Mg-RICH CARBONATE MICROBIALITES FROM SEVERAL ANALOGUE SITES EXPOSED TO MARS-LIKE SURFACE CONDITIONS WITH RELEVANCE TO JEZERO CRATER, MARS.

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Introduction: Magnesium-rich carbonates have been detected on Mars using the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [1, 3] and the Planetary Fourier Spectrometer aboard the Mars Express Orbiter [3].

Within and around Jezero crater carbonates are distributed between three separate geomorphic units in the NE Syrtis region (basement unit, Fractured unit, Feature-bearing slope unit) capped by the Syrtis Major lava flows [4, 5]. The aqueous history of the region extends from the late Noachian into the Hesperian and spans at least 250 Mya [4]. Both orbital and in situ Mg-carbonate observations have been made [6 7, 8, 9, 10, 11] with several hypotheses for their formation including a potential fluvial-lacustrine origin. The carbonate units identified by orbiters within Jezero rater provide a unique opportunity to investigate possible lacustrine deposits with the potential of the carbonate units forming and preserving microbialites similar to Earth-based environments [12].

The analogue sites and Jezero crater have several similarities within their environmental conditions including the mafic or ultramafic bedrock precursors, the formation of Mg-carbonates, and the mean annual temperatures ranging from ~15 to -5 °C with below-freezing temperatures found at all analogue sites during winter months [13, 14, 15, 16].

The goal of this study was to determine the likelihood of microbialite and/or Mg-carbonate formation within Jezero crater forming through evaporation processes within ultramafic and mafic precursor bedrock regions for biosignature potential using reflectance spectroscopy.

Methods: The selection of the samples was based on the known presence of Mg-carbonates on Mars and within and around Jezero crater, and their utility for constraining past surface conditions prevalent during their formation. The suite of samples were from multiple Mars analogue sites including the Atlin playas (Canada), Clinton Creek (Canada), Lake Salda (Turkey) and, Lake Alchichica (Mexico). The samples were subjected to 42 days of Mars surface conditions including ~5-7 millibars of CO_2 and ambient temperatures. Reflectance spectra were collected before the Mars surface experiment in air and through a 10 mm thick sapphire window, throughout the experimental run 7 times through the sapphire window. The experiment is currently ongoing. Reflectance spectra were collected with an ASD LabSpec4 Hi-Res® spectrometer (350-2500 nm) at a viewing geometry of i=0°, e=30-40°.

The samples were hand crushed using an alumina mortar and pestle and dry sieved to <45 µm using stainless steel sieves. To minimize any alteration from mechanical heating or liquid solvents, the samples were hand crushed instead of mechanically crushed and dry sieved instead of wet sieved.

Results: Spectral changes were assessed in terms of user-defined significant changes in band depth, shape, position and overall spectral slope. No significant changes within the reflectance spectra led us to determine that the microbialite samples are mineralogically stable on Mars.

All the samples exhibit characteristic spectral features associated with OH and H_2O around 1400 and 1900 nm. The reflectance spectra indicated that these samples are hydrous Mg-rich carbonates.

Three of the Atlin playa samples (ATM3, ATA3 and ATP3) are composed of a mixture of magnesite (2300 µm) and aragonite (2330 µm) [17], The spectra of these microbialites did not change significantly, with the continued presence of strong H_2O related features and the carbonate absorption during the experimental exposure to Mars surface conditions (Figure 1).

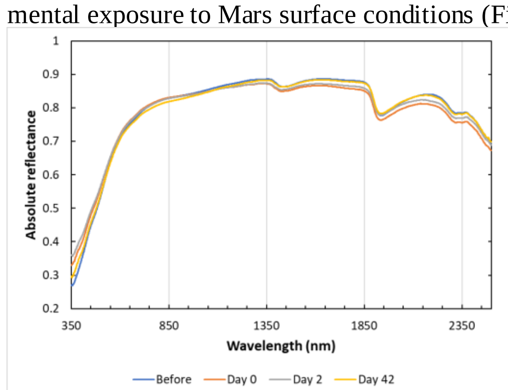

Figure 1. Atlin playa sample ATP3 reflectance spectra before the experiment were collected in air, Day 0 spectra were collected 10-20 minutes after samples were pumped down to 5-7 millibar, Day 2 and Day 42 of Mars surface conditions.

