BASALT 2016: MARS ANALOG RESEARCH IN LAVA TERRAINS OF IDAHO AND HAWAI`I. S.E.K. Nawotniak[1], D.S.S. Lim[2], S.S. Hughes[1], A. Sehlke[2], A. Brady[3], C. Cockell[4], S. Payler[4], A. Stevens[4], C. Haberle[5], R. Elphic[2], W.B. Garry[5], E. Gibbons[3], C. Borg[1], E. Sandmeyer[1], and the BASALT team. [1]Department of Geoscience, Idaho State University, Pocatello, Idaho (kobsshan@isu.edu), [2]NASA Ames Research Center, Moffett Field, CA, [3]School of Geography & Earth Sciences, McMaster University, Hamilton, Ontario, Canada [4]UK Centre for Astrobiology, The University of Edinburgh, Edinburgh, Scotland, [5]Planetary Geodynamics Laboratory, Code 698, NASA Goddard Space Flight Center, Greenbelt, MD

Introduction: Biologic Analog Science Associated with Lava Terrains (BASALT) is a multidisciplinary project using lava flows in Idaho and Hawai`i as analogs for Martian science and exploration. Geologists, microbiologists, and organic geochemists work together to identify trends in microbial habitability as a function of rock alteration, mineralogy, texture, etc. [e.g., 1-3], within the structure of simulated manned missions to Mars [e.g., 4,5]. The project deployed to Craters of the Moon National Monument and Preserve (COTM) in June and Hawai`i Volcanoes National Park (HVNP) in November of 2016. Here, we introduce project goals and preliminary results.

Research objectives: The overall guiding question of BASALT's science agenda is how do microbial communities and habitability correlate with the physical and geochemical characteristics of chemically altered basalt environments. We investigate this within two broad climate conditions, with COTM standing in for the relatively cold and dry modern Mars while HVNP represents a hot, wet ancient Mars. The ultimate goal is to determine the upper bounds of biomass that could have been supported on Mars in order to guide the search for, and detection of, life on the red planet. Research is conducted using *in situ* spectroscopy and field observation, petrographic and geochemical analyses, microbe culturing and DNA extraction, and measurement of lipids on the rock.

Idaho: The COTM fieldwork focused on Big Craters and Highway flows (~2ka), geochemically and morphologically distinct lava flows located at the northern end of the Great Rift system [6]. We collected samples demonstrating high, moderate, and no alteration for hot and cold alteration styles for each lava flow. Cold alteration, characterized by carbonates and salts in <1 mm thick white veneers on interior crack surfaces, are the result of exposure to wind and precipitation. The hot alteration, produced by syn-emplacement volatile interaction, is dominated by hematite, goethite and related (hydr-)oxides that appear as bright reds, yellows, and oranges in the outcrop. Cold alteration is pervasive throughout the field areas, concentrated along cracks. Hot alteration is spatially organized around vent-proximal areas, seams between lava flow lobes, along major extension cracks, and within blisters in the tops of flows where volatiles would have been able to accumulate.

Preliminary results indicate abrupt gradients in alteration associated with distinct microbial communities. Habitability is low in unaltered rock, though still measurably different between the Big Craters and Highway flows [7,8].

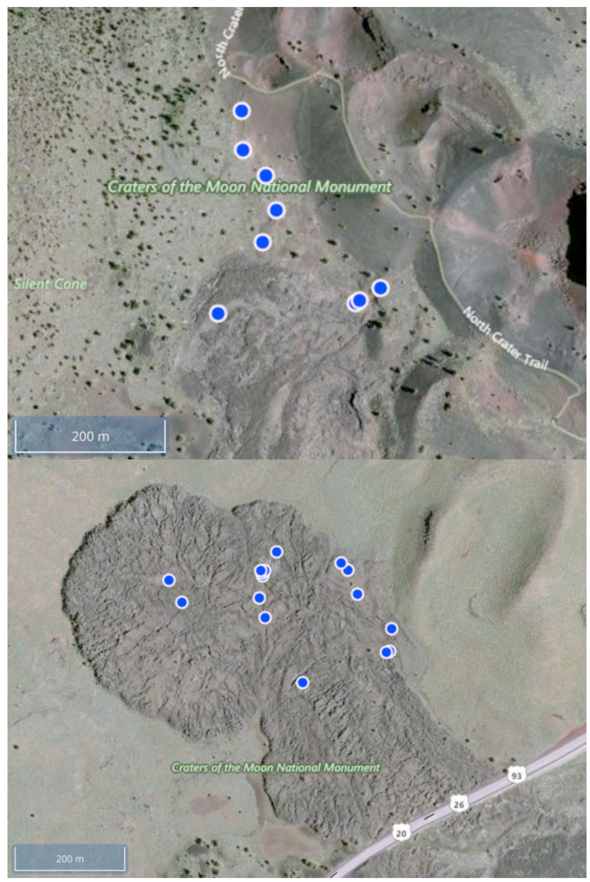

Figure 1. *Idaho field areas with sample markers. Upper panel: Big Craters Flow. Lower panel: Highway Flow.*

Hawai`i: Mauna Ulu, part of Kilauea's the east rift zone, erupted 1969-1974. In major contrast to Idaho, fieldwork at Mauna Ulu emphasized the role of fumaroles on alteration and habitability. In addition to sampling unaltered and hot, syn-emplacement alteration for direct comparison with COTM samples, we also collected for active and relict fumaroles. Fumarole states were distinguished from one another using a FLIR thermal camera. Due to the youth of the lava, relict fumarole could not have been long past their active periods. Fumarolic samples were dominated by low-iron by secondary mineral growth and high degrees of friability, with infrequent but intense deposits of sulfur precipitate. While it is possible that the relict fumaroles identified in the field may have been in periods of temporary quiescence, they demonstrated degradation of secondary mineralization (visible in hand sample) that suggested at least sufficient time had past since active status that it represented a different condition.

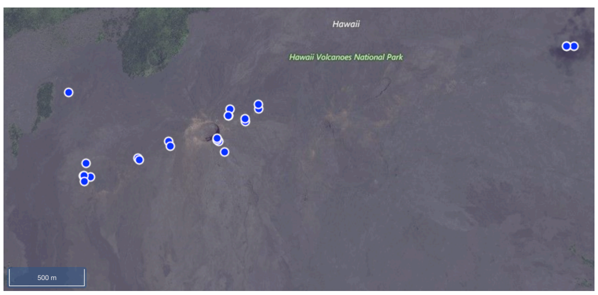

Figure 2. *Hawaii field area with sample markers. Mauna Ulu volcano.*

Continuing work: BASALT researchers are continuing to evaluate mineralogy, geochemistry, texture, DNA, and lipids in the rocks from COTM and HVNP, as well as evaluate in situ instruments and mission deisgn. Correlation between geologic, microbial, and organic geochemical results will be used to determine the impacts of various lithologic and alteration states on microbial habitability, thereby offering pathways forward in the search for past or present life on Mars. Please see preliminary results by Sehlke, Sandmeyer, Mallonee, and others at this meeting.

References: [1] Kobs-Nawotniak et al. (2016) *AGU Fall meeting.* [2] Sehlke et al. (2016) *AGU Fall meeting.* [3] Hughes et al. (2016) *AGU Fall meeting.* [4] Beaton et al. (2017) *IEEE Aerospace* #2118 3 [5] Deans et al. (2017) *IEEE Aerospace* [6] Kuntz et al. (1994) *USGS OFR* 94-659. [7] Brady et al. (submitted) AbSciCon 2017. [8] Cockell et al. (submitted) AbSciCon 2017

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