

Tricky, Sticky Stuff: developing new ways to look at what makes up sedimentary biofilms in marine, river and hot spring settings

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Project Summary

Since the Archean, microbes have been present in every environment on Earth, and today at least half of global biomass is prokaryotic (Whitman et al., 1998). Microbes within sediment are not bystanders, and they are key agents in controlling an impressive range of processes from coastal sediment stability & resistance to storm surges (Paterson, 1989), through biogeochemical cycles of carbon and nutrients (Duda et al., 2016) in addition to remediation of industrial contamination (Gomes et al., 2017). Sedimentary biofilms have been present since the advent of life, and the fossil record of these communities is outstanding (Riding, 2000). These communities may have had more effect on the Earth system than any other part of the biosphere (Dupraz et al., 2009). However, the physical scale of sedimentary microbes means many of their impacts are poorly understood. Harnessing these systems for geoengineering, as we have macrophytic plants (Salt et al., 1998), will permit us to develop passive systems for nutrient and carbon management, contaminant immobilisation and shoreline & bank stabilisation. We have come a long way in understanding what the bacteria themselves are doing. We also know that these communities are crucially important bio-engineers, making sediment more resistant to erosion, alerting the chemistry of the water they live in and producing minerals from the ions in solution. However, our understanding is limited by our poor ability to understand the sticky stuff they produce to engineer their local environment – the Extracellular Polymeric Substances, or EPS.



This project will attack that problem directly. The Student will work on a range of river, hot and cold-water spring and marine settings in the UK and Italy, potentially expanding to additional sites in the USA, Oman and Turkey later in the project. Fieldwork will focus on sampling biofilm EPS materials from a range of geochemical contexts, but will also undertake fundamental sedimentological and geomorphological analysis of the sites so the context of each biofilm is properly known and recorded. The samples will be returned to the laboratory at Hull, and analysed for its organic acid content. These organic acids are the active ingredient which permit the biofilm to interact chemically with the inorganic components of the environment in which they live. The laboratory work will include some method development work, and the student will be responsible for determining the standard approaches to sampling and processing for their project, and for subsequent research within our group and elsewhere.

Once we have an improved understanding of the range, concentration and pattern of organic acid content within the biofilms, the student will develop a toolbox for sedimentologists and geomorphologists working on biofilm related problem to assist them in identifying, sampling and analysing the microbial materials they come across within their systems.

This project will truly break new scientific ground, and set the scene for subsequent research looking at the interaction of sedimentary biofilms and their environment. We anticipate the work generating several exciting publications in the international scientific literature, and significant international interest in our findings.

The project is hosted within the Department of Geography, Geology and Environmental Science (Prof. Mike Rogerson), the Energy and Environment Institute (Dr. Chris Hackney) and the Department of Chemistry (Dr. Kevin Welham) at the University of Hull and will also benefit from supervision from Prof. Erin McClymont of the University of Durham. This newly formed, interdisciplinary team has the expertise and field knowledge to find and analyse the range of sites the student will study, and the instruments and specialist skills needed to extract, measure and understand their makeup. The project is an exciting opportunity for a physical geography or geology student with interests in Earth System Science, wanting to do some genuinely creative research in the field of earth surface processes and sedimentary systems.

Student profile

The prospective student should have, or expect to receive, a first class BSc degree, or a distinction at Masters level, in an appropriate discipline. They should have interests and experience in most, if not all, of the following topics: geochemistry (including doing measurements), sedimentology or geomorphology, laboratory work and fieldwork. This experience together with other skills and interests that the applicant wishes to develop can be supported by the supervisors and developed during the project. A range of funding sources are available for the project which the candidate can apply to in collaboration with the supervisors.

Skills and training

Training in interdisciplinary research skills will include presenting your ongoing results and receiving constructive feedback from peers in the Hull University Geochemistry & Geobiology (HUGG) group, the Energy and Environment Institute and the Analytical Chemistry research group, from wider networks through Prof. McClymont and colleagues in fieldwork destination countries, and at a Faculty postgraduate research day. An additional important part of the research training will be to attend national and international conferences to present results and gain feedback. The student will be encouraged to write and submit papers for publication during the project. Discipline specific skills will be developed on organic and inorganic geochemistry, microbial carbonate sedimentology and analytical method development. Full training in field and office-based techniques will be provided, although it is anticipated that the successful candidate will have a background in the skills outlined above. This project will preferably involve data collection in the field, in the UK and Italy initially expanding to take in sites unavailable in these countries, contingent on funding, permits and logistics.

Enquiries

Informal enquiries should be directed to Mike Rogerson at m.rogerson@hull.ac.uk.

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Related undergraduate subjects:

- Chemistry
- Environmental Science
- Biogeochemistry
- Microbiology
- Earth science
- Earth system science
- Geography
- Geological science
- Geology
- Geoscience
- Physical geography