

IMPERIAL

Department of Earth Science
and Engineering
PhD Project Description

Hard Rock to Heavy Metal: Data and tools for geochemical baselines and chemical fluxes through landscapes

Supervisors

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Project Summary

Geochemical maps and measurements of chemical fluxes through drainage networks are essential for identifying elevated elemental concentrations. Such data may indicate economic mineralisation, sources of toxic and carcinogenic heavy metals, and contamination and pollution pathways. They impact application of regulatory controls and land management. However, at present only ~20% of the Earth's surface has been mapped geochemically at any scale. Sampling bedrock, sediment or water chemistry over large areas is logistically challenging and can be extremely expensive due to the large numbers of samples that must be processed. As such, methods able to produce maps of elemental concentrations from small inventories of field samples and/or remote sensing data must be developed. Our preliminary work has indicated that topology of drainage networks combined with erosion and mixing models provides means to rapidly and robustly predict composition of river sediments throughout drainage basins.

This mathematical foundation has been used to successfully invert inventories of sedimentary samples for the concentration of elements in drainage basins (see reading list below). These methods are a promising step towards identifying natural and anthropogenic contributors to elemental concentrations in drainage networks. The goal of this project is to develop these methods to determine sedimentary geochemical baselines and to demonstrate the feasibility of mapping sources of heavy metals in river sediments from sparse observations.

Select reading from our group

- Chrapkiewicz et al. Apportioning sources of chemicals of emerging concern along an urban river with inverse modelling, *Science of the Total Environment*, (2024), doi:10.1016/j.scitotenv.2024.172827.
- Eschenfelder et al. Predicting hazardous elemental concentrations in drainage basins assuming conservative mixing, *Journal of Geochemical Exploration*, (2023), doi:10.1016/j.gexplo.2023.107178.
- Lipp et al. Geochemical mapping by unmixing alluvial sediments: An example from northern Australia, *Journal of Geochemical Exploration*, (2023), doi:10.1016/j.gexplo.2023.107174.
- Lipp et al. Source region geochemistry from unmixing downstream sedimentary elemental compositions, *G-Cubed*, (2021), doi:10.1029/2021GC009838.

Who are we looking for?

This project will combine fieldwork, laboratory analyses and computational modelling to generate natural baselines for rivers and to identify source region compositions. It will suit a numerate Earth scientist, physicist or applied mathematician wanting to work on Earth Science problems. The student will be given technical training to develop their computational modelling, laboratory and field skills.