DETECTION OF MICROBIAL ORGANIC BIOMARKERS IN TERRESTRIAL BASALTS IN A MARS ANALOGUE ENVIRONMENT.

A. L. Brady[1] G. F. Slater[1] E. Gibbons[1] S. Kobs Nawotniak[2] S. S. Hughes[2] S. Payler[3] A. Stevens[3] C. S. Cockell[3] C. Haberle[4] A. Sehlke[5] R. C. Elphic[5] D. S. S. Lim[5,6]
[1]School of Geography and Earth Sciences, McMaster University, Hamilton, ON, Canada, [2]Idaho State University, ID, USA, [3]Centre for Astrobiology, University of Edinburgh, UK, [4]Arizona State University, AZ, USA [5]NASA Ames Research Center, CA, USA, [6]Bay Area Environmental Research Institute

Introduction: Hypothesized wide-spread volcanism on Mars could have led to the creation of habitable environments. Rock weathering and alteration may have increased porosity and generated secondary minerals that could provide new energy sources for organisms [1]. There is thus a critical need to examine the relationship between mineralogical and/or geological features associated with such alteration (e.g. identifiable through remote sensing hyperspectral data) and the potential for the detection and characterization of putative microbial biosignatures. The objectives of this study were the direct assessment and mapping of the distribution of organic compounds associated with terrestrial basalt terrains that exhibit variation in features such as mineralogy, texture and the degree of alteration (e.g. hot volatile interaction, subsequent cold aqueous alteration).

Samples were collected as part of the NASA BASALT (Biologic Analog Science Associated with Lava Terrains) project. This work focuses on samples from Craters of the Moon National Monument and Preserve (COTM) in Idaho, one of two high fidelity Mars-analogue basalt sites selected due to their range of alteration features enabling sampling along gradients of alteration and volcanic activity. The COTM fieldwork focused on two morphologically distinct lava flows: Big Craters and Highway flows (both ~ 2,000 years in age). Basalts exhibiting highly altered features (for both hot and cold alteration styles) as well as unaltered material were collected as end-members along an alteration gradient at both flow locations.

Results: Microbial phospholipid fatty acid (PLFA) analysis was used to quantify viable microbial biomass [2] and characterize the microbial communities [3]. Some variation in PLFA profiles was observed between samples. Ubiquitous straight chain fatty acids, predominantly 16:0, are present in all samples (< 15% total PLFA) but at lower proportions than observed in some other microbial environments (e.g. [4]). Instead, monoenoic PLFA, typically associated with gram-negative bacteria, dominanted in most samples with proportions ranging from 16 – 48%. Polyenoic PLFA dominated in Big Crater samples (16 – 61%) but were overall lower in the higher-silica Highway samples (7.5 – 12.5%). In comparison to Big Craters, Highway had higher proportions of mid-branched PLFA often associated with heterotrophic bacteria (up to 33%) [4]. Polybranched PLFA were only detected in highly altered Big Craters samples.

Preliminary results suggest a difference in the total amount of microbial biomass associated with unaltered and altered basalts. PLFA concentrations in all samples ranged from an average of 1.5 µg/g of rock (total range: 0.62 to 3.54 µg/g) for highly altered replicates, to below the limit of detection for unaltered materials (total range: n.d. to 0.33 µg/g). Unaltered, dense basalt from both Big Craters and Highway flows were lower than corresponding highly (hot) altered material from the same flow (e.g. BC: 0.2 vs. 3.5 µg/g PLFA). PLFA in unaltered material from Highway Flow was below detection limits. Interestingly, Big Craters total biomass in highly altered material was measureably higher than the most highly altered material collected from Highway Flow (avg. 1.7 vs. 0.75 µg/g PLFA), likely a reflection of the observed mineralogical and morphological differences that exist between the two flows. Highway Flow samples are more dense compared to Big Craters where volatile expansion and vesiculation tended to be greater and likely led to increased alteration. The Highway Flow is also more geochemically evolved relative to the lavas sampled from Big Craters vent region. In particular, analyses of samples from the Highway Flow relative to those from Big Craters are significantly higher in average SiO_2 (64.5 vs. 51.5 wt.%) and K_2O (4.8 vs. 2.3 wt.%), yet lower in average TiO_2 (0.63 vs. 2.59 wt.%), total FeO (8.4 vs. 15.6 wt.%), MgO (0.18 vs. 2.8 wt.%), and P_2O_5 (0.14 vs. 1.6 wt.%).

Understanding the habitability of distinct geochemical, mineralogical and textural properties associated with Mars-like terrestrial basalts and related organic biomarkers is fundamental to identifying targets and methods for astrobiological investigations. Results suggest that different alteration styles, identifiable through remote sensing, may exhibit variations in total microbial biomass, potentially informing selection of future life detection sites on Mars.

References: [1] Cousins C. (2015) *Life 5*, 568-586 [2] Green C.T. and Scow K.M. (2000) *Hydrogeol J 8*, 126-141 [3] White D.C. et al. (1979) *Oecologia 40*, 51-62 [4] Brady A.L. et al. (2013) *Geobiology 11*, 437-456