Conference: LPSC 2017 (http://www.hou.usra.edu/meetings/lpsc2017/)
Session: Exobiology: Searching for (Signs of) Life High and Low, Near and Far, Tuesday, March 21, 2017, 6:00 p.m.

Title: Lessons from Astrobiological Planetary Analogue Exploration in Iceland: Biomarker Assay Performance and Downselection

Abstract:
Understanding the sensitivity of biomarker assays to the local physicochemical environment, and the underlying spatial distribution of the target biomarkers in 'homogeneous' environments, can increase mission science return. We have conducted four expeditions to Icelandic Mars analogue sites in which an increasingly refined battery of physicochemical measurements and biomarker assays were performed, staggered with scouting of further sites. Completed expeditions took place in 2012 (location scouting and field assay use testing), 2013 (sampling of two major sites with three assays and observational physicochemical measurements), 2015 (repeat sampling of prior sites and one new site, scouting of new sites, three assays and three instruments), and 2016 (preliminary sampling of new sites with analysis of returned samples).

Target sites were geologically recent basaltic lava flows, and sample loci were arranged in hierarchically nested grids at 10 cm, 1 m, 10 m, 100 m, and >1 km order scales, subject to field constraints. Assays were intended to represent a diversity of potential biomarker types (cell counting via nucleic acid staining and fluorescence microscopy, ATP quantification via luciferase luminescence, and relative DNA quantification with simple domain-level primers) rather a specific mission science target, and were selected to reduce laboratory overhead, require limited consumables, and allow rapid turnaround. All analytical work was performed in situ or in a field laboratory within a day's travel of the field sites unless otherwise noted.

We have demonstrated the feasibility of performing ATP quantification and qPCR analysis in a field-based laboratory with single-day turnaround. The ATP assay was generally robust and reliable and required minimal field equipment and training to produce a large amount of useful data. DNA was successfully extracted from all samples, but the serial-batch nature of qPCR significantly limited the number of primers (hence classifications) and replicates that could be run in a single day. Fluorescence microscopy did not prove feasible under the same constraints, primarily due to the large number of person-hours required to view, analyze, and record results from the images; however, this could be mitigated with higher-quality imaging instruments and appropriate image analysis software.

Fimmvörðuháls has proved to be a reliable and high-yield field site, accessible over multiple field seasons, providing several areas with similar, undisturbed geology that are both a short enough hike from the nearest vehicle access to allow transport of field equipment yet still with relatively limited recreational activity. Eldfell had significantly higher anthropogenic disturbance, and, requiring ferry travel, was subject to weather limitations. Mælifellssandur was initially promising due to its easy access, but as a commonly flooded area, the amount of transported material present made finding enough sample sites that met our definition of 'homogeneous' difficult. The Holuhraun field, which did not exist prior to our 2015 expedition,

appears similar to Fimmvörðuháls and will be a focus going forward. A further three expeditions are planned to complete the study.

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