EXPLORATION OF BIOSIGNATURE PRESERVATION POTENTIAL OF ANCIENT AND MODERN EVAPORITES.

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Introduction: Understanding the modes of preservation of life in evaporites is an essential component in determining habitability on other planets [1]. Previous research has shown the presence of primary microorganisms, such as prokaryotes, algae, and diatoms, preserved within gypsum crystals [1, 2], while halite has been reported to contain enigmatic "hairy blobs," thought by some to be preserved microorganisms [3, 4] and it has even been suggested that halite can preserve viable bacterial spores [5, 6]. However, less work has been done on the chemical biosignatures preserved within evaporite samples. This study pairs petrographic examination of modern and ancient evaporite samples with biomarker extraction analysis, the better to understand the chemical record of preserved life that can be locked in these minerals.

Methods: Two different classes of evaporative minerals have been examined in this study: halite and gypsum. Samples were collected throughout the North American Midcontinent and range in age from Permian to modern. Additionally, some of the evaporites are primary, preserving an original record of deposition, and some are secondary, preserving the dissolution and reprecipitation of evaporites. The primary environments of deposition vary from transitory lakes to back reef to deep basin, while the secondary precipitants represent vein-filling environments as well as subsurface precipitation. The variable ages and environments of deposition allows for three important components to be considered: (1) how diagenesis can alter both the gypsum and organic material, (2) which environment is optimal for life preservation, (3) whether weathering inclusions play a role in preserving modern signs of life.

These samples were examined using three different microscopic techniques: transmitted light, polarized light, and excitation by UV light. The transmitted and polarized light microscopy allows an exploration of the mineral textures and cross-cutting relationships, while the fluorescent microscopy allows a determination of whether these evaporites contain auto-fluorescent material. Although there are multiple ways to induce autofluorescence in geological samples, given the depositional history of these samples, any autofluorescence is likely due to the presence of organic carbon compounds.

Once the microscopy is completed, samples were crushed in a clean stainless steel ball mill then solvent extracted. These extracts were then analyzed via gas chromatography/mass spectrometry to identify any organic compounds preserved within the evaporites.

Results: Preliminary microscopic analysis of gypsum has revealed the presence of organic carbon compounds within the evaporite minerals. Features suggestive of weathering inclusions, individual crystals filled with organics, and microorganisms have all been observed as modes of life preservation. Additionally, in samples where the matrix is composed of multiple generations of gypsum, only certain crystal morphologies contain autofluorescent compounds.

Another component seen within the gypsum crystals are fluid inclusions. At this point, no organics have been observed in the inclusions. However, they could prove useful in future research to determine the chemical signatures of the original brine [7].

Organic extractions of Permian-aged Blaine Formation gypsum revealed the presence of microbial biomarkers, including hopanes, suggesting that it should be possible to correlate a record of autofluorescent organic compounds with a record of extractable biomarkers. Taken together these data indicate that evaporite minerals could contain a rich record of chemical fossils as well as physical fossils, making them an excellent prospect in the search for life on Earth and beyond.

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References: [1] Benison K. C. and Karmanocky III F. J. (2014) *Geology, 42,* 615-618. [2] Schopf, J. W. et al. (2012) *Astrobiology, 12,* 619-633. [3] Benison K. C. et al. (2008) *Astrobiology, 8,* 807-812. [4] Benison K. C., et al. (2007), *Journal of Sedimentary Research, 77,* 366-388. [5] Vreeland R. H. et al. (2000) *Nature, 407,* 897-900. [6] Vreeland R. H. et al. (2006) *Extremophiles: Life under Extreme Conditions, 10,* 71-78. [7] Ayllón-Quevedo F. et al. (2007) *Sedimentary Geology, 201,* 212-230.