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BIOSIGNATURES IN MARS ANALOG ACID SALT LAKES.

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Introduction: Paleolake sites on Mars, particularly buried deposits that have been shielded from surface radiation, serve as intriguing targets for the search for life. Mars-like ephemeral playa lakes here on Earth can offer insights and perspectives on the possibilities for physical, metabolic, and biomolecular biosignature recovery from similar environments on Mars.

Acid Salt Lakes: Naturally-occurring acid salt lakes in Western Australia have received attention in recent years as a terrestrial Mars analog [1-4]. Hosted within the deeply weathered Archaean rocks of the Yilgarn Craton, these lakes range in size from m^2 to km^2 and are marked by cycles of flooding, desiccation, and evapoconcentration. The lakebeds are home to a distinctive mix of iron oxides, sulfates, chlorides, and clays, including hematite, kaolinite, some smectites, halite, gypsum, alunite, and jarosite [1,2,5]; sedimentary and alteration features also suggest similarities to Mars [1]. Despite the extreme conditions (pHs as low as 1.4, high fluxes of solar radiation, water stress during desiccation, high metal concentrations, and large shifts in diurnal temperature), these sites are highly habitable, home to a diverse array of organisms living in both lake waters and sediments [4,6].

Effects of Biology on Patterns of Mineralization. Our work in this analog environment suggests that we could be meaningfully underestimating the potential effects of biology on the chemistry of clay- and sulfur-rich environments on Mars. Metagenomic results indicate that genes associated with sulfur metabolism may be producing or consuming acidity in the local depositional environment [4]. In addition to potentially altering mineral stability fields, microbes can generate characteristic minerals as a byproduct of their metabolism; for instance, *Acidithiobacillus*, found in our community surveys, can precipitate a type of crystalline jarosite in both aerobic and anaerobic environments at a much wider range of pH conditions than abiotic processes alone, and thus its detection on Mars, particularly in the context of persistent aqueous processes, could serve as a biomarker for microbial sulfide oxidation [7]. Whether the coetaneous presence of acid sulfates and clays within these lakes, mineral groups that are thought to form under distinct pH conditions, could itself be a result of biology remains unknown.

Lipid Biomarkers. Because lipids are among the most resistant biological molecules, they have been used to characterize both physical environments and biological systems on the early Earth. Organic matter is commonly codeposited in evaporites, but it is generally believed that decay should proceed rapidly as long as oxidants, such as Fe(III) minerals, remain present in a sedimentary environment [8]. However, there are diagnostic microbial lipids in acid salt lake sediments, such as 1-*O*-alkylglycerols [See Fig 1] [9]. Moreover, terrigenous plant lipids that have been washed into the catchment zone of the lakes are present; the surprising resilience of these lipids, chemically similar to microbial lipids but certainly dead, lends support to other studies (e.g. [10]) that suggest sulfates, as well as clays, should be targeted in astrobiological investigations. Older acid salt lake facies, dating back to the Permian, are currently being analyzed.

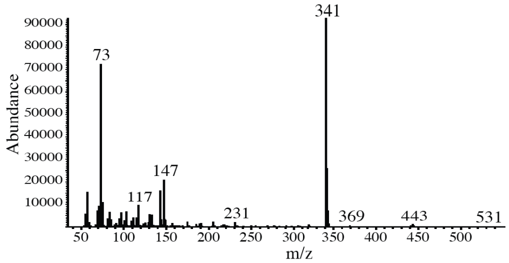

Fig 1. Mass spectrum of a 1-*O*-C16 glycerol monoether, likely formed by the *Thermodesulfobacteria* detected in our genetic data.

Solid and Fluid Inclusions. Organic compounds such as beta-carotene and long-chain hydrocarbons have also been identified by UV-vis microscopy and laser Raman spectroscopy in acid-precipitated halite and gypsum associated with the lakes [11,12]. During times of evapoconcentration, when salinities in the lakes can reach as high as 32% TDS, the formation of solid and fluid inclusions provides another means for trapping organic material and preserving biosignatures.

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