Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31249

Biofilms in Serpentinization-Associated Extreme Environments: Implications for Habitability and Life Detection.

SARAH GONZALEZ HENAO[1], MATTHEW O SCHRENK[1], GAËL ERAUSO[2], RICARDO SÁNCHEZ-MURILLO[3] AND ALEXANDRA MAY[3]

[1]Michigan State University
[2]Aix Marseille Université, Mediterranean Institute of Oceanography, CNRS/IRD, UMR7294
[3]University of Texas at Arlington

Serpentinization occurs when ultramafic rocks interact with water, forming serpentine minerals, hydrogen, and methane, which support microbial life. This process takes place in subduction zones, mid-ocean ridges, and ophiolites, playing a role in Earth's history and possibly in early life evolution. This project examines three serpentinizing systems across different environments: **(i)** The Lost City Hydrothermal Field (LCHF), located on the Mid-Atlantic Ridge, is a submarine hydrothermal system crucial for studying ultramafic-hosted microbial life. **(ii)** The Prony Hydrothermal Field (PHF) in New Caledonia is unique for its combination of submarine and intertidal sites that discharge alkaline, hydrogen- and methane-rich fluids. **(iii)** The Santa Elena Ophiolite (SEO) in Costa Rica features terrestrial hyperalkaline springs (pH 11.18) with high methane concentrations.

Bacteria thriving in these extreme environments form thick biofilms, creating microenvironments where cells are embedded within a self-produced matrix of Extracellular Polymeric Substances (EPS). EPS, composed of polysaccharides, proteins, enzymes, extracellular DNA (eDNA), and lipids, play a crucial role in microbial interactions with their surroundings. Given that serpentinization-associated environments serve as compelling analogs for astrobiological studies due to their prevalence in the solar system, microbial biofilms may provide valuable insights into habitability and biosignature detection in extreme terrestrial and extraterrestrial settings [1].

Considering this, we aim to: *(i)* investigate EPS biosynthesis potential in LCHF, SEO, and PHF by analyzing biosynthetic gene clusters (BGCs) and *(ii)* compare microbial biofilm communities and metabolisms across these serpentinizing systems using metagenomic, advanced microscopy, and biochemical approaches. Preliminary data reveal BGCs involved in exopolysaccharide biosynthesis in LCHF and SEO, with compositions and abundances dictated by physicochemical conditions. LCHF and SEO favor the production of sphingan exopolysaccharides, which demonstrate remarkable stability at high pH (up to 12) and temperatures (100–150 °C) while exhibiting strong selectivity for calcium. These findings highlight the adaptability of microbial communities and the role of EPS in shaping biosignatures within serpentinization-driven ecosystems (Figure 1)[1].

References:

1. Gonzalez-Henao, S., & Schrenk, M. O. (2025). An astrobiological perspective on microbial biofilms: their importance for habitability and production of detectable and lasting biosignatures. *Applied and Environmental Microbiology*, e01778-24.