PRESERVATION OF ORGANIC COMPOUNDS IN CIRCUMNEUTRAL IRON DEPOSITS.

M. N. Parenteau[1,2], L. L. Jahnke[2], T. F. Bristow[2], S. M. Som[2,3], D. J. Des Marais[2], J. D. Farmer[4]. [1]SETI Institute, Mountain View, CA (mary.n.parenteau@nasa.gov), [2]Exobiology Branch, NASA Ames Research Center, Moffett Field, CA, [3]Blue Marble Space Institute of Science, Seattle, WA, [4]School of Earth and Space Exploration, Arizona State University, Tempe, AZ.

Introduction:

Today liquid water is unstable at the Martian surface due to the low temperature and atmospheric density. However, evidence suggests that during the Noachian (4.1–3.7 Ga) and Early Hesperian (3.7 to ~3.4 Ga), an active hydrologic cycle once existed on Mars [1, 2].

Data collected by the Mars Science Laboratory and Mars Exploration Rover missions from the surface of Mars have provided (and continue to provide) mineralogical insights regarding this hydrologic cycle, including the redox cycling of Fe. The *Opportunity* rover gave the first detailed look at Fe-bearing sedimentary rocks of the Burns formation of Meridiani Planum, Mars [3, 4]. These sediments contain mineralogical and textural evidence of Fe(II) mobilization and oxidation within acidic (pH ~2-4) brines [4, 5]. Acidity was generated through oxidation of upwelling circumneutral Fe(II)-bearing groundwater sourced from an underlying basaltic aquifer [5, 6]. Hurowitz et al. [5] describe how the flux of groundwater to the surface was a key control on the degree of oxidation and pH of resulting brines.

Recent observations made by the MSL rover *Curiosity* highlight the importance of ancient martian sedimentary deposits that experienced a smaller degree of Fe(II) oxidation (and thus, less acidity generated), allowing more benign – low salinity and circumneutral pH conditions to persist [7, 8, 9, 10].

Microbes such as chemolithotrophs can exploit the oxidation of Fe(II) to power their metabolism in both acidic as well as circumneutral settings [11]. We are investigating the capture and retention of chemolithotrohpic and phototrophic biosignatures in modern circumneutral Fe springs to (1) characterize the composition of lipid biomarkers produced by the microbial communities, and (2) determine how lithification by Fe oxides affects the biomarker signature of the communities. The aim is to characterize the taphonomy of the lipid biomarkers in this Fe-rich system, namely, which compounds survive microbial degradative processes within the mats and through the earliest stages of diagenesis in the Fe deposits beneath the mats.

Results:

We analyzed two distinct microbial populations: phototrophic mats containing photoferrotrophs, and a loose biofilm composed of chemolithoautotrophs such as *Leptothrix* and *Gallionella*. The phospholipid and glycolipid fatty acid profiles of the highest-temperature microbial mats indicate that they are dominated by cyanobacteria and green nonsulfur filamentous anoxygenic phototrophs (FAPs). Diagnostic lipid biomarkers of the cyanobacteria include midchain branched mono- and dimethylalkanes and, most notably, 2-methylbacteriohopanepolyol. Diagnostic lipid biomarkers of the FAPs (*Chloroflexus* and *Roseiflexus* spp.) include wax esters and a long-chain tri-unsaturated alkene. Surprisingly, the lipid biomarkers resisted the earliest stages of microbial degradation and diagenesis to survive in the Fe oxides beneath the mats. Understanding the potential of particular sedimentary environments to capture and preserve fossil biosignatures is of vital importance in the selection of the best landing sites for future astrobiological missions to Mars. This study explores the nature of organic degradation processes in Fe(II)-rich groundwater springs— environmental conditions that have been previously identified as highly relevant for Mars exploration.

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