Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.24330

Palaeolacustrine environments as windows on microbial biosignature preservation on the Precambrian Earth and Noachian–Hesperian Mars

KEYRON HICKMAN-LEWIS[1,2], VICTOR DORNELES[1], MAËVA MILLAN[3] AND BARBARA CAVALAZZI[1]

[1]Università di Bologna

[2]Imperial College London

[3]Laboratory Atmospheres and Space Observations (LATMOS)

Presenting Author: keyron.hickman-lewis@nhm.ac.uk

Modern analogues of Precambrian environments and ecosystems are rare, but provide us with unique insights into the nature and distribution of life billions of years ago. Such analogue field sites may be used to explore the depositional and diagenetic mechanisms by which traces of past life become preserved over geological timescales and provide a framework for understanding planetary habitability in similar settings on Mars.

We will present an ensemble of field-, sample-, micro- and nano-scale data obtained from recent and sub-fossil microbialites of Miocene–Holocene age in basalt-hosted (palaeo)lacustrine environments from Tigray (Ethiopia) and Patagonia (Argentina). In both lake systems, exceptionally well-preserved microbialites develop along the shorelines, preserved as Mg-calcite in which filamentous microfossils are abundantly preserved in life position, forming microbial mats and microbial palisade fabric. Coupled Raman–FTIR microspectroscopy and synchrotron-STXM show that primary aromatic/aliphatic organic materials are preserved within these microbialites. SEM-EDX and micro-XRD mineralogical characterisation further demonstrate that diverse silicates, including phyllosilicates, are associated with filamentous microstructures, and are interpreted to play a crucial role in their preservation. Indeed, multiple taphonomic pathways, including replacement of organic materials and entombment by authigenic secondary phases, may facilitate microfossil preservation. Carbonate chemistry may also influence the fidelity of preservation, and this may assist in guiding life detection in similar settings on Mars. Our ensemble of evidence demonstrates that exceptional biosignature preservation can be achieved in lacustrine carbonates from early Earth- and Mars- analogue environments.

Ongoing Mars rover missions (MSL and Mars 2020) are exploring habitable lacustrine environments in Gale and Jezero craters. Microbialites from terrestrial basalt-hosted lacustrine environments provide exceptionally pertinent planetary field analogues that can help guide the search – in both spatial and temporal dimensions – for biosignatures in Martian environments. Lakeshore carbonate-bearing rocks have been identified at Jezero crater, and may preserve similar morphological and geochemical biosignatures. Constraining the micromechanics of biosignature formation (biomass growth) and preservation (mineralisation and diagenesis) within similar lacustrine settings on Earth is key to anticipating and (re)interpreting mission data and preparing for the application of high-resolution, high-sensitivity laboratory-based techniques to potential biosignatures in geological materials brought to Earth by Mars Sample Return.