ONE Planet Doctoral Training Partnership

Natural Environment Research Council

Project title: Electrochemical sensors for monitoring enhanced rock weathering systems
Ref: OP2455

