IDENTIFICATION AND VALIDATION OF BIOGENIC PRESERVATION: DEFINING CONSTRAINTS WITHIN MARTIAN MINERALOGY.

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Introduction & Motivation: Minerals precipitated from former and currently receding lake beds can capture and entomb biogenic evidence within its crystal structure. We seek to understand how preservation of DNA and proteins, within such aqueous settings, can sustain preservation on different timescales in order to confine how we view minerals observed within the Martian shallow subsurface both from orbit and on the surface. We have chosen to investigate the evaporate minerals halite and gypsum due to their confirmed detection by the CRISM instrument [1], their physical transparency, and short-term precipitation timescales. These minerals have been observed within the subsurface of Mars [2] in proximity to ancient aqueous settings either via groundwater or evaporated lake beds.

Methodology: In order to understand how archaea is preserved and how to uncover these biogenic features in-situ we have employed the use of two independent investigations. Microbiologically, we intend to extract and confirm entombed DNA within the evaporate crystals gypsum and halite. After successful extraction and confirmation preserved DNA will be sequenced to understand what forms of life can inhabit and thrive in such saline environments. Both gypsum and halite have been collected from our sites with careful field procedures in mind to avoid introducing contamination into our sample sets. Our DNA extraction techniques and protocols allow for solid samples to be examined directly to allow for a direct field-to-lab analysis [3]. After sequencing information is known we will attempt to geographically correlate known archaea to other field sites that share common aqueous histories. Laboratory spectral analyses will also be made to compare mineral information from the CRISM instrument on MRO to field samples to compare diagnostic absorption bands from minerals observed on Mars to our samples [4]. Complementary analyses will also measure proteins and bulk organics. Analogous to the above experiments we will also use instrument concepts selected for the next Martian rover to analyze our known biogenic-filled minerals [6] to determine differences in instrument datasets

Current Results & Ongoing Efforts: We have successfully developed protocols for solid sample DNA extraction and verified via qPCR the presence of entombed DNA in our halite crystals. SEM (Fig. 1) and lab spectrometer investigations have shown that our field gypsum and halite have similar absorption bands to minerals observed by the CRISM instrument. Ongoing investigations continue to determine protein and bulk organic carbon content.

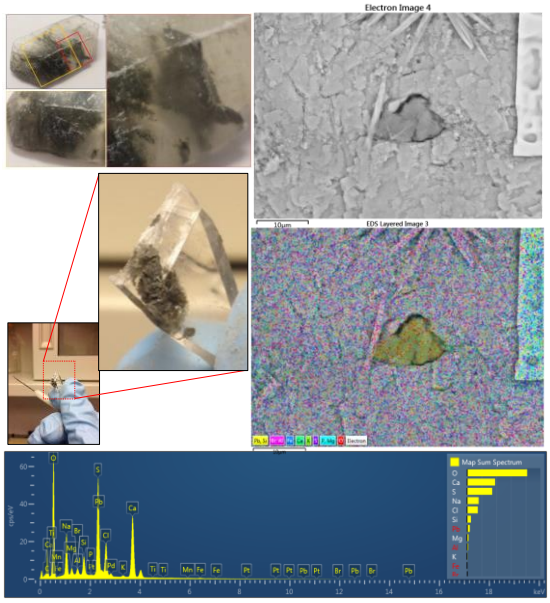

Figure 1. Gypsum crystal with entombed clays and organics (Top-L). SEM image showing micron-scale organic and clay mixture (top-R). Image under EDS filter (mid-R). Elemental spectrum of clay/organic mixture within gypsum parent constituent (bottom).

Future analyses include comparing datasets with the Mars 2020 instrument concepts [5,6] and their instrumentation such as green and deep UV (SHERLOC) and X-Ray fluorescence (PIXL) to understand how organics will be analyzed in-situ if found in the Martian shallow subsurface [7].

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