Imperial College London

Natural Environment Research Council

2023_45_ESE_Roberts: Hard Rock to Heavy Metal: Data and tools for geochemical baselines and chemical fluxes through landscapes

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Geochemical maps and measurements of chemical fluxes through drainage networks are essential data-products for identifying elevated elemental concentrations. Such data may indicate economic mineralisation (e.g. high concentrations of uranium, lithium), sources of toxic and carcinogenic heavy metals (e.g. cadmium, mercury), 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 integrative downstream erosion and mixing models provides means to rapidly and robustly predict composition of river sediments (Lipp et al., 2020, JGR-Earth Surface, doi:10.1029/2020JF005700). This mathematical foundation has been used to successfully invert small inventories of sedimentary samples for the concentration of elements in drainage basins in the Cairngorms (Lipp et al., 2021, Geochem. Geophys. Geosys., doi:10.1029/2021GC009838; e.g. Be, V, Ca, Li, U, Ba, Zn, Cr, Rb, Co, K, Sr, Ni, Mg). 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 further develop these methods to determine sedimentary geochemical baselines and to demonstrate the feasibility of mapping sources of heavy metals in UK river sediments from sparse observations.

This project will combine fieldwork, laboratory analyses and computational modelling to generate natural baselines for UK 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.