DOLOMITIZATION OF CAMBRIAN STROMATOLITES AND IMPLICATIONS FOR INTERPRETING MARTIAN CARBONATE DIAGENESIS. A. E. Murphy[1] and M. Glamoclija[1], [1]Department of Earth and Environmental Sciences, Rutgers University, Newark, NJ 07102; (ashley.murphy@rutgers.edu).

Introduction: The occurrence of Mg carbonates on the Martian surface [1,2,3,4,5,6,7] and the inferred presence of dolomites at Nili Fossae [1,2] brings renewed attention to investigations of dolomitization processes, especially those associated with past evidence of microbial life. Two Martian missions, the MRO's CRISM (Nili Fossae) and the MER's Spirit rover (Gusev crater, a possible Mars2020 landing site), revealed the presence of Mg carbonates [3,7]. This implies that carbonate rocks may have been more common than previously thought during the Noachian Period on Mars [7].

Diagenetic and metamorphic processes will alter and even erase traces of microbial life preserved in rocks of Earth [8], making interpreting biosignatures difficult and often controversial. Understanding dolomitized microbial carbonates on Earth is important for interpreting the ancient life record, so that the evidence of life on other planets (Mars) does not go overlooked due to post-diageneses or metamorphic effects.

In this study, we aim to interpret the mode of dolomitization and how it affected the biosignatures using high-resolution microscopic and spectroscopic analysis. Our intention is to constrain the origin and formation of multiple generations of dolomite within a formation to assess the level of diagenetic and metamorphic processes, and their influence on the biosignatures in obvious microbially maintained structures (stromatolites). The results will contribute to a better understanding of the debatable formation of dolomite [9,10,11,12,13] and interpretation of ~500 Ma old biosignatures.

Geologic Setting: The 500-515 Ma old, Allentown Formation (New Jersey and Pennsylvania), contains the large convex mound (round-headed columnar layered mats), thrombolite-like structures (chaotic texture) and wavy bed types (undulatory and laterally linked mats) of stromatolitic morphologies [14]. The first two types were collected from an outcrop in New Jersey and these will be discussed here. This formation has been interpreted as a subtidal setting with limestone deposition [15].

Methods: Petrological Microscopy was conducted using a transmitted light microscope and polished thin sections of each stromatolite type. Powder X-ray Diffraction (XRD) using a Bruker D8 Advance to determine bulk mineral composition of both stromatolitic morphologies. The XRD employed a CuKα source running 40 kV and 25 mA and a LynxEye detector. Samples were scanned in steps of 3526 at 0.250 seconds from 5° to 75° 2Θ. Peak finding and matching with XRD patterns were performed in DIFFRAC.suite. Eva V3.1 software using the International Center for Diffraction Data database (version PDF2013). Scanning Electron Microscopy / Energy Dispersive X-ray Spectroscopy (SEM/EDS) using a Hitachi S-4800 with an Apollo X EDAX using standard vacuum and 20 kV beam voltage. Cathodoluminescence (CL) analyzed using the electron microprobe (JEOL 8200), beam conditions were 15 kV accelerating voltage, 13.9 nA beam current, 1μm step size, and 30 ms dwell time. Confocal Raman Spectroscopy using a WITec alpha300 with a 532 nm wavelength laser.

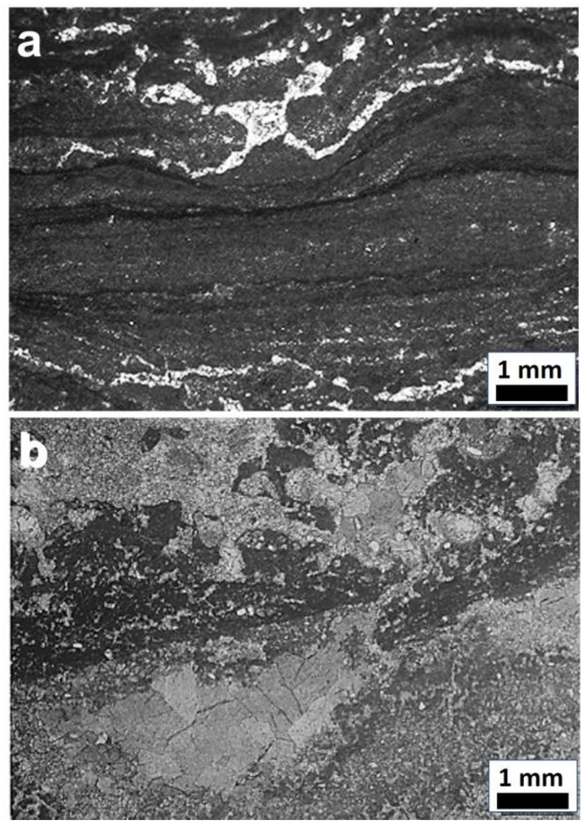

Figure 1: *Photomicrographs of the two types of stromatolites in thin section: (a) convex mound type with lamination and dolomite-filled vugs (white minerals), (b) thrombolitic type showing chaotic texture and large dolomite-filled vugs (large grey minerals).*

