Paper ID: 78772
oral

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – missions current and future (3A)

Author: Dr. Jennifer Blank
National Aeronautics and Space Administration (NASA), Ames Research Center /Blue Marble Space Institute of Science, United States, jgblank@gmail.com

TESTING OPERATIONAL DESIGNS FOR A FUTURE ROBOTIC MISSION TO A MARTIAN LAVA TUBE

Abstract

More than 1200 potential volcanic caves entrances have been identified using Mars orbiter data. One of these may, in the near future, provide the most direct access to the Martian subsurface in the search for signs of past or extant life, water ice, or shelter for future human habitats. We have been preparing for a future mission to a Martian cave, practicing with wheeled and legged robots equipped with scientific and autonomy platforms deployed in lava tubes on Earth. We will share lessons learned from these Mars mission simulation activities that we have tested over five field seasons. NASA's BRAILLE (Biologic and Resource Analog Investigations in Low Light Environments) Project is a multi-year analog research program centered around field research at Lava Beds National Monument (Northern California, USA), our analog environment for Mars. The BRAILLE Team's objectives have been to (1) characterize microbial life and microbial community structure in terrestrial lava caves and the nutrients in rock and water that sustain them; (2) distinguish secondary minerals, associated with microbes in the caves, that are macroscopic, putative signatures of life that could persist long after any life died away; and (3) practice robotic life-detection and mapping mission operations and evaluate performance metrics. The first two of these objectives are independent of the mission simulation activities but provide valuable ground truth information used for the development of a cave life detection algorithm for robotic deployment as well as the interpretation, by remote scientists, of subsequent data collected robotically. The cave environment presents several challenges for robotic investigation that need to be overcome through mission design or the use of novel technologies. Our activities focused on operations inside the caves, assuming ingress had been achieved. Initial field tests used a wheeled platform that conducted transects along segments of a cave wall; preliminary data were transferred to a distant Mission Operations Center and interpreted by a remote science team, which then directed the rover to return to selected priority sites for further characterization. Subsequent tests used free-roaming Boston Dynamics legged Spot robots equipped with the NeBula autonomy platform developed by JPL. We compared the efficiencies of one- and two-robot teams working independently, or with a human-in-the-loop, to map and explore. This work was funded by the NASA PSTAR Program NNH16ZDA001N. We thank the US National Park Service, the US National Forestry Service, and the American Cave Research Foundation for logistical support during field deployments.