Astrobiological Characterization of Biosignatures from a Planetary Lava Cave Analog

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Planetary caves provide protection from radiation, impacts, and thermal fluctuations making them attractive astrobiology targets. These characteristics may also enhance preservation of biosignatures. BRAILLE (Biologic and Resource Analog Investigations in Low Light Environments) is a NASA PSTAR team focused on characterizing microbial life and associated chemical and morphological signatures of lava tube microbial ecosystems using astrobiology field research in tandem with rover opperations.

The team undertook its first field deployment to Lava Beds N.M. in November 2017 and will have a follow up campaign just prior to the meeting. Lava Beds hosts >780 identified lava caves, most extending ~20-45 m below the surface, situated in 30-35 Ka and 11-12 Ka basalts. We selected 3 caves for our initial phase of work: Valentine (VAL), Hopkins-Chocolate (HOP), and L300 based on their accessibility, age, and anthropogenic impact. During the first deployment we characterized the sites using spectral mapping and imaging and collected of a suite of materials for biosignature characterization. Samples for sequencing, SEM, organic geochemistry (lipids, TOC), stable isotope (C,O,H) geochemistry, and geochemistry and mineralogy of basalt, secondary minerals, and microbial mat materials were collected from cave walls and floors.

Preliminary analyses are underway. DNA extraction and sequencing is being done in two laboratories to compare methodologies on samples ranging from pure mineral to extensively encrusted. SEM images reveal stunning and diverse microbial morphologies. While DNA yields are low distinct communities of microbes are found between sample types with the most diversity occurring in microbial mats. Lipid biomarkers extracted in parallel will allow for direct comparison of biosignature yields and compositions between lipids and DNA. Cave fluid chemistry reveals that the extent of basalt-water interaction releases trace elements like Fe, Mn, Al, Sr, Cu and Zn in high concentrations into the water. We will present a full characterization of this compelling suite of samples at the conference.