POTENTIAL FOR PRESERVATION OF BIOSIGNATURES FROM ENDOLITHIC MICROBIAL COMMUNITIES IN A MARS ANALOG FUMAROLE ENVIRONMENT.
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Introduction: Mars has been a volcanically active planet throughout its history, and the scarcity of water at the surface through most of this time suggests that fumaroles may have been more common than hot springs. In fumarolic environments, condensation of volcanic vapors would have provided localized warm, moist habitats for life on Mars, even when dry and cold conditions prevailed over most of the planet. In an effort to understand more about the potential for life and biosignature preservation in fumarolic systems, we have begun studying endolithic photosynthetic communities that inhabit fumaroles at Cerro Negro volcano, Nicaragua (Fig. 1a). These communites inhabit environments where condensation of steam-rich vapors provide a continuous source of moisture and elevates temperatures well above ambient conditions.

Geologic setting: Cerro Negro is a young, basaltic cinder cone that last erupted in 1999. Within the volcano's crater, steam-rich vapors discharge to the surface in two principal modes: (1) localized areas of focused, high temperature (to >200°C) venting of strongly acidic, SO_2-rich steam, and (2) broad areas where vapor flows diffusively through cinders and altered mineral deposits [1,2]. In the diffuse areas, condensation of vapors leaves a layer of moisture on the mineral deposits, where temperatures range from ~100°C down to ambient and the pH of condensed fluids range from mildly acidic (~4) to circumneutral (~7).

Endolithic communities: The presence of photosynthetic communities within the fumarolic deposits is readily recognizable by layers of green pigmentation (Fig. 1a). The pigment layers are enclosed within mineral deposits, typically 0.5 cm or more below the surface. While temperatures in areas of diffuse vapor discharge can range to over 100°C, the pigmented deposits are confined to areas with T <65°C. Pigmented layers are found in a number of different settings, encompassing a range of mineral substrates (amorphous silica, gypsum), pH (acidic to circumneutral), and fluid compositions (e.g., high vs. low sulfate).

Initial analysis of one endolithic community indicates it is dominated by acidic red algae (*Cyanidiales*), accompanied by a highly diverse microbial population that includes aerobic bacterial heterotrophs (*Ktedonobacteria*) and archaeal thermoacidophiles (*Hyperthermus, Caldisphaera,* and *Thermofilum*) [3]. Examination of the pigmented layers by SEM revealed widespread spherical shapes ~5 μm in diameter that presumably represent photosynthetic cells (Fig. 1b).

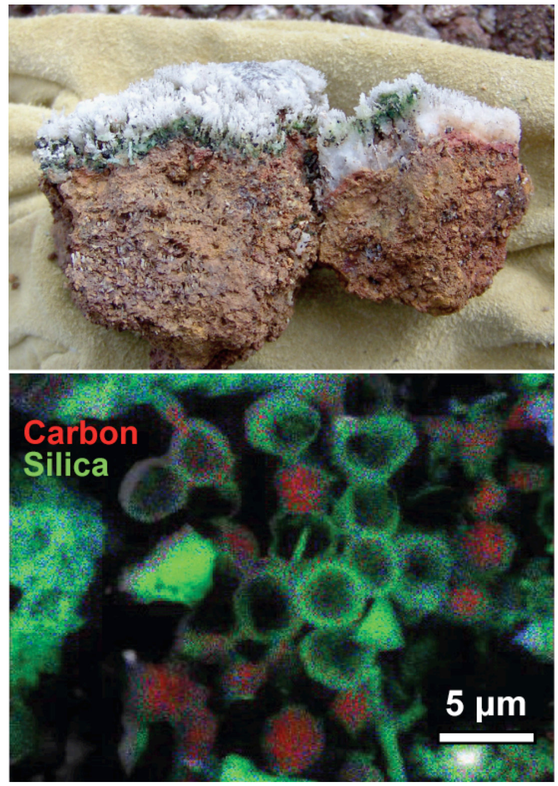

Figure 1. (a) Photosynthetic endolith community embedded in amorphous silica deposited on top of basalt. (b) Elemental map of pigmented layer, showing carbon-rich coccoidal cyanobacteria cells and SiO_2-coated spheroids presumably deposited on relict cells.

Biomarker preservation: Because the endolith communities inhabit sites of active mineral precipitation, there is a high potential for preservation of morpholigical and chemical biosignatures. For example, initial analyses show algal cells become coated with deposits enriched in Si and Mg (Fig. 1b), which preserves morphological evidence for cells in older deposits. Efforts are underway to further charactize these preserved cells and any carbonaceous deposits that may be associated with them.

References: [1] McCollom T. M. et al. (2013) *JGR, 118,* 1719-1751. [2] Hynek B. M. et al. (2013) *JGR, 118,* 2083-2104. [3] Rogers K. L. et al. (2014) AGU Fall Meeting, Abstract P32A-02.