REPORT ON EXPEDITION / PROJECT

Expedition/Project Title:	Spatial Heterogeneity of Biomarkers in Mars analogue environments
Travel Dates:	July 10th – July 19th
Location:	South Coast of Iceland
Group Members:	Vincent Rennie
Aims:	To determine the depth profile of microbes living in Mars analogue environments as a guideline for drill depth on future Mars missions

Introduction to the Expedition

The expedition was multidisciplinary, with scientists present whose expertise ranged from spectroscopy to field geology to microbiology. The expedition team was also very international, with groups coming from Washington University, Jet Propulsion Laboratory in California, Georgia Tech University, University of Stockholm, and University of Cranfield. Although we were all working towards the solving the same puzzle as it were, each group had its own focus within the team, their own puzzle piece.

Figure 1: This is a picture taken on the last day of the expedition, with the author positioned as fourth from left to right.

The expedition started out with bad news as the main sampling site that we had chosen from satellite data was snowed over due to Iceland having its harshest winter in over 30

Figure 2: Morgan Cable, our spectroscopist from JPL (Jet Propulsion Laboratory) explaining the importance of the research for future missions to Mars.

years. However, we regrouped and quickly identified other sampling sites, which suited our science goals so that we could go ahead with the expedition. Because I was part of a team and the fact that we were on a very tight timeframe, I did not work exclusively on my project in the traditional "sampling followed by analysis" sense. Instead I chose to learn as much as I could about the various techniques as well as the basic logistics so that when I organize an expedition myself, it will run smoothly so that the data we receive from it will be publishable. As an additional surprise, Cable Morgan from JPL got a call early on in the expedition telling her that a Discovery Channel film crew were coming to film the expedition team for the next few days as part of a new show they are launching called "Meet the Superbrains".

Expedition Team Outcomes

The narrative that the expedition is based on is simple. Humans have been sent to Mars to do sampling of geologically interesting sites. First, they send out a drone that provides reconnaissance information that provides the team with an oversight of the larger area and allows them to identify sampling sites without walking over and contaminating potential sampling sites. Next, they sample this location and bring the samples back to home base for analysis. Part of the goal of this expedition was to test this narrative on Earth to see what potential problems scientists sampling might have

Figure 3: Two members of the Georgia Tech University group, Professor Amanda Stockton (left) and Thomas Cantrell preparing to operate the drone for reconnaissance. The images received from the camera on the drone will help us decide a sampling site.

on Mars and try to identify ways that these problems may be mitigated. Once such problem we encountered is that basaltic tephra is magnetic meaning that when our drone crashed, lots of tephra got trapped in the rotors. Unknown to us, the tephra had logged and stuck to the rotors of the drone which meant that when we tried to fly it to see if it was still functional after the crash, the rotors overheated and some plastic components melted. This is very relevant due to the fact that Mars has a considerable amount of basaltic and similarly magnetic rocks on its surface. The data that we have so far received from the different have been mixed, which is not a surprise given the very short timeframe we had. The data will be doubled checked back in the respective labs.

Personal Expedition Outcomes

I found this expedition to be one of the most enriching educational experiences that I have had so far in my studies. This expedition gave me the opportunity to learn from experts in the metafield of astrobiology. I learned several new analysis techniques including computer-based cell counting, ATP bioluminescence assaying, and RAMAN spectroscopy. Additionally, I was able to build on my practical skills that I had learned at my first two years the University of Edinburgh including DNA extraction protocols and quantitative PCR (qPCR).

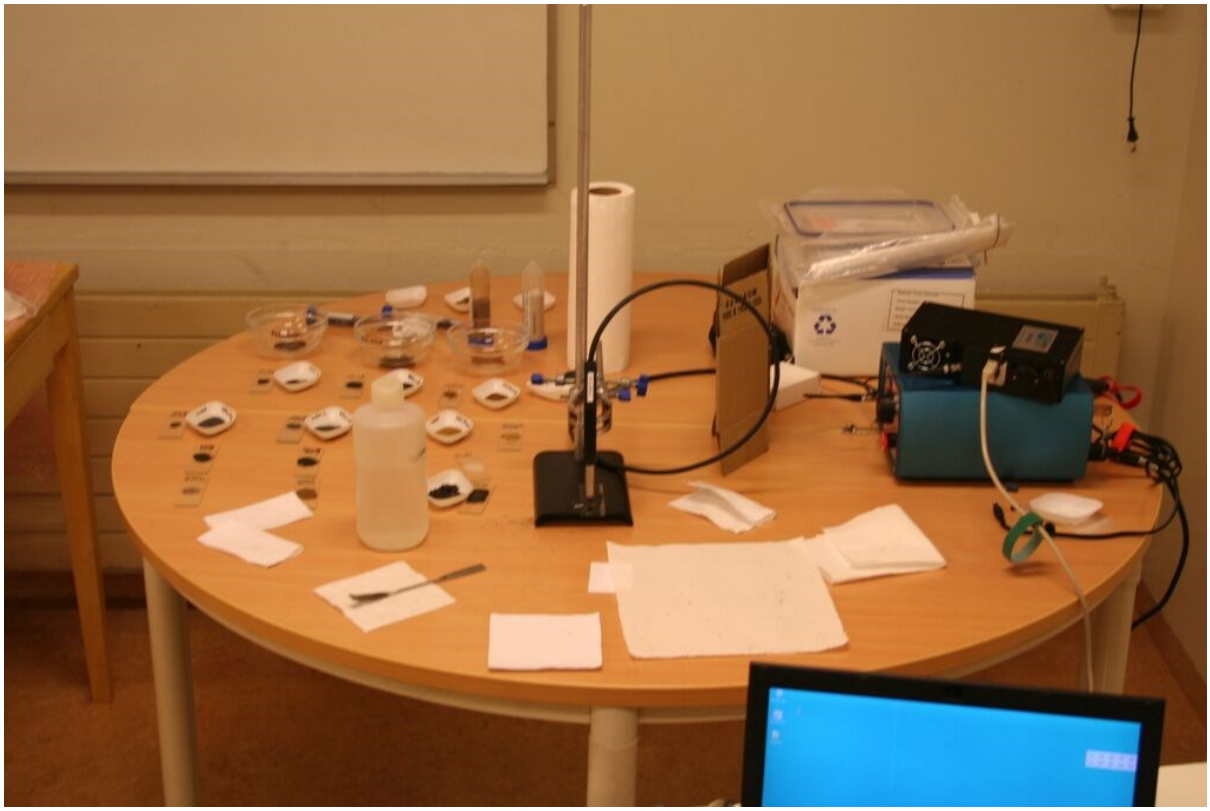

Figure 4: The setup for the RAMAN spectroscopy instrument. This instrument allows us to look at the mineralogy of the samples we bring back from the field and may allow us to draw some correlation between the environment sampled and the microorganisms that we tend to find in that kind of environment.

The data that was coming back from the ATP bioluminescence assays of the depth profiles recovered from M site, the basaltic desert environment, showed a fairly strong correlation between ATP content and depth. This indicates that the further down you go in the volcanic tephra the less biomass there is. My hypothesis is that is may likely be due to the rain that falls on the plain, carrying with it microorganisms which would be detectable due to the low amount of biomass that is initially present in this lithotrophic environment. Due to the time constraints, we were unable to start going through the PCR results from the samples, but I have asked the Georgia Tech group to send me the complete data set on the depth profiles as soon as they have it ready.

I also learned a lot about sampling technique and the importance of primary reconnaissance. This is vitally important for the minimization of contamination because if you can identify specific sampling location before going out into the pristine

landscape then you greatly reduce the risk of contaminating your sampling site because you can avoid them based on drone images.

The team meetings were also a very enriching experience because it taught me a great deal about the planning and logistics that go into a scientific research expedition. The issues experienced during the expedition such as the identified sampling site being inaccessible taught me to always have several options available so that there is no significant setbacks to the science goals of the expedition.

In terms of publications, I will be on the general expedition team paper as a secondary author and the group from Georgia Tech University have suggested that they would like for me to write the majority of the depth profile paper and therefore be first author on that paper.

Lastly, I have made many useful connections with other researchers and professors during this expedition, which may in the future give me the opportunity to do a PhD and continue to pursue a career in astrobiology.

Acknowledgements

I would like to start out by thanking my friends and family for their continual support and help with preparing me for the expedition. I thank Adam Stevens for giving me the opportunity to participate in this expedition. I also thank the rest of the expedition team for being very welcoming, helpful, and friendly. Lastly, I would like to extend my gratitude to Professor Richard Ennos and the rest of the Davis Expedition Fund committee for funding this project.