Biosignature Capture and Preservation Potential of Modern Carbonates; a View into Destructive Early Diagenetic Processes. J. Zaloumis[1] and J.D. Farmer[1], [1]Arizona State University, School of Earth and Space Exploration. Contact: jzaloumi@asu.edu or Jack.Farmer@asu.edu

Introduction: Carbonate minerals represent one of the major potential targets of the search for a fossil record on Mars primarily due to its association with aqueous environments and the potential to capture evidence of past microbial life. Though macro-scale morphological biosignatures such as stromatolites, thrombolites, and oncoids are well documented in the literature, there is less evidence for the ability of carbonates to preserve finer-scale biogenic features such as cellular or filamentous microfossils. In order to understand the taphonomic potential of carbonates and the effects of early diagenesis, particularly as compared to other lithotypes (e.g. silica, sulfates, etc.), it is instructive to look towards modern, actively forming carbonate deposits to see potential biosignature-destroying mechanisms at work.

Crystal Geyser, an early taphonomic window: In order to understand carbonate taphonomic potential through early diagenesis, we look towards Crystal Geyser, an active cool-water (~18 °C) mildly acidic geyser that within the last century has formed a spectacular carbonate mound (~80 x 100 m^2) comprised of terraced and micro-terracette structures. This mound has been shown to host a variety of microorganisms that are dominantly composed of photoautotrophs [1]. Owing to rapid precipitation, microbes and their exopolymeric sheaths become readily entombed in carbonate. Additionally, organic domains in thin section appear to be associated with micro-scale stromatolites, which display typical biogenic indicators such as upward-accretion and increased lamina thickness towards each stromatolitic dome's apex.

Methods: We characterized microscale textures and mineralogy in thin sections using standard petrographic microscopy. More detailed mineralogical information was gathered using X-Ray Diffractometry, Raman spectroscopy, and infrared spectroscopy. Microstructural features such as stromatolites were imaged at higher resolutions using a Leica SP5 confocal imaging system and an XL30 ESEM-FEG Scanning Electron Microscope. Spot elemental compositions of organic material were acquired using the EDX capabilities of the ESEM-FEG. In addition to morphological information, isotopic measurements were made of bulk samples, extracted organics, and targeted micro-cores of samples representing distinct diagenetic domains.

Results: The carbonate deposited in this system appears to heavily favor morphological and chemical biosignature capture following precipitation. However, the potential to preserve these micro-scale signatures through geologic time appears low. This is seen by the rapid degradation of stromatolites within short accumulation depths (<1 cm from surface) via dissolution and recrystallization, as well as by secondary infilling of cements resulting in obfuscation of the original stromatolitic morphology. Additionally, discrete organic-rich laminations appear to transform into diffuse domains composed of particulate kerogen. Although micro-scale morphological biosignatures appear to be destroyed by early diagenesis, organics derived from the original microbial communities are still detectable via Raman spectroscopy as well by the isotopic analysis of extracted organics, which show an average $\delta^{13}C$ fractionation of -24.8‰ that is consistent with organics derived from photoautotrophic microbial communities. Given the problems induced by early diagenesis, carbonates are still understood to host the majority of the Precambrian fossil record and should continue to be regarded as a high-priority target for the search for a fossil record on Mars.

References:

[1] Takashima C. et al. (2011) *Advances in Stromatolite Geobiology*, 123-133.