Preliminary Results: *Texture and Petrography:* The convex mound stromatolites show laminated layers while the chaotic structured stromatolites appear more thrombrolitic in texture than stromatolitic (**Fig. 1**). Large (<1/2 mm in diameter), rounded quartz and feldspars (microcline and orthoclase) are common among the top layer of the convex mound type and they occur throughout the thrombolite type. Previous study suggests a detrital origin for these minerals from the weathering of inland rocks that were in contact with the sea at the time [15]. The feldspars exhibit signs of recrystallization marked by overgrowth rims and smaller crystals that are commonly associated with the mineral boundaries. The quartz seems not affected. These results indicate temperature triggered metamorphic changes of the stromatolites and there is no evidence of the pressure or strain effect that could have been produced by the tectonic processes that operated at the time.

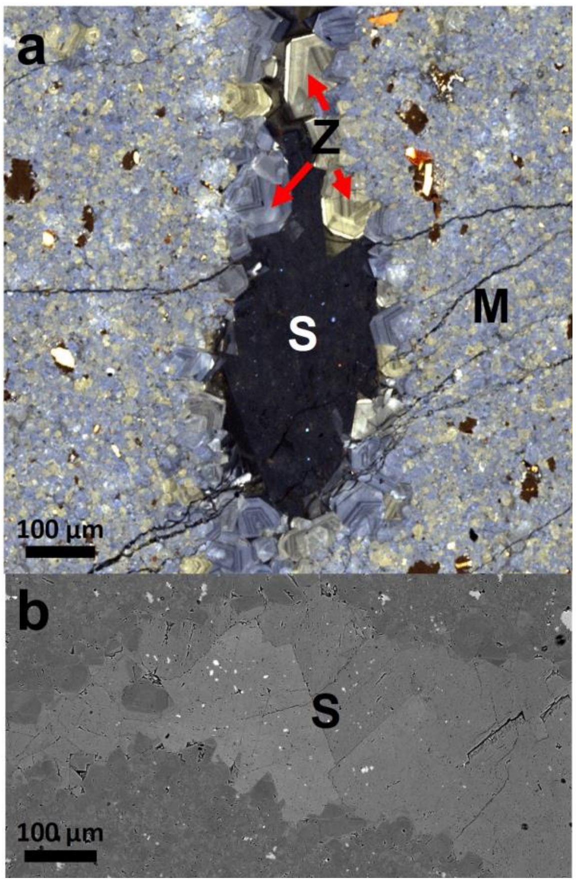

Figure 2: *(a) CL RGB composite image of the convex mound type stromatolite showing three generations of dolomite: micritic (M); zoned (Z); and saddle (S). (b) the BS image of the same sample (different area) to better display the saddle dolomite (S).*

Mineral Assemblages: XRD analysis reveals the convex mound type's bulk composition is predominately dolomitic while the thrombolite type contain predominantly dolomitic and feldspatic compositions with minor quartz. SEM/EDS reveals Ti-oxides, Fe-oxides, and apatite present in convex mound type, while Fe-oxides and weathered pyrite grains are identified in the thrombolite type. The detected metal oxides range from euhedral to highly deformed (shattered and/or warped).

The SEM/EDS analysis reveals mineral re-growth, particularly in Fe-oxides. The CL reveals three generations of dolomite in both types of the analyzed stromatolites, which are, in order of formation: a drusy micritic dolomite, a zoned euhedral to sub-hedral dolomite, and finally a saddle dolomite (**Fig. 2**). Additionally, the luminescence of gold, blue, and grey is repeated throughout the micritic and zoned dolomite generations; likely due to various crystal orientations of dolomite in the samples. Raman spectroscopy indicates that D and G bands are associated only with the first generation of dolomite (micritic) for both types of the stromatolites.

The overall petrology of the analyzed stromatolites suggests variations in temperature regime during various post-depositional phases.

Future Work: In order to better reconstruct the rock history and better understand the biosignatures associated with these stromatolites, we will apply thermometry combined with oxygen and carbon stable isotopes to assess the temperatures and environmental setting for each generation of dolomites. We are aiming to answer: 1) did the three dolomite generations form by the same fluid at different temperatures or by various fluids of different compositions, 2) were the temperatures of formation favorable to the preservation of original organics, and 3) the distribution of organics within micritic dolomite.

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