BIOSIGNATURE DETECTION IN GYPSUM ACROSS VARYING ENVIRONMENTS OF PRECIPITATION. M. A. Birmingham[1], D. Lockamy[1], T. A. Plattner[2], J. M. Weber[3], R. H. Goldstein[1], P. T. Doran[4], J. S. Bowman[5], B. E. Schmidt[6], and A. N. Olcott[1], & OAST Science Team [1]Department of Geology, University of Kansas (Slawson Hall, Rm 270, 1420 Naismith Dr., Lawrence, KS 66045, mbirmingham@ku..edu), [2]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, [3]Jet Propulsion Laboratory, [4]Department of Geology and Geophysics, Louisiana State University, [5]Scripps Institute of Oceanography [6]Department of Earth and Atmospheric Sciences, Cornell University.

Introduction: The discovery of gypsum on Mars has opened a new avenue for life detection on the red planet. Biosignatures and microorganisms, including halophiles, have been detected in gypsum samples on Earth [2]. These organisms can be entrapped in either the crystal matrix [2] or fluid inclusions [3] during crystal growth. However, gypsum precipitates in a variety of marine, lacustrine, and groundwater environments, making it difficult to establish a baseline model for the types of biosignatures that can be preserved. In order to successfully search for signs of life in our solar system, we must fully understand how the record of life is preserved on Earth. An increased understanding of gypsum precipitation across geologic space and time will help delineate the relationship between inclusions, biosignatures, and environment of precipitation. The goal of this research is to complete preliminary studies of four localities ranging in age from Permian to modern. The samples encompass two environments of precipitation: (1) bottom growth in a body of water and (2) precipitation in ground water. The inclusions and biosignatures will be compared between each locality to establish baseline controls of environment on preservation of signs of life.

Methods: Gypsum samples were collected from four sites: (1) Blaine Formation, KS (2) Lake Lucero, White Sands National Park, NM (3) South Bay Salt Works, San Diego, CA and (4) salt lakes in Western Australia. Field observations and literature reviews were used to place each sample into its setting to fully understand the environmental and biological controls.

To identify organic inclusions in the gypsum, different methods of microscopy were employed. First, small sections of gypsum were visually scanned for organics using bright field microscopy. Once identified, plane polarized microscopy was used to confirm the inclusion was distinct from the crystal matrix. The samples were also analyzed under UV microscopy to test autofluorescence of the entrapped organics. It is important to note that not all organic compounds autofluorescence. Thus, this method does not rule out organic origin, but instead is used as an additional line of evidence to indicate the presence of organics.

Results: Field observations indicated two environments of precipitation. Gypsum collected in South Bay Salt Works and Blaine Fm represent bottom growth gypsum. Samples collected from Lake Lucero represent groundwater precipitated gypsum. The Western Australia samples encompass both bottom growth and groundwater fed gypsum.

Preliminary lab results show a multitude of organics in both crystal matrices and fluid inclusions across each locality. Samples from Lake Lucero and various Western Australia salt lakes have included a wide range of microorganisms ranging in size from roughly 4 μm to 50 μm encased in the crystal matrix and in fluid inclusions. Samples from South Bay Salt Works and Blaine Fm show organic material being entrapped in the center of the crystals.

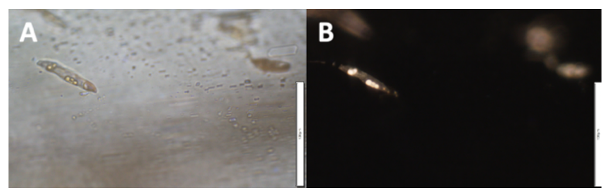

Figure 1. Gypsum from Lake Brown, Western Australia. Single-cell organisms under (a) bright field and (b) UV light.

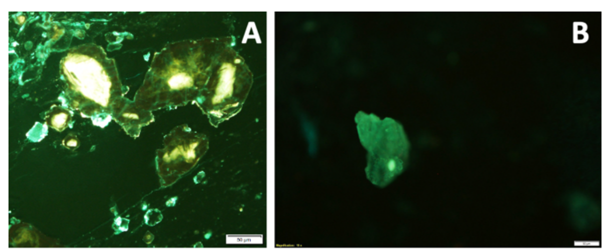

Figure 2. Organic inclusion in the crystal matrix autofluorescing under UV light from (a) Blaine Fm and (b) South Bay Salt Works.

Conclusion: The variance in type of organic inclusion between localities shows the complexity of biosignature detection in gypsum. There appears to be three common modes of entrapment across the samples. First, single-celled microorganisms are entrapped in the crystal matrix. Second, single-celled microorganisms are entrapped in fluid inclusions. Third, organic matter is entrapped in the core of equant crystals. At this point, there appears to be no correlation between environment of precipitation and mode of entrainment. Further case studies would be needed to establish a trend.

Acknowledgments: This research is part of the collaborative Oceans Across Space and Time project, funded by NASA's Astrobiology Program Award 80NSSC18K1301 (PI B.E. Schmidt).

References: [1] Fishbaugh K. E. et al. (2007) *Journal of Geophysical Research*, 112, 1-17. [2] Benison K. C. and Karmanocky III F. J. (2014) *Geology, 42,* 615-618. [3] Goldstein R. H. (2001) *Lithos, 55,* 59-93. [4] Warren, J. K. (2010) *Earth-Science Reviews*, 98, 217-268.