The Fate of Lipid Biosignatures in a Mars-Analogue Sulfur Stream. J. S. W. Tan[1], J. M. T. Lewis[2], and M. A. Sephton[1], [1]Imperial College London, London, SW7 2AZ, UK (jonathan.tan12@imperial.ac.uk), [2]NASA Goddard Space Flight Center, Greenbelt, MD, 20771.

Introduction: Past life on Mars would have generated organic remains in the form of biomarkers that may be preserved in Martian rocks that are accessible in the present day [1]. Of the potential biomarkers that are accumulated, biological lipids are the most resistant to degradation and thus become concentrated in the rock record [2].

The latest period in Martian geological history that supported widespread surface water was the late Noachian to early Hesperian (3.7 Ga) [3,4], which would have sustained the most evolved and widely distributed Martian life. Acidic, sulfur-rich streams can be used as geochemical analogues for this period in Martian history [5], and the investigation of the preservative qualities of the iron sulfates and iron oxides in these environments can guide future missions to Mars.

Chemistry of Fe-rich Sulfur Environments: Acidic, ferric sulfate-rich streams are geochemically complex and typically precipitate jarosite due to dissolved aqueous sulfates derived from the oxidation of pyrite (FeS_2) [6], which is analogous to some of the modes of formation proposed for martian jarosite [7].

Iron oxyhydroxides are found in these environments in the form of goethite that may either have been precipitated from the acidic stream in areas of higher water-to-rock ratios and/or pH, or as a transformation product of jarosite under humid conditions [7,8]. Terrestrial sulfur stream environments are hosts to diverse communities of extremophilic microorganisms and algae that may be analogous to microbial biomass that may have evolved in outcrops of Hesperian Mars [5]. This diverse suite of organic material provides an opportunity to study the early stage diagenesis of lipids in an acidic, Fe-rich environment.

Field Work and Methods: Samples were collected from St. Oswald's Bay, Dorset where an acidic stream (pH 3.5) flows from slumped Wealden Beds that are rich in pyrite. Jarosite and goethite are found present in the sands surrounding the stream. A purple microbial mat that covers the goethite layers, and acidophilic algae is observed in the deepest sections of the stream. Stream samples were extracted in cylindrical cores and returned to the laboratory for analysis. Lipids in each sample were extracted using the Bligh-Dyer procedure, and derivatized with BF_3-methanol and 99-1 N,O-bis(trimethylsilyl) trifluoroacetamide (BSTFA)-trimethylchlorosilane (TMCS) before analysis on a gas chromtaography-mass spectrometer (GC-MS).

Results: Saturated straight-chain fatty acids were found to be the most common general indicators of life, consistent with their recognised abundance in terrestrial organisms [9], and exhibit a strong even-over-odd predominance (EOP) in carbon chain lengths that is preserved at regardless of depth or mineralogy. More specific biosignatures include cyclopropyl fatty acids, certain forms of monounsaturated fatty acids, polycyclic terpenoids and long-chain alcohols. It is possible to infer the fossilised form of these lipids in a Martian environment by observing their diagenetic products as they undergo decarboxylation and defunctionalisation [10].

The acid stream data also indicate a mineralogical influence on biosignature preservation. Concentrations of lipids are highest in goethite layers which represent environments of increased aqueous activity that is more conducive to habitation, and hence predisposed to receiving heightened microbial fossil inputs. Goethite has also been suggested recently as a high priority mineral for sampling because of its ability to originate from the transformation of jarosite [8] and host organic matter, yet avoid the negative effects of oxygen generation and organic combustion during thermal extraction [11].

Discussions and Conclusion: Acid stream data show that a significant amount of fossilised organic material is preserved in the form of a diverse suite of biological lipids. Several organic markers are identified that allow for the indication of previous life, or specific groups of organisms. The discovery of lipids preserved in goethites suggest that microbial fossils may be preferentially preserved in rocks that indicate local environments that are more conducive to habitation. Thus, it is suggested that iron oxide remnants of sulfur-rich environments are good candidates for future life detection missions on Mars due to their demonstrated preservation potential.

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