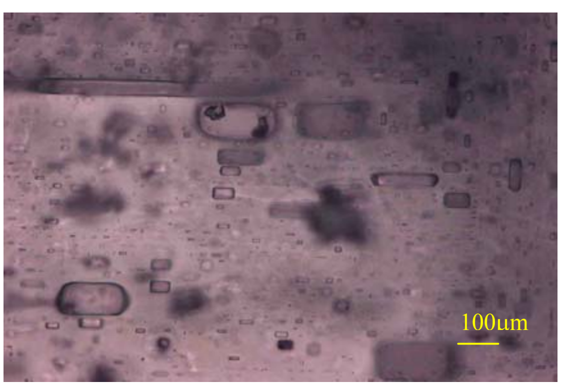

Figure 1. Fluid inclusions within natural halite.

Fluid inclusions: Terrestrial surface mineral precipitates usually contain fluid inclusions, and evaporite minerals such as halite can contain abundant fluid inclusions (Figure 1). Fluid inclusions are mineralogically sealed samples of aqueous fluids trapped during mineral growth and as such represent unaltered samples of past fluids. Palaeo-water may be preserved within Martian mineral fluid inclusions even although the surface of Mars currently lacks water.

The entrapment of organic material within fluid inclusions can occur by the mechanisms shown in Figure 2.

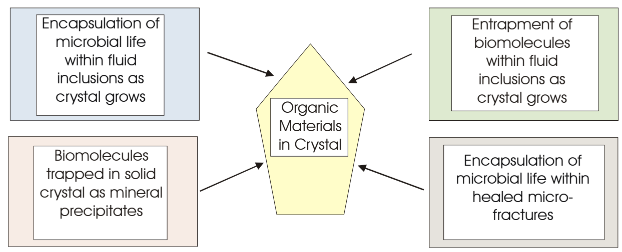

Figure 2. Mechanisms of organic matter entrapment during mineral growth.

Entrapment of biomolecules in epsomite fluid inclusions: Water within fluid inclusions contains materials that reflect the ambient environment during mineral growth. Natural waters can contain organic compounds such as amino acids, carboxylic acids and hydrocarbons [5]. Therefore, theoretically, fluid inclusions could contain such organic compounds. We therefore sought to grow model crystals containing organic compounds within fluid inclusions, to test organic detection techniques that may be used during astrobiological exploration (Figure 3).

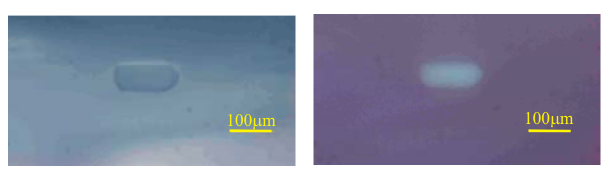

Figure 3. Fluorescein trapped within epsomite model test crystal. Left: In plane polarized light. Right: Under UV light exhibiting fluorescence.

Microbes in halite model crystals: Terrestrial bacteria can range from 0.5mm to a few millimeters in diameter [6] and it is possible that microbes would be entrapped in minerals that grew in environments that supported life such as within surface mineral precipitates.

Numerous workers have recorded the entrapment of bacteria within evaporites either within the fluid inclusions or encased in the solid material [e.g. 7, 8] and the entrapment of bacteria within evaporites has been duplicated by our experiments (Figure 4).

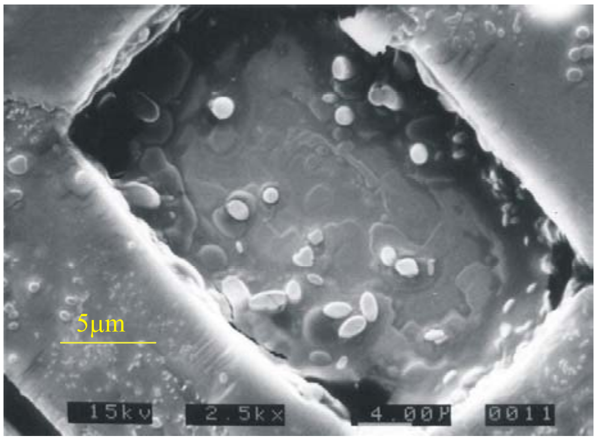

Figure 4. Bacteria within fluid inclusions and below fracture surface of laboratory grown halite crystal.

Potential Applications: The growth of model crystals containing either microbes or organic chemicals allows us to develop standards for testing various analytical techniques (Figure 5).

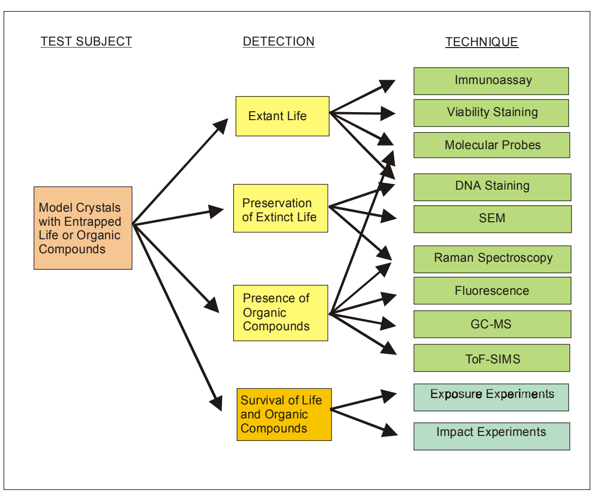

Figure 5. Techniques in astrobiological exploration for which model crystals can be used as standards.

Examples of analytical techniques currently under development for the in situ analysis of Martian samples include the identification of specific organic molecules using mass spectrometry [9], detection of specific biomarkers using molecular micro-array sensors [10], detection and identification of amino acids using in situ gas chromatography [11], detection of microorganisms by fluorescence microscopy [12] and the detection of specific organic molecules by Raman spectroscopy [13]. Crystals grown within our laboratory, containing microbes and/or organic molecules, would be ideal standards for these and other techniques proposed for the astrobiological exploration of evaporite deposits.

Studies of exposure to UV radiation in space are also important to determine the viability of life and organic molecules in the Martian environment. Crystals of naturally occurring gypsum-halite containing microbes have already been subject to the BIOPAN exposure facility on a FOTON mission [14]. Future exposure experiments could make use of our standardised laboratory grown crystals.

Conclusions: Evaporite deposits sought within Martian impact craters should contain minerals with fluid inclusions that could yield valuable information on the ambient fluid conditions during mineral precipitation such as temperature and chemistry. Therefore, model evaporite crystals have significant potential to test the various techniques proposed for the astrobiological exploration of Mars.

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