Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN2-071
Name: Assoc. Prof. Tina Santl-Temkiv
Home Institution: Faculty of Science, Aarhus University, Department of Biology, Section for Microbiology
TA Facility visited: Matis, Iceland

Project Title: Deposition of organic matter as a factor controlling microbial colonization of analogue terrestrial surfaces

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

This project was designed to improve the understanding of biosignatures in analogue terrestrial surfaces, volcanic rocks, that result as a consequence of microbial colonization and weathering. During the visit, the automatic medium-volume sampling system PNS DM modified to run on batteries charged with solar panels was assembled, tested, and calibrated in the laboratory of Matis. Due to a delay in shipment of the solar panels, the installation of the system at the field site could not be performed but will be finalized by the host institution in the near future. As a part of the visit, the area of the Fagradalsfjall volcano was visited and the location where the sampling system will be installed was discussed. Once the sampler system will be installed in proximity of the Fagradalsfjall volcano crater, aerosol samples will be collected continuously for a year along with replicate rock samples in order to investigate the impact of aerosol deposition on rock microbial community assembly, using microbial, chemical and physical analysis. This will be performed in collaboration between the team of Prof. Viggó Þór Marteinsson and the team of Assoc. Prof. Tina Santl-Temkiv and will result in greatly improved understanding of colonization, community assembly, and biosignature emergence in analogue terrestrial surfaces.

Full Scientific Report on the outcome of your TNA visit

Project aims and the strategy

This project was designed to address the following key objectives: (i) First, we aim at improving the understanding of biosignatures in analogue terrestrial surfaces, volcanic rocks, that result as a consequence of microbial colonization and weathering. (ii) Second, we aim at obtaining in-depth knowledge of the role that the deposition of aerosols plays as a nutrient source for pioneer microbial communities (bacteria, archaea and fungi) on terrestrial surfaces. (iii) Finally, we aim at consolidating knowledge of how the type and quality of atmospheric nutrients impacts the succession on volcanic rocks, which in turn affects the geochemistry of rocks. Since we submitted the application, we have significantly advanced the workplan to address these goals due to two factors: (i) Starting in March 2021, the area known as Fagradalsfjall volcano has erupted three times and produced novel lava fields in relative proximity of Reykjavik (Fig 1, left). (ii) The team of Viggó Þór Marteinsson has obtained funding to purchase the automatic medium-volume sampling system PNS DM (Comde Derenda, Stahnsdorf, Germany, Fig 1, right). The first development means that we can start following the aerosol deposition in volcanic landscapes from a very early stage of rock formation. The second development allows us to extend the aerosol sampling period from the initially planned field campaign that was supposed to span a week to a much longer period of months to years, while still collecting aerosols from a large volume of air (125-250 m^3 of air over 3.5-7 days). In the team of the applicant and the visiting scientist, Assoc. Prof. Tina Santl-Temkiv, we have been using the same automatic medium-volume sampling system over the past 4 years at different Arctic location and have therefore obtained experience with setting up, handling, and calibrating the system as well as subsequent analysis of samples obtained with this system.

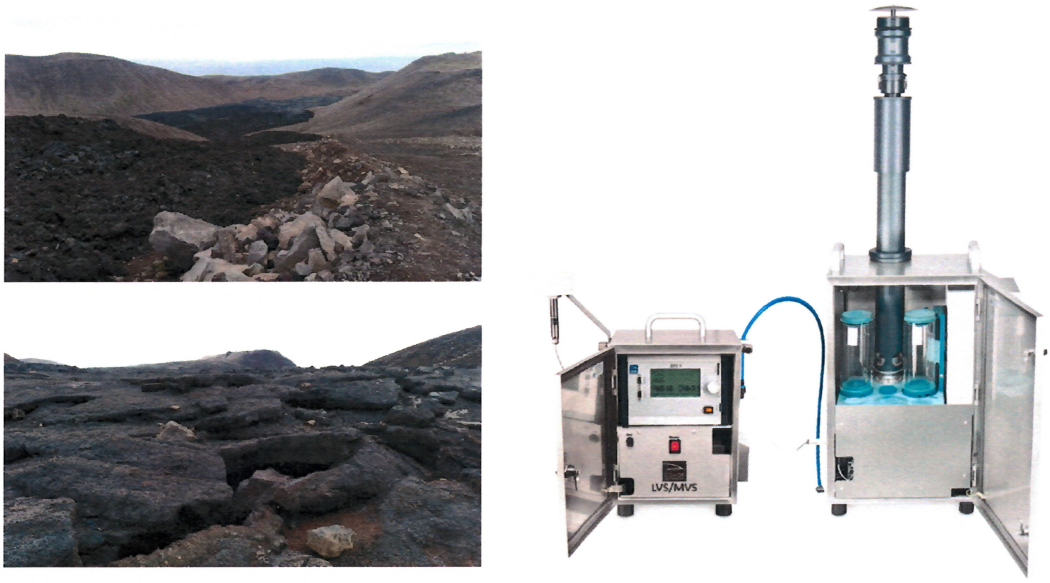

Figure 1: Left – Fresh lava flow and magmatic rocks within the Fagradalsfjall Volcano system. Right – The automatic medium-volume sampling system PNS DM.

