OU STEM EEES Project Proposal Form – 2024 entry

Project Title	**Microbial survival in martian brines: implications for planetary protection**
Key words	Microbiology, astrobiology, Mars, planetary protection
Supervisory team (including email address	**PI:** Karen Olsson-Francis (k.olsson-francis@open.ac.uk) **Co-I:** Michael Macey (micheal.macey@open.ac.uk) Javier Martin-Torres (Javier.martin-torres@abdn.ac.uk), University of Aberdeen. Maria-Paz Zorzano (maria-paz.zorzanomier@abdn.ac.uk), Centro de Astrobiología (CAB), Spain
Is the PhD suitable for part time study?	Yes ☐ No ☒

Project Highlights:

- Use state-of-the-art Mars simulation chambers to understand the feasibility of terrestrial microbial contamination surviving and proliferating on Mars.
- Develop a cross-cutting interdisciplinary skill set including microbiology, molecular biology, Mars environment and geochemistry.
- Contribute to an international endeavour to address scientific knowledge gaps underpinning the planetary protection requirements for future missions.

Overview:

Planetary Protection aims to ensure that scientific investigations of possible extra-terrestrial life forms, precursors, and remnants are not jeopardised (COSPAR 2020). This is reflected in the Committee on Space Research's (COSPAR) Planetary Protection Policy, which offers international guidelines. The Policy is non-binding and evolves with our scientific understanding of terrestrial life and extra-terrestrial environments.

For Mars, a recent paper (Olsson-Francis, 2022) identified a series of knowledge gaps relating to the Policy. A key area is the feasibility of terrestrial contamination to survive and proliferate on Mars. This is prudent, as our understanding of water distribution on Mars is evolving rapidly.

Based on large-scale climate models, Mars is deemed to be dry and highly desiccating; however, indirect evidence suggests transient water exists in the equatorial regions of Mars. For example, humidity, air and ground temperatures suggest that brines can exist in the uppermost 5 cm of the subsurface (Martin-Torres et al., 2015). Moreover, some salts, such as sulfate, perchlorate and chloride, found within the martian regolith (Figure 1) can form stable hydrated compounds and liquid solutions by absorbing atmospheric water vapour (Ramachandran et al., 2021).

To examine the feasibility of microbial contamination to survive and replicate on the surface of Mars, laboratory-controlled simulations are required to mimic the physicochemical

environments. Using these simulation experiments, the studentship will investigate the ability of transient martian brines to support microorganisms isolated from cleanroom environments to survive and proliferate on the martian surface.

This work will contribute to ongoing international activities in planetary protection by developing our understanding of the habitability of Mars. This will be key for developing the planetary protection guidelines for future missions.

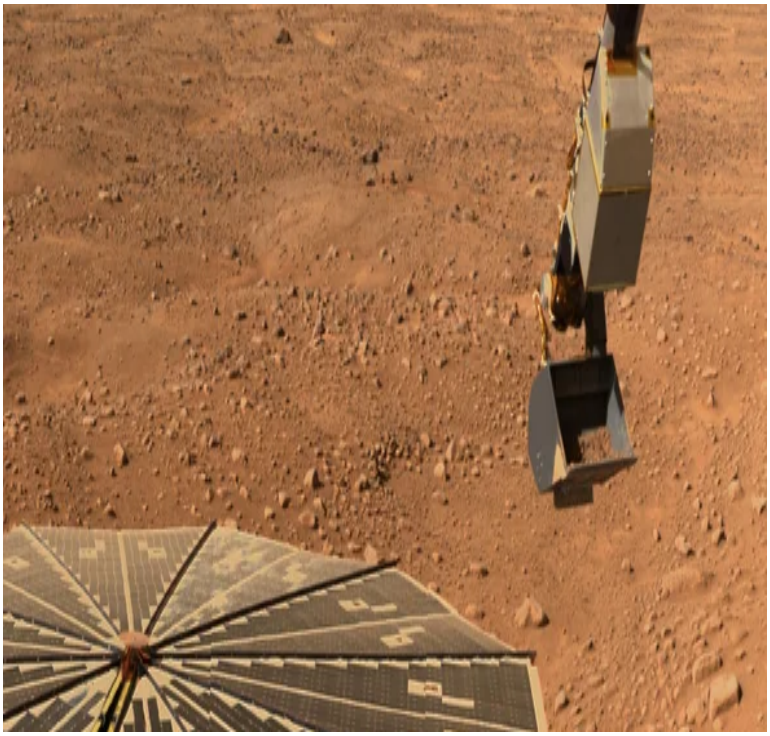

Figure 1: The Phoenix lander detected perchlorates in the martian soils in 2008. Credit: NASA, JPL-Caltech.

Methodology:

The student will: 1) Screen microorganisms isolated from cleanroom environments for their ability to survive and proliferate in modelled martian brine chemistries; 2) Simulate the water cycle on Mars using a state-of-the-art Mars environmental simulation chamber; 3) Use microbiology and molecular biology techniques (such as qPCR, culturing and fluorescence microscopy) to monitor the survival and growth of the cleanroom isolates in the Mars environmental simulation chamber.

Training and skills:

The student will receive training in geochemistry and microbiology analyses, and in running environmental simulation experiments. The student will also benefit from bespoke training organised by the School (Earth, Environment and Ecosystem Sciences, EEES) and by AstrobiologyOU, including mandated training, such as health and safety and laboratory skills. They will benefit from being a member of a cross-school research group, with relevant in-house training offered as part of the NERC-funded CENTA and SEPnet schemes. AstrobiologyOU also offers dedicated training events and seminars, including CV-writing support, managing budgets and fellowship writing training.

Partners and collaboration:

Possible timeline:

Year 1: Perform a literature review, select microorganisms and carry out initial growth experiments with different brine compositions.

Year 2: Conduct growth and survival studies using the Mars simulation chambers. Present results at a national conference.

Year 3: Prepare and submit manuscript regarding the growth and survival results. Write and submit thesis. Present data at an international conference.

Further reading:

1. COSPAR (2020) COSPAR Policy on Planetary Protection. Space Research Today, 208, August 2020, 10-22.
2. Olsson-Francis, Doran, P., Zorzano MP. et al. (2022). The COSPAR planetary protection policy for robotic missions to Mars: A review of current scientific knowledge and future perspectives. Life Sciences in Space Research. Article S2214552422001018, https://10.1016/j.lssr.2022.12.001
3. Martin-Torres F., Zorzano MP., Valent.n-Serrano, P. et al. (2015) Transient liquid water and water activity at Gale Crater on Mars. Nature Geoscience 8, 357–361. https://doi.org/10.1038/ngeo2412.
4. Ramachandran A. V, Zorzano M. P. and Mart.n-Torres, J. (2021). Experimental investigation of the atmosphere-regolith water cycle on present-day Mars. Sensors, 21(21), 7421. https://doi.org/10.3390/s21217421.

Further details:

Please contact Karen Olsson-Francis (k.Olsson-Francis@open.ac.uk) for further information and informal discussion about this project.