ORGANICS PRESERVATION IN THE HYPERARID QAIĐAM BASIN, CHINA: AN ANALOG FOR FLUVIO-LACUSTRINE DEPOSITS IN GALE CRATER, MARS. S. E. Shaner¹, A. J. Williams¹ and G. Zhuang², ¹Department of Geological Sciences, University of Florida shaner.sydney@ufl.edu, ²Geology and Geophysics, Louisiana State University

Introduction: Organics preservation in Mars analog environments is a topic of great interest in the astrobiology community. Analog environments provide terrestrial materials that exhibit Martian properties, allowing preparation for Mars experiments through local geochemical analysis. One such analog environment in the Qaidam Basin, China, sheds light on how organic material is preserved in a hyperarid environment similar to Gale Crater, Mars, and how effective space-flight gas chromatography-mass spectrometry (GC-MS) methods are at detecting these organics. NASA’s Sample Analysis at Mars (SAM) instrument suite equipped with GC-MS to explore and analyze Martian sediments is on the Curiosity rover that landed on Mars in 2012 and does experiments similar to those done in this investigation.

Qaidam Basin is an intermontain, non-marine basin situated on the North Tibetan Plateau, NW China. It exhibits numerous geologic similarities to those identified on Mars. A large portion of these analogous features are geomorphological, including aeolian dunes and yardangs, providing insight as to how wind as the predominant erosive mechanism in the basin is analogous to wind-dominated Martian features. Additionally, the presence of analogous lacustrine features in the basin is a potential analog to the history of water on Mars as it represents the history of water and lake evolution in the basin, from fresh to saline lakes to playas [5]. Beyond the macroscopic geology of the Qaidam Basin, extremophile communities have also been studied. Bacillus and halophilic archaea dominate the basin due to its high degree of evaporite mineralogy [5]. Clays are present in several stratigraphic units of Gale Crater, Mars [2], making Qaidam Basin an appropriate analog, with the playa clays of Eocene age being the focus of this study.

Because of the hyperaridity of Qaidam Basin, complex molecules such as lipids that would be indicative of fossilized life have high preservation potential [5]. Biomarkers such as these can be analyzed in different ways to determine the most fruitful method of detection. In this study, we observe the preservation of straight-chained hydrocarbons in this hyperarid analog using flash pyrolysis. Fatty acids were quantified with TMSH (trimethylsulphonium hydroxide) thermochemistry (to convert fatty acids to fatty acid methyl esters (FAMES). TMSH, compared to previously tested TMAH (tetramethylammonium hydroxide), allows methylation of lipids to happen at a lower temperature and with a more direct reaction pathway [1]. This has implications for GC-MS instruments that are sent to Mars as we aim to ascertain the optimal method for detection and analysis of organic biosignatures on Mars [5].

Methods: Mud- and siltstones (7 total) were collected from Qaidam Basin, China, and each broke into 3-5 mm pieces using a rock hammer andashed (500°C for 8 hours) chisel. Samples were then ground with an ashed mortar and pestle to a homogenous powder. Residual surface organics were then removed from the powdered samples with solvent washing and sonication. To do this, each sample was placed in a 100 mL beaker, covered with methanol, and sonicated for 10 minutes. Excess methanol was decanted, and the process was repeated with DCM (dichloromethane). Excess DCM was decanted, and the process was repeated with DCM with 5 minutes of sonication until no suspended particles were observable in the solvent. Samples were transferred to solvent-washed vials with a solvent-washed scoop in the hood for refrigerated storage.

Simple pyrolysis alkane/alkene preparation: Three to five mg of each sample were transferred into sterile pyrolysis cups. 1.5 μL of C₉ was injected in each cup as the internal standard.

Thermochemistry preparation: A second set of samples were prepared identically with C₁₉ as the internal standard, and a volume of 1 μL TMSH to 1 mg sample was injected to convert fatty acids to FAMES via thermochemistry.

GC-MS: Samples were analyzed on an Agilent GC-MS coupled to a Frontier pyrolyzer. Samples analyzed for alkanes were pyrolyzed at 600°C for 0.5 min. The oven program ramped from 50°C to 300°C at 20°C/min with a 10 minute hold. Samples analyzed for fatty acids were subject to the same pyrolyzer and oven programs as for alkanes. Molecules were identified using ChemStation software.

Results and Interpretation: Several alkanes, alkenes, and FAMES were identified in chromatographs produced by the GC-MS.

By pyrolysis, straight-chained hydrocarbons produced through the seven samples include: C₄, C₅, C₆, C₇, C₈, C₉, C₁₀, C₁₁, C₁₂, C₁₃, C₁₄, C₁₅, C₁₆, C₁₇, C₁₈, C₂₀, C₂₁, C₂₂, C₂₃, C₂₄, C₂₅, and C₂₆ (Figure 3). By the TMSH method, the FAMES C₄, C₅, C₆, C₇, C₈, C₉,
C_{10}, C_{11}, C_{12}, C_{14}, C_{16}, and C_{18} were found in the seven samples (Figure 2). The even-over-odd chain length preference in FAMEs indicates a modern microbial community and is illustrated in Figure 2. There is a lack of wax esters in these samples, which is typically expected of a hyperarid clay environment due to the charged mineral surfaces of clays [3].

**Conclusion:** The organic molecules present in these samples are biosignatures due to their presence in bacterial and eukaryotic phospholipid bilayers of cell membranes. We conclude that an abundance of constituents that make up life can be preserved under these hyperarid clay conditions and detected by this method of flash pyrolysis and TMSH injection. These methods should be considered when constructing rover instrument payloads in order to find more conclusive evidence of organic matter preservation in Martian sediments. This study provides ample reason for the SAM instrument on the *Curiosity* rover to visit sites with clay dominated mineralogies in search of the lipid biosignatures.