# Europlanet TA Scientific Report

**PROJECT LEADER**

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| **Project number:** ***22-EPN3-006*** |
| **Name: Michael Christopher Macey** |
| **Home Institution: The Open University** |
| **TA Facility visited: TA1.05 Makgadikgadi Salt Pans, BW** |

## Project Title: An Isotopic Inventory of Mars analogue environments

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

Fieldwork undertaken as part of the Third Europlanet funding call took place between 17/01/24 and 26/01/24 as part of an international team of scientists from The Open University and the Botswana International University of Science and Technology. Fieldwork was conducted across the Makgadikgadi Basin. The aim of the research conducted was to collect sediment cores and water samples to assess how viability of sulfur-cycling microbes varies across a gradient of salinities, desiccation, and UV-exposure, and how this might impact the formation of biosignatures. The timing of the trip allowed sampling across a spectrum of fluctuating environmental stressors in terms of the availability of water. During the trip, a total of 16 x 30 cm cores were collected for geochemical and microbiological characterisation. Furthermore, environmental variables were taken with pH, temperature, conductivity, redox potential, and UV monitored. The trip was a success, with the collection of ideal samples to identify the relative abundance and diversity of sulfur cycling microbes across this analogue environment.

## Full Scientific Report on the outcome of your TNA visit

**We encourage you to add figures to your report, which should be approx. 1 page of text plus figures.**

**Background**

Analogue environments enable hypothesis development for extraterrestrial habitability, metabolic pathways, and their impact on potential biosignatures. Investigating various analogues is crucial due to their terrestrial variations and Mars' diverse geological history (1). Early Mars, rich in water during the Noachian era, transitioned to an arid state in the Hesperian. Analysing Noachian-Hesperian waters requires environments with specific chemistries, such as the Salt flats of Botswana serving as suitable analogues for former aqueous environments on Mars (2,3). Sampling took place across the Makgadikgadi Basin between 17/01/24 and 26/01/24. As part of this expedition, we were accompanied by the field lead, Dr Lesedi Lebogang, and Dr Fulvio Franchi of The Botswana International University of Science and Technology. The aim of the field campaign was to collect sediment cores and water samples to assess how microbial communities stratify with depth and which metabolism were playing a key role in these extreme environments.

A total of 16 x 30 cm cores were collected for geochemical and microbiological characterisation across the Basin. Sampling points are indicated in figure 1. Kubu Island in the Sua Pan was the focus of sample collection, as the extent of the water in this region allowed sampling across a spectrum of water availability (deeper water, shallower water and dry beach) and productivity (The presence and absence of biofilm layers) – cores were collected in triplicate at three distinct points. Additional core samples were also collected from Mosu in the Sua Pan and the across the Southern and Northern sides of the Ntwetwe Pan. Further to variation in the presence of water, additional variation between these sites was also observed in terms of the visible gradients of the sediments visible in the cores, the variability in the presence and thickness of biofilm (Figure 2) (4) and the enriched presence of sulfide in specific environments. This variability in geochemistry and microbiology across the basin further reinforces the value of the Pan as an analogue environment, as it enables investigation into putative viability of metabolisms across a spectrum of variables that are relevant to the diverse geologies observed across Mars. Whist in the field, environmental variables were collected including conductivity, pH, temperature, oxidation-reduction potential, dissolved oxygen (DO), and ultra-violet A and B intensity (290-390 nm). These results aid in giving context to the results from the microbiological analysis.


**Figure 1. A Sediment cores were taken around the Makgadikgadi Basin, Botswana. Mosu is marked by the red arrow and Kubu Island by the Blue arrow. Additional sampling points across the Basin are marked by the yellow arrows. B and C show Kubu island and the relative positioning of the sampling points from the high-water mark (B) and the furthest sampling point from the edge (C).**

During the fieldwork, both my student and I gained experience and knowledge of the Pan and benefitted greatly from Dr. Lebogang's knowledge of the environments and variation from prior sampling campaigns. Having the opportunity to discuss concepts and sharing knowledge that was relevant to both my research and my PhD student's project was invaluable and greatly enhanced our ability to select environmentally relevant and informative samples.

Thorough analysis of the samples collected from this sampling campaign will provide fundamental data on the viability of a key-mars relevant metabolism across a salinity and desiccation gradient analogous to that of the Noachian-Hesperian transition. This has the potential to better define our understanding of the role of sulfur-cycling bacteria in biosignature formation and the viability of resultant biosignature formation and preservation.


**Figure 2. Biofilm samples were observed and collected at multiple points around the Makgadikgadi Basin, Botswana. The desiccation and the structure of the biofilm varied significantly across the Pan. Samples A and B were collected at the North of the Ntwetwe Pan and sample C was collected at Kubu Island.**

1. Macey MC, Fox-Powell M, Ramkissoon NK, Stephens BP, Barton T, Schwenzer SP, et al. The identification of sulfide oxidation as a potential metabolism driving primary production on late Noachian Mars. Sci Rep. 2020 Dec 1;10(1).
2. Carr MH, Head JW. Geologic history of Mars. Earth Planet Sci Lett. 2010 Jun;294(3–4):185–203.
3. Scheller EL, Hollis JR, Cardarelli EL, Steele A, Beegle LW, Bhartia R, et al. Aqueous alteration processes in Jezero crater, Mars-implications for organic geochemistry. Science (1979) [Internet]. 2022;378:1–6. Available from: https://www.science.org
4. Filippidou S, Price A, Spencer-Jones C, Scales A, Macey MC, Franchi F, et al. Diversity of Microbial Mats in the Makgadikgadi Salt Pans, Botswana. Microorganisms. 2024 Jan 1;12(1).

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

I will be preparing an abstract for the Microbiology Society Annual Conference in 2025 with details of this analysis.

# - 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:<br>NA<br><br>Arrived:<br>NA | 17-01-2024 | 2 | 8 | 0 | 26-01-2024 | Departed:<br>16-01-24<br><br>Arrived:<br>27-01-2024 |

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

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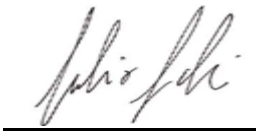
| **Host Name** | **FULVIO FRANCHI** |
| **Host Signature** |  |
| **Date** | 05 February 2024 |

# - 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**

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| **Project Leader Name** | Michael Christopher Macey<br>The Open University |

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| **Project Leader Signature** |  |
| **Date** | **5-2-24** |