Characterising the Transfer of Biomarkers within the Phobos-Mars System

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CHARACTERISING THE TRANSFER OF BIOMARKERS WITHIN THE PHOBOS-MARS SYSTEM.

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How can material be transported from Mars to Phobos?

Initial impact into Mars

Martian ejecta ascends through atmosphere undergoing aerodynamic heating

Martian ejecta spreads upwards towards the orbit of Phobos

Ascending martian ejecta intersects Phobos' orbital path impacting Phobos' sub-Mars hemisphere

Phobos sweeps up ascending martian ejecta in Phobos' orbital path

Martian ejecta loses energy and disperses covering a larger area of Phobos' orbit and begins to descend

Descending martian ejecta intersects Phobos' orbit again impacting Phobos' anti-Mars hemisphere

Could there be martian biomarkers on Phobos?

- Phobos itself is not considered habitable [1]
- However, its proximity to Mars and short orbital period have led to the hypothesis that:

Large impacts into Mars could eject material, containing biomarkers remnant from past life, that could deposit onto Phobos [2-4].
- Therefore, biomarkers could potentially exist on the surface of Phobos and be sampled by future sample-return missions like MMX [5,6]

How can this be tested?

This study involves a series of impact and heating experiments, using the All-Axis Light-Gas Gun at the Open University

1. Fire inert projectile into martian bedrock analogue doped with biomarkers. Collect ejecta from impact
2. Subject this ejected material to heating simulating aerodynamic heating from Mars’ atmosphere.
3. Fire this processed ejected material into Phobos regolith simulants and assess the survivability of the biomarkers

What about organic contamination in the Light-Gas Gun?

- Within the light gas gun unwanted carbon-based material can act as contamination.
- Samples from throughout the gun (✱) will undergo organic characterisation with GC-MS.
- Characterisation is vital to prevent false-positive identification of biomarkers.

Defining biomarkers

- Biomarkers represent the essential building blocks for a broad range of life forms and could survive billions of years in the harsh martian surface environment [7].
- The contamination in the gun constrains the chosen biomarker.
- Possible biomarkers include:
  - Sterols
  - Amino Acids
  - Long chain alkanes
  - Fatty acids
- The biomarker(s) will be used to dope martian bedrock analogue & bespoke projectiles.

Developing bespoke projectiles

Bespoke projectiles are required to simulate martian ejecta.
They should exhibit:
- Compositional and physical constituency with martian ejecta.
- Spatially homogenous doping with biomarkers to a known concentration

Summary and implications

The results from these procedural and analytical developments:
- Allow for bespoke impact experiments, focussed on organics, to take place with constrained instrument contamination.
- Highlight the detection limits of analytical techniques (e.g. GC-MS) when analysing shock processed biomarkers, with major implications for current and future astrobiology missions.