Lava Cave Microbial Mat and Secondary Mineral Deposit Communities: Implications for Life Detection on Other Planets

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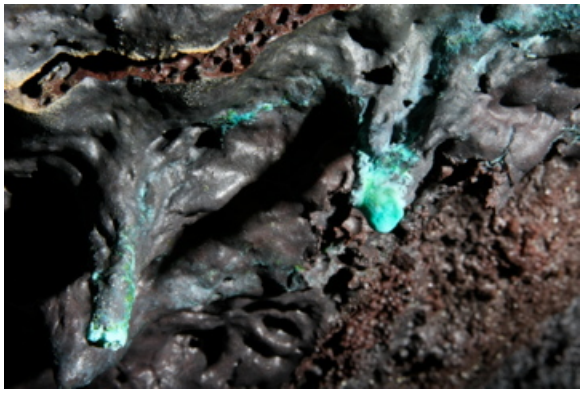
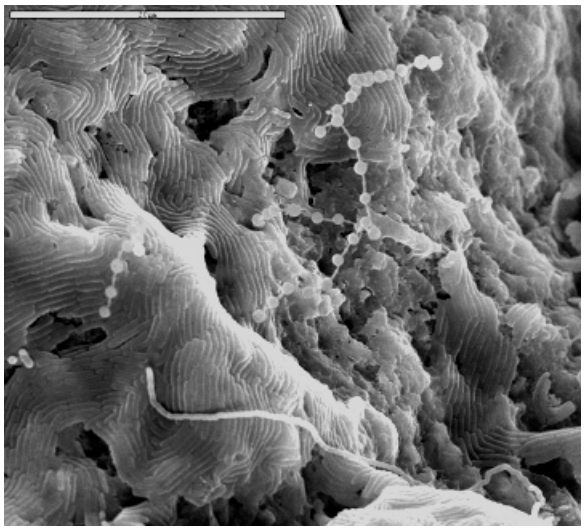
Lava caves represent an untapped microbial habitat with a wealth of microbial mats that vary in color from yellow, white, pink, tan, orange, or gold. These communities have received very little attention in the published literature and only recently have studies employed culture-independent techniques to study community makeup. In addition to these very biological-appearing deposits, there are many secondary mineral deposits that do not appear to be purely mineral in appearance, which have received even less attention. Calcium carbonate deposits and a soft ooze-like coating were found in several locations. Of special interest was an amorphous blue-green, copper-silicate deposit (Hawai‘i), which contains reticulated filament and fuzzy structure morphologies. Iron-oxide formations and pink iron-oxide hexagon structure on basaltic glass were found in lava caves in the Azores, but not in the other two locations. In both New Mexico and Hawai‘i, we sampled gold-colored deposits that form veins or chunky deposits on the walls of lava caves and which may represent a harden form of the soft oozes found in other lava caves. We used molecular to analyze the bacterial composition of these communities. Molecular analyses revealed a community that contains fourteen phyla of bacteria across microbial mats and secondary minerals in three locations: the Azores, New Mexico, and Hawai‘i. A great deal of overlap was seen at the phylum level in the microbial mat communities, but substantial differences exist at the OTU level among communities. Hawaiian and Azorean communities were significantly different in



terms of selected elements in the host rock on which microbial mats reside and in geographical location. Bacterial communities in New Mexico varied across different colors and by age of the lava flows in which the host lava caves were located. Similarities exist between bacterial phyla found in microbial mats and secondary minerals, but marked differences also occur, such as the lack of *Actinobacteria* in two-thirds of the secondary mineral deposits. Scanning electron microscopy (SEM) of these mats and deposits show commonalities among the different geographical sites and some unique morphologies. SEM also reveals the presence of a variety of putative biological morphologies among the secondary mineral deposits.



The discovery that secondary mineral deposits are quite biological in nature is critical to our understanding of what habitats are promising for the detection of life on extraterrestrial bodies, such as Mars, which are known to contain lava caves.

Lava cave photos by Kenneth Ingham.