The Atlin playa sample ATH3 and Lake Salda sample LS3 were determined to be hydromagnesite with sharp OH absorption features at 0.96 and 1.4 µm that are superposed on the OH/H_2O bands at 1.44 and 1.96 with C-O band centers present at 2260, 2320, and 2430 nm [12] (Figure 2). Hydromagnesite was deemed stable due to both samples not changing spectrally.

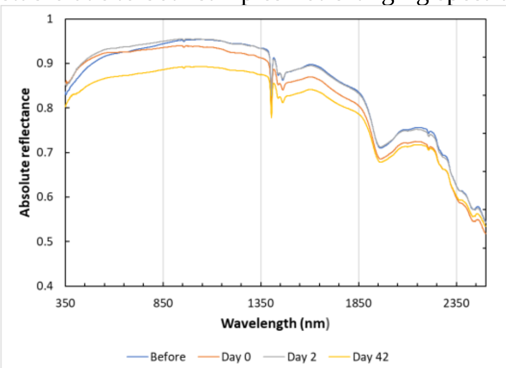

Figure 2. Atlin Lake sample ATH3 reflectance spectra before the experiment were collected in air, Day 0 spectra were collected 10-20 minutes after samples were pumped down to 5-7 millibar, Day 2 and Day 42 of Mars surface conditions.

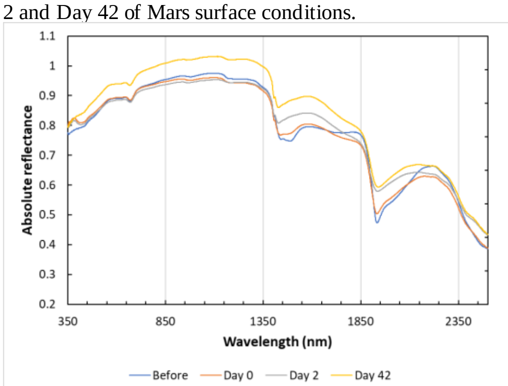

Figure 3. Atlin Lake sample ATH209 reflectance spectra before the experiment were collected in air, Day 0 spectra were collected 10-20 minutes after samples were pumped down to 5-7 millibar, Day 2 and Day 42 of Mars surface conditions.

The Atlin Lake sample ATH209 experienced the most spectral changes, with the loss of absorbed H_2O as evidenced by changes in the longer wavelength wings of both the 1400 and 1900 nm features. The spectral slope beyond 2200 nm increased in reflectance resulting in a more defined absorption at 2400 nm (Figure 3).

The Lake Alchichica sample spectra exhibit a likely mixture of hydromagnesite from the sharp hydration feature ~1.4 µm and aragonite due to the wide absorption band cantered at 2330 nm with a downturned slope towards longer wavelengths. Similar to the ATP3 sample the mixture of aragonite within the Mg-carbonates does not have implications on the spectral changes to the spectrum of LALE (Figure 4). There is a chlorophyll-associated absorption feature near 670 nm that does not exhibit any significant decrease or shifts in the band centre [18].

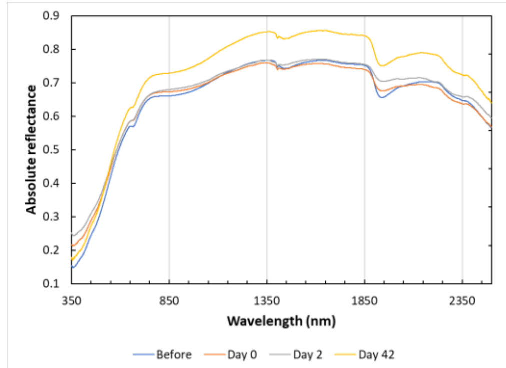

Figure 4. Lake Alchichica sample LALE3 reflectance spectra before the experiment were collected in air, Day 0 spectra were collected 10-20 minutes after samples were pumped down to 5-7 millibar, Day 2 and Day 42 of Mars surface conditions.

Discussion/Summary: Jezero crater may host microbialites and preservation of Mg-carbonate signatures, with our results suggesting their spectral detectability at the surface of Mars.

The microbialite samples from this study exhibited similar stability to previous magnesite and hydromagnesite samples under Mars-like surface conditions [19], and the persistence of the chlorophyll-related absorption suggests the resistance to degradation under Mars surface conditions [20]. The detection of an absorption band at ~670 nm would be possible evidence for an Mg-rich carbonate to have some sort of biogenicity.

Additional longer-term data from this study's Mars surface experimental run will continue to be acquired.

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