Chemical and Textural characterisation of two Phobos regolith simulants

How to cite:

© 2019 The Authors

https://creativecommons.org/licenses/by-nc-nd/4.0/

Version: Poster


Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online’s data policy on reuse of materials please consult the policies page.
Could life, or its signatures, survive the journey from Mars to Phobos?

- Studies have suggested that impact ejecta from Mars, which would represent Mars’ surface over its geological history, could have accreted onto Phobos [2].
- Mars ejecta could constitute up to 0.05% of Phobos’ regolith, where ~200 ppm was deposited in the last 10 million years [2–4].
- If life existed on Mars during its ancient past, evidence may have been altered or destroyed by subsequent geological processes [5].
- Impact ejecta, which could have contained ancient martian biosignatures, may have been deposited onto Phobos and could still be preserved today [5,6] – lithopanspermia.

Without direct samples, regolith simulants are vital.

- Currently, all we know about Phobos comes from remote sensing.
- Future sample return missions (i.e. JAXA’s Martian Moons eXploration mission MMX) are in development.

Demand for Phobos simulants:

- Mission tests – landing/take off mechanisms, microgravity sampling techniques and spacecraft exhaust contamination – Planetary Protection.
- Science - *in-situ* resource utilisation potential assessment of Phobos and NEAs [7] and testing the Mars-Phobos lithopanspermia hypothesis.

An ESA concept study funded the design and production of a Phobos regolith simulant. Feasibility dictated that two simulants were needed to meet all the physical and chemical requirements of potential uses [4].

Spectral data suggest Phobos’ surface is similar in composition to D- or T-type asteroids, carbonaceous chondrites and lunar mare regolith [8,9].

Best available analogue is a combination of Tagish Lake and lunar regolith [4,10,11].

### Compositional simulant (Phobos-1C)

- Inherent density of compositional simulant is comparable to Phobos’ regolith.
- Crushed particles subsequently sieved into three size fractions <425 μm, 1.2-3.3 mm and >5 mm for future experiments.

### Physical simulant (Phobos-1P)

- Using size distribution power law: 
  \[ N(D) = k (D^{-b} + D_0^{-b})^{-1/b} \]
  power law index \( x \) turnover index \( D_0 \)
  cut-off index \( b \) constant \( k \) [12]

- Physical simulant mimics Phobos’ hypothesized average regolith grain size of ~1 mm [13], with <300 μm depletion [14].

### Compositional simulant mineralogy

- Plagioclase: An3.4–4.7 Or0.3–6.5 Ab6.6–9.6
- Pyroxene: Wo0.0–48.8 En27.6–83.8 Fs4.8–81.5
- Olivine: Fo45.4–84.5 Fa15.2–25.5
- Quartz and glassy phases

### Physical simulant mineralogy

Quartz & Calcite, consistent with concrete.

Crushed aggregate concrete *Topcrete* chosen for the physical simulant because it is physically comparable to Phobos [8] with a density of 1.67 ± 0.05 g cm\(^{-3}\).

- Density 1.67 ± 0.05 g cm\(^{-3}\)
- Compressive strength 3.5 MPa

### Future aims:

- Further characterisation: XRD (NHM)
- Run impact experiments using the high-velocity All-Axis Light-Gas Gun to test the survival and modification of biosignatures.
- Assess the accuracy and reliability of current biosignature identification and analysis techniques.