Astrobiology Survey of a Lava Cave at Lava Beds National Monument by a Rover Carrying a Remote Sensing Instrument Payload

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We report here on a survey of a lava tube cave by a rover that is instrumented for astrobiology missions. The NASA Ames testbed rover, CaveR, was deployed in Valentine Cave in Lava Beds National Monument (N. CA, USA) during August of 2018. The rover carried an instrument package consisting of Near Infrared and Visible Spectrometer System (NIRVSS) a point spectrometer operating in 1590-3400 nm range, sensitive to H_2O and -OH bearing minerals, pyroxenes, and carbonates (Roush, et al 2018); the bore sighted Drill Operations Camera (DOC), a monochrome imager illuminated by LEDs at 410, 540, 640, 740, 905 and 940 nm; a Realsense ™ depth sensor system for 3D model generation; and a high resolution DSLR stereo camera (Figure 1). The payload was mounted on a tiltable instrument platform attached to the left side of the rover. The rover was driven manually in the cave by field operators, following instructions from a remote science operations team, and simulating a mission concept with science-guided autonomy. A simulated mission took place for 3 days with a team of 3 scientists selecting targets and interpreting data from the payload. To begin the mission, the rover drove along one wall of the cave imaging continuously with the Realsense in 20 m cave segments, three total. At the start of each day, the images from a 20m segment and a panorama stitched from them were provided to the science team to examine. The science team used these data to prioritize specific points along the cave wall for the collection of NIRVSS, DOC, and DSLR data. The objective of the data collection was to identify and study putative biological and mineralogical features in the cave. The data were delivered in xGDS, a customized mapping, planning, and data base management software developed at NASA Ames (Lee, et al 2013). Once the targets for further observations were selected, a plan for collecting the observations (positions in the cave and pointing for each requested observation) was constructed using xGDS and delivered to a rover team to execute the science data collection plan. Acquired data were delivered back to the science team for analysis. Preliminary results from the experiment illustrate the utility of the system (rover plus payload) to study the cave geology and mineralogy and its potential for identifying biomineral features.

References:

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Figure 1-a. Cave instrument package consisting of point spectrometers (1]), a multi-illuminant spectral imager (2), a 3D depth mapping sensor (3), stereo DSLR cameras (4), and custom photographic illumination (5). **Figure 1-b.** The CaveR rover used to carry the science payload and simulate a NASA planetary cave mission.