Variations in biosignature preservation: Geochemical analysis of kerogen comparing two Mars analog environments. K. N. Lorber[1,3], A. D. Czaja[1], and P. Lee[2,3,4], [1]University of Cincinnati (Lorberkn@mail.uc.edu), [2]SETI Institute, [3]Mars Institute, [4]Nasa Ames Research Center.

Introduction: Mars exploration has revealed evidence for a variety of potential life-supporting habitats, past or present, from near-surface aqueous environments to potential subsurface habitats. While the Earth and Mars are different planetary bodies, and have experienced different evolutionary histories, comparative planetary geology investigations between the Earth and Mars may lead to developing promising strategies that could help identify and characterize potential habitats and biosignatures on Mars, past and/or present. Of particular interest is gaining an understanding of the preservation through time of ancient microbial habitats in the geological record. In this context, investigations of the preservation of biosignatures from Early Earth, and also studies of the preservation of microbial biosignatures following impacts on Earth, are particularly relevant for the search for biosignatures on Mars.

We report here on new studies of the preservation of biosignatures from Early Earth and from impact crater environments on Earth, both of which may be viewed as first order analogs for common geologic settings on Mars. We focus on geochemical biosignatures preserved in the form of kerogen. Kerogen is an organic chemical biosignature in rocks that can be present either in the form morphologically preserved fossils of microorganisms, i.e., microfossils, or in the form of amorphous kerogen. Analyses of kerogen biosignatures preserved in rocks from Early Earth and in rocks subject to impact processing on Earth, whether in microfossil or in amorphous form, may shed light on how potential biosignatures might have been preserved - or altered - on Mars [1,2].

Methods and Results: We investigated two distinct paleo-biosignature environments on Earth: 1) Archean-age (2.5 Ga-old) deep marine microfossil-bearing chert units from the Tsineng Member of South Africa, and 2) Ordovician-Silurian marine carbonates of Devon Island, High Arctic, which were affected by the Miocene-age Haughton impact event. For samples from each site, microscopy and Raman spectroscopy were used to identify and characterize any variability in the morphological and geochemical preservation of the microfossils and of their organic matter (kerogen), or of amorphous kerogen.

The Tsineng cherts were sampled from four different localities (two drill cores and two outcrops). Observed are the same taxon of filamentous microfossils in each sample site, providing a unique opportunity to understand how microfossil morphology relates to geochemical variations in kerogen signature. Differences in the physical (morphologic) preservation of the microfossils are stark, ranging from highly fragmented to complete filaments. Variations in the geochemical signatures of the microfossil kerogen are also pronounced, suggesting differences in thermal alteration. Kerogen preservation is thought to be a function primarily of thermal alteration, but the regional geology indicates all of the specimens experienced the same thermal history, so variations in thermal alteration are unlikely to be the cause of the observed variations in biosignature preservation.

For the Haughton Crater site, we compared samples of dolomitic country rock (non-impact affected rocks) from the Allen Bay Formation to those from the same formation that were significantly affected (shocked and brecciated) by the impact event. We examined specifically the extent to which amorphous kerogen was altered by the impact event. Geochemical variations were noted in the Raman spectra.

Conclusions: Investigations of Archean cherts presented here show that the preservation of microfossils may present variations that are not due to small scale changes in temperature between localities within the same region, but may be due to other factor(s) affecting microfossil preservation not yet well understood at that site. For the Devon Island site, although only amorphous kerogen was studied, preliminary results provide insights on how impact events may contribute to altering microbial biosignature records preserved in rock. Our investigations are providing new insights into the preservation of kerogen and the factors that may affect it. Through morphological and geochemical characterization of the earliest known forms of fossilized life on the earth, and parallel investigations of the preservation of biosignatures following impact processing, we hope to achieve a greater understanding of how biosignatures might be preserved and found on Mars.

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