LAVA TUBE CAVES ON MARS AS REFUGIA FOR MICROBIAL LIFE. R. J. Léveillé[1,4] , J. Ni[1], B. O'Connor[2,4], C. Patterson[3] and L. G. Whyte[2,4], [1]Earth and Planetary Sciences, McGill University, Montreal, Canada, QC, H3A 0E8, richard.leveille@mcgill.ca , [2]Natural Resource Sciences, McGill University, St-Anne-de-Bellevue, Canada, QC, H9X 3V9, 3Bioresource Engineering, McGill University, Ste-Anne-de-Bellevue, QC, Canada, H9X 3V9, [4]McGill Space Institute, McGill University, Montreal, QC, Canada, H3A 2A7.

Introduction: Subsurface caves on Mars have long been thought of as protected subsurface environments of interest in astrobiology [1]. Compared to surface environments, caves may provide a more stable environment with minimal diurnal or seasonal temperature fluctuations and protection from wind and dust storms. The rocks above caves, even if only a few meters thick, would provide protection from harmful radiation at the surface. Specific geometric configurations may affect air flow and lead to conditions that are different than surface conditions. Lava tube caves, in particular, appear to be abundant and widespread in the large volcanic regions of Mars. Ice could be stable in lava tubes and low-altitude, low-latitude caves could maintain small amounts of liquid water under specific conditions. We have even found evidence of impact-induced liquid water interaction with a subsurface void, which putatively could be a lava tube, in recent times. We hypothesize that lava tube caves may act as subsurface refugia that could enable life to survive through less habitable conditions, including possibly in modern times.

Current Research and Results: We are currently studying lava tube caves at Lava Beds National Monument (LABE), CA, as part of the CSA-funded "ATiLT: Astrobiology Training in Lava Tubes". Lava tubes on Earth are considered to be similar to lava tubes on Mars as they form in similar ways – during the cooling of basaltic lava flows. LABE is in a high altitude, semi-arid desert environment with little to no surface water. Several hundred distinct caves have been documented in four main lava flows of the Medicine Lake volcano. While all are based on basaltic lava flows, each cave environment is different due to variations in lava composition and age, meteoric waters, secondary cave minerals, cave sediment fill, geographic setting, physical attributes (geometry, air flow, etc.). Even within a single cave, multiple microhabitats (e.g., floor sediments, primary rock, secondary minerals, drip pools, ice formations) can be found. This offers the potential to document and study microbial diversity and controls on microbial colonization and development. Diverse cave environments likely host distinct microbial communities. For example, at LABE, we have found that perennial ice and related ice-rock interfaces in some caves appear to favor cold-adapted microorganisms (Figure 1). We are working to characterize this ice-associated microbial diversity in greater detail building on previous work by others focusing more on biofilms on cave surfaces at LABE [2], as well as studies of other cave systems [3]. We are also beginning to probe the functional potential of the microbial community to determine what adaptations they may be using to survive in this unique environment. To do so, we are combining the use of mission-relevant in situ analytical instruments (e.g., LIBS/Raman/IR spectroscopy) and the MinION DNA sequencing platform. Such an instrument suite, in a relatively low-mass package, could conceivably detect and characterize microbial life in Martian lava tubes.

Figure 1. Aseptic sampling of perennial ice covering the floor of Cox Cave, Lava Beds National Monument, CA.

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