Geophysical investigation of lava tubes at the HI-SEAS planetary analog site in Hawai‘i

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Abstract. Orbital imagery of the Moon and Mars shows evidence of lava tubes in the form of sinuous rilles, pit craters, topographic ridges, and skylights. These caverns are important for planetary exploration from geological, biological, and engineering perspectives. They offer access to undisturbed rocks that are relatively pristine from surface weathering processes. Caves are a prime site to search for life on Mars since they offer protection from ultraviolet radiation and conditions that might be favorable for stable water to exist. They are also prime locations for astronaut shelters because the subsurface environment provides protection from radiation, dust, and large ambient temperature variations. Before a rover or human can safely enter a lava tube on another world, geophysical surveys are required to peer into the subsurface at candidate sites and determine the existence, size, extent, and floor material characteristics of any lateral voids.

In cooperation with SSERVI's Remote, In Situ, and Synchrotron Studies for Science and Exploration (RIS^{4}E) team, we have carried out a geophysical survey of a lava tube at the Hawai‘i Space Exploration Analog and Simulation (HI-SEAS) planetary analog site on Mauna Loa, Hawai‘i. Multiple geophysical methods can detect and characterize subsurface voids. Each technique has benefits and limitations depending on the subsurface geology, void size, target depth, and surface conditions. Here, we report our findings from an initial field test comparing LiDAR, GPR, and magnetic surveys over a known lava tube system near HI-SEAS.

The HI-SEAS program studies team function and autonomy on long duration exploration missions conducted in a remote habitat located on Mauna Loa, Hawai‘i. The basaltic terrain and sparse vegetation of the site make it a good geologic analog to the Moon or Mars, and since the site is accessible year-round, it allows for longer-term isolation studies than other analog locations. Since 2012, NASA has funded ongoing HI-SEAS missions ranging from four to twelve months in duration. These missions are comprised of six crewmembers who live in the habitat and interact with a mission support team remotely via an imposed 20-minute communications delay to provide Mars-like operational latencies. Crewmembers wearing simulated space suits regularly conduct extra-vehicular activities (EVAs) to explore their surroundings. The geophysical data we have collected at this lava tube serves as a control to help evaluate the field mapping performance of HI-SEAS crews. It also helps identify operational best practices to plan and carry out future field surveys to characterize subsurface voids on similar volcanic terrains.