MICROBIAL ECOLOGY, EVOLUTION, AND BIOSIGNATURE POTENTIAL IN ISOLATED CHEMOSYNTHETIC CAVE ECOSYSTEMS. D. S. Jones[1,2,3], Z. E. Havlena[4], and J. L. Macalady[5], [1]New Mexico Institute of Mining and Technology, Department of Earth and Environmental Science, Socorro, NM, USA, daniel.s.jones@nmt.edu, [2]National Cave and Karst Research Institute, Carlsbad, NM, USA, [3]University of Minnesota, Department of Earth Sciences and BioTechnology Institute, Minneapolis, MN, USA, [4]New Mexico Institute of Mining and Technology, Department of Earth and Environmental Science, Socorro, NM, USA, zoe.havlena@student.nmt.edu, [5]The Pennsylvania State University, Department of Geosciences, University Park, PA, USA, jlm80@psu.edu

Sulfidic caves are hotspots for life in Earth's subsurface. These caves form where hydrogen sulfide (H_2S)-rich groundwaters interact with oxygen in recent surface recharge or cave air, and the resulting chemical disequilibrium supports robust, chemosynthetically-based ecosystems in which sulfide oxidizing microorganisms are the primary producers. These sulfide oxidizing microbes are also important geomorphological agents that contribute to the evolution of the cave system by producing corrosive acids and creating distinctive mineralogical features. Although "active" sulfidic caves are rare and are limited to a handful of sites worldwide, "fossil" sulfidic caves that contain morphological and mineralogical records of past sulfidic episodes are more common.

Because sulfidic caves host isolated ecosystems supported by inorganic chemical energy, they are analogues for sheltered subsurface biological repositories that could occur on other planets (e.g., [1,2]). Sulfidic caves also contain deposits of gypsum and other minerals that occur on the Martian surface (carbonates and possibly elemental sulfur; [3]), and preserve chemical, organic, and mineral biosignatures for microbial activity. Biosignatures may also occur at larger and more widespread scales in these systems, such as in the distribution and isotopic composition of gypsum deposits [4] and elemental sulfur masses [5,6], and possibly even the large-scale morphology of cave passages themselves.

The Frasassi cave system is a large, actively-forming sulfidic karst complex in central Italy. Dissolved sulfide from an anoxic aquifer supplies energy to the water table, where robust sulfide-oxidizing microbial communities occupy diverse niches (Figure 1). Above the water table, $H_2S(g)$ flux from the sulfidic aquifer provides energy for microbial communities on cave walls and ceilings. These subaerial communities include acidophilic and extremely acidophilic biofilms where gypsum corrosion residues shield sulfide oxidizers from buffering by the cave limestone (Figure 1). We will present research on microbial ecology, biogeochemical sulfur cycling, and potential biosignatures at the Frasassi water table, including a case study in which we used acidophilic biofilms as natural experiments to test how dispersal restrictions influence microbial biogeography and evolution in the subsurface. We will also present preliminary results from new research on microbial communities and processes in ancient gypsum deposits from a fossil sulfidic cave.

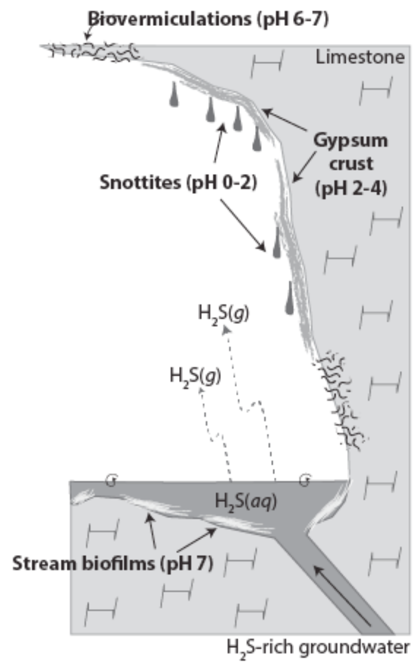

Figure 1. Schematic depicting the distribution of microbial communities near the sulfidic water table in the Frasassi cave system.

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