Robotically Based Detection of Proposed Universal Microbial Biosignatures For Lavatubes on Earth and Extraterrestrial Targets

P.J. Boston [1, 2] (and a cast of thousands…)

Unique microbial patterns (aka "biovermiculations") and other biotextures and biominerals may be indicative of present or past microbial communities in caves and other extreme habitats. Since 2007, we have been mathematically modeling such patterns, studying them in nature, and attempting to simulate them in the laboratory. The work is now mature enough to have taught us some important lessons about how such features are established, and continue to change as physical, chemical, and biological circumstances continually shift. Although such biopatterns occur in a wide variety of cave types, and even some surface environments, their occurrences in basaltic lavatubes is often particularly striking and thus, provide an exceptional example for extended study. We will present a visual trip through the various morphologies and scaling factors to be found in lavatube biovermiculations and a summary of our findings of 8+ years of research to date.

The direct application of our findings to the detection, identification, and characterization of such features in caves and other habitats on Earth is being explored using robotic platforms under development for planetary exploration (Figure 1). We will present results of integrated science-on-robot trials in New Mexico lavatubes during September 2015. The latest cutting edge robotic concepts for access to subsurface and other challenging terrains will also be briefly reviewed, time permitting.

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Figure 1: Prototype of the LEMUR robot under development at the Jet Propulsion Laboratory Rock Wall Test Facility. A version of this robot was recently tested in lavatubes at El Malpais National Monument, in Grants, New Mexico. LEMUR possesses unique footpads fitted with Microspines™ that grip rock using a series of circular arrays of sharp hooks, thus enabling secure clinging across a wide span of relative surface roughness conditions. The project goal is to integrate a variety of scientific instruments with such robots for access to lavatubes on Earth that may be inaccessible due to size, thermal characteristics, or gases poisonous to human investigators and to develop such capabilities for application to extraterrestrial mission targets including Mars and lunar lavatubes, and possibly cryogenic volcanic cavities on icy Solar System bodies. Image courtesy of A. Parness, NASA-JPL.