Work performed during the visit and remotely

Before the visit, the team of Viggó Þór Marteinsson ordered the automatic medium-volume sampling system PNS DM modified to run on solar panels as well as the solar panels. In addition, electrical fittings necessary to couple the sampler to the panels were produced. During the visit of Assoc. Prof. Tina Santl-Temkiv to Matis, we have assembled, tested, and calibrated the sampler. After assembly, we performed a leak test and tests on filter membranes made of different materials (e.g. polycarbonate, PTFE, nylon) and with different pore sized (0.2-3 μm) to obtain a range of flow rates compatible with the different filters. We performed a calibration in the flow rate range between 0.5 and 1.5 m3 h^{-1} using the calibration adaptor fitted with an air flow regulator (Roykon, Federicia, DK). Assoc. Prof. Tina Santl-Temkiv also visited the site at the

Fagradalsfjall volcano (Fig 1, left) in order to assess the location where the sampling system will be installed. Following the visit, the team of Viggó Þór Marteinsson subsequently did the following remote work on the project: they modified the instrument to run with solar panels; the fan for cooling the instrument has been ordered and installed; and they tested the instrument by running it for 48 hours at 1.1 m^3 h^{-1} with a filter change each 12 hours. The test run was successful and the filters retrieved from the 48 hours-test are under investigation (DNA extraction, PCR amplification and sequencing of the 16 and 18S rRNA gene for taxonomic profiling). A casing has also been designed to protect the device to extreme weather conditions on site and the and the device is now ready for being deployed.

Future work

In addition to a large number of aerosol samples, which will describe in detail the deposition patters as a function of season and weather patterns, the team of Viggó Þór Marteinsson will periodically collect triplicate samples of newly formed volcanic rocks in proximity to the air sampling sites. The aerosol samples and the rock samples will be collected and preserved at -20ºC until analysis and will be analysed for bacterial and fungal community composition. We will extract DNA from air and rock samples using previously developed methods (Lever et al 2015, Kelly et al 2014). Microbial cells and their ribosomal content will be quantified by flow cytometry and quantitative PCR. Next-generation sequencing using Illumina MiSeq platform will be used to comparing bacterial communities (Santl-Temkiv et al 2018). Thus, we will link community assembly on rocks to depositing cells from the aerosol samples. A part of the filters containing aerosols will be extracted and analysed using an Ultra High Performance LiquidChromatograph (Dionex UltiMate 3000) coupled to the electrospray ionization source of a BrukerDaltonic quadrupole time-of-flight mass spectrometer (UHPLC-ESI-qTOF-MS) as previously described (Kristensen et al., 2016) to identify organic acids and other easily biodegradable organic compounds. The information on nutrient deposition will be used in combination with microbial analysis. In addition, volcanic rocks will be analysed by geochemical methods XrayFluorescence Spectrometry Analysis, porosity, and surface area measurements to understand how the rock properties change with microbial community development, which is key to understand and interpret rocky biosignatures. The laboratory, bioinformatic, and statistical analysis of our samples is still to be performed.

References

T. Šantl-Temkiv, U. Gosewinkel, P. Starnawski, M. Lever, and K. Finster, FEMS Micriobiology Ecol., 94 (4), 2018.

L. C. Kelly, C. S. Cockell, and J. Stevenson, Microb Ecol, 68(3), 2014.

T. Šantl-Temkiv et al., Environ. Sci. Technol., 51(19), 2017.

M. A. Lever, A. Torti, P. Eickenbusch, A. B. Michaud, T. Šantl-Temkiv, and B. B. Jørgensen, Front. Microbiol., 6, 2015.

Kristensen, K. et al. *Atmos. Environ*. 130, 36–53, 2016

- Give details of any publications arising/planned (include conference abstracts etc)

Once we obtain our data, we plan to present our research in several international conferences and in a scientific peer-reviewed paper. The conference presentations will be carried out once the sample analysis is performed, starting summer 2024. The publications will be written after summer 2024. We aim at publishing the results of the study in scientific papers target international high impact astrobiological journals.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 29.06.23 Arrived: 29.06.23	29.06.23	1 (by Santl-Temkiv)	1 (by Santl-Temkiv) +2 (by P. Vannier & A. Daussin after visit)	0	30.06.23	Departed: 01.07.23 Arrived: 01.07.23

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	**Viggó Þór Marteinsson**
Host Signature	
Date	**19.10.2023**

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports? YES

Project Leader Name	Tina Santl-Temkiv

Project Leader Signature	
Date	16.10.2023