PROJECT TITLE: Environmental functional nanomaterials for improving water quality

DTP Research Theme(s): Dynamic Earth, Changing Planet

Lead Institution: University of Bristol

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Project keywords: Water quality, iron minerals, nanotechnology, spectroscopy, sustainability

Environmental functional nanoparticles (NP), containing mixed valent iron (i.e. both Fe(II) and Fe(III)) will be developed as a treatment method for improving water quality.

Project Background: Poor water quality, as a result of natural and anthropogenic drivers, is responsible for adversely impacting public and environmental health, and reducing agricultural productivity around the world. Providing cost-effective and simple to use methods for removing contaminants, e.g. arsenic, nickel, cadmium, lead, etc., at both small and large scales is thus critical for future generations. Much research over recent decades has focused on the application of iron minerals which are strong adsorbents for many toxic contaminants in soils, water, and at solid-water interfaces. Emphasis is so far given on only iron minerals which are of the oxidized Fe(III) form, overlooking the relevance of mixed valent iron minerals. Mixed valent iron minerals, which contain both Fe(II) and Fe(III) have the potential to simultaneously sorb as well as oxidise/reduce problematic contaminants. They can act as both electron sources and sinks in environments which should theoretically broaden the scope of inorganic and organic contaminants that can be treated. However, little is known about how mixed valent iron minerals would behave as contaminant adsorbents in an environmental context, and how they compare to commercial alternatives that are already available.

Project Aims and Methods: The main aim of the project is to develop functional mixed valent iron minerals for improvement of water quality. At the fundamental level, the student will synthesise novel materials, and evaluate the interactions between them and inorganic contaminants under varying environmental conditions. The student will use this knowledge to subsequently address methods for improving water quality. The student will couple analytical and spectroscopic methods to conduct laboratory-based experiments on contaminants such as arsenic, cadmium, nickel, and lead in simulated and real world samples. They will use column studies to develop reactive transport models and elucidate how to optimise these novel materials for water treatment. The student will also explore options to scale up processes. The core objectives of this project include: (1) determine the sorption capacity of different contaminants on
mixed valent iron minerals; (2) evaluate the fate and kinetics of contaminants exposed to mixed valent iron minerals in simulated and natural groundwater; (3) design systems which can be upscaled for treating contaminated water. The students involvement in project design and research direction will be essential to ensuring a successful outcome.

Candidate requirements: This project would be well suited to a student with a passion for tackling environmental problems, with a background in environmental science, chemistry (bio)geochemistry, or another Earth Science related field (preferably to MSc-level). Highly motivated multi-disciplinary students from other backgrounds will also be considered. The work will include the planning, setup and running of all experiments under the supervision of the supervisors including data analysis, presentations in group seminars and at conferences, as well as writing of publications together with supervisors. The PhD student will be sent on relevant training workshops to learn new techniques where appropriate. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Project partners: This project will take advantage of world leading research happening at two GW4 Universities Bristol and Cardiff. In particular, the combination of the School of Earth Sciences with the School of Engineering will help ensure technological development from fundamentals to application.

Training: The student will be trained in a range of laboratory-based techniques on water quality assessment, mineralogy, and water treatment. This includes mineral synthesis, microbial cultivation, geochemical measurements and analytical methods including synchrotron based tools, and electron microscopy. They will be encouraged to participate in NERC GW4+ DTP training courses and be able to access training opportunities from Bristol and Cardiff such as lectures within BSc/MSc courses. Funding is provided for the student to present their research at a high-profile international conference and will be encouraged to apply for grants that support further travel opportunities.

Background reading and references

Useful links
http://www.bristol.ac.uk/earthsciences/courses/postgraduate/
https://envmin.github.io/bristolbiogeochem/

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2023/doctoral/phd-great-western-four-dtp/

How to apply to the University of Bristol:
Go to http://www.bristol.ac.uk/study/postgraduate/apply/ and search for “Geology (PhD)”

Please note: If you wish to apply for more than one project please contact the Bristol NERC GW4+ DTP Administrator to find out the process for doing this.

The application deadline is Monday 9 January 2023 at 2359 GMT. Interviews will take place during the period 22 February – 8 March 2023.

NERC GW4+ DTP Website:
For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk.

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