The University of Oxford Department of Earth Sciences

EARTHSCIENCES

UNIVERSITY OF OXFORD

Microbial biomineralization: role in cooperation and population structure in biofilms

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Key Words	**Geomicrobiology; Microbe-mineral interactions; Biomineralization; Microbial cooperation; Biofilms**

Overview

Prokaryotes have been shaping the surface of the Earth and impacting geochemical cycles for the past four billion years. Biomineralization, the capacity to form minerals, is a key process by which microbes interact with their environment. While we keep improving our understanding of the mechanisms of this process ("how?"), questions around its functions and adaptive roles ("why?") have been less intensively investigated. Here, we propose to investigate biomineral functions for different prokaryotic biomineralization systems (namely, extracellular elemental sulfur and extracellular carbonates in biofilms).

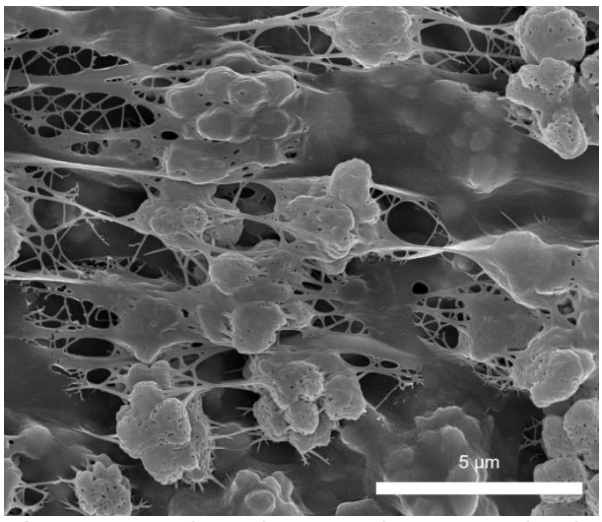

Figure: *Scanning Electron Microscopy showing elemental sulfur biominerals in a microbial biofilm*

We will use experimental evolution approaches allowing us to study microbial biomineralization through the lens of adaptation. In particular, we will test hypotheses on the potential roles of biomineralization in microbial cooperation and as important components of biofilm architecture and population structure. The results will contribute toa deeper comprehension of how microbial communities function in natural ecosystems, and improve our understanding of life co-evolution with its mineral environment.

Methodology

Laboratory experiments with model microorganisms, light and fluorescence microscopy, analytical techniques for the characterization of the microbial-mineral interface (see Training and Skills section below).

Timeline

Year 1: Doctoral training courses, literature review, laboratory training: cell cultures, microscopy and spectroscopy techniques, design of the experiments

Years 2 and 3: Laboratory experiments, presentation of research at national conferences

Year 4: Data integration, thesis completion, preparation of articles for peer-reviewed scientific journals, presentation of research at an international conference

Training & Skills

The student will be trained in laboratory techniques for the culture of bacteria, as well as in a range of analytical techniques for the micron- to nano-scale characterization of (bio)minerals: Raman, SEM, TEM, and potentially synchrotron-based X-ray methods (STXM at the Diamond Light Source). Training and guidance will also be provided in data interpretation and compilation, writing of scientific articles, and presentation of research results.

References & Further Reading

Cron B, Macalady J. L., Cosmidis J, 2021. Organic stabilization of extracellular elemental sulfur in a Sulfurovum-rich biofilm: a new role for Extracellular Polymeric Substances? Frontiers in Microbiology. https://doi.org/10.3389/fmicb.2021.720101

Keren-Paz, A., Kolodkin-Gal, I., 2020. A brick in the wall: Discovering a novel mineral component of the biofilm extracellular matrix. New Biotechnology 56, 9–15. https://doi.org/10.1016/j.nbt.2019.11.002

Further Information

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