PROJECT TITLE: Engineering bacterial biomagnetic batteries to clean up contaminated UK waters

Project Science Theme: Science for Environmental Solutions
Project keywords: Water; biomagnetism; Fe-biogeochemistry; remediation; sustainability

Lead Institution: University Bristol
Lead Supervisor: Dr James Byrne, Bristol, School of Earth Sciences
Co-Supervisor: Devin Sapsford, Cardiff University, School of Engineering

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Webpage: https://envmin.github.io/bristolbiogeochem/

Project description:

(a) Across the UK, decades of legacy mining, industrial discharge and agricultural runoff have left groundwaters and rivers contaminated with arsenic, cadmium, nickel and lead, threatening drinking water safety and freshwater ecosystems, and requiring remediation. Certain bacteria have already solved part of this problem. They produce mixed-valence iron minerals that behave like natural biogeochemical batteries, storing and releasing electrons to capture and transform toxic metals. This project asks what controls the sorption capacity and selectivity of these biomagnetic minerals for priority UK contaminants, how their battery-like electron-transfer properties govern contaminant transformation and mobility under realistic groundwater conditions, and whether this natural process can be engineered into a deployable, low-cost water treatment technology. In doing so, it bridges mineralogy, microbiology and environmental engineering, with a clear route from fundamental discovery to real-world application.

(b) Building on preliminary data and established protocols, the student will culture iron-reducing and iron-oxidising bacteria to biosynthesise mixed-valent iron minerals, then characterise them by electron microscopy, X-ray diffraction, Mössbauer spectroscopy and X-ray absorption spectroscopy. Batch experiments will first map sorption across environmentally relevant pH and redox conditions, before progressing to innovative flow-through column designs simulating reactive transport under dynamic groundwater conditions. Results will then inform the design of scaled-up systems for applied, field-based deployment.

(c) Student training spans microbiology, mineralogy, advanced spectroscopy, geochemical modelling and data science, building on the DLTP's programme, alongside science communication and policy engagement. The researcher will shape the project's direction, choosing which contaminants to prioritise and steering the scale-up strategy.

(d) Co-supervision from Prof. Devin Sapsford at Cardiff University brings geo-environmental engineering expertise in designing and scaling up water treatment systems, extending Bristol's mineralogy and geochemistry base into a route from bench chemistry to deployable technology. The researcher will work across both institutions, exploiting close ties between these GW4+ groups.

Useful recruitment links:

For information relating to the research project please contact the lead Supervisor via: james.byrne@bristol.ac.uk

Bristol NERC GW4+ DTP Prospectus:
https://www.bristol.ac.uk/study/postgraduate/research/great-western-four-doctoral-training-partnership-nerc/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/

The application deadline is Thursday 7 January 2027 at 2359 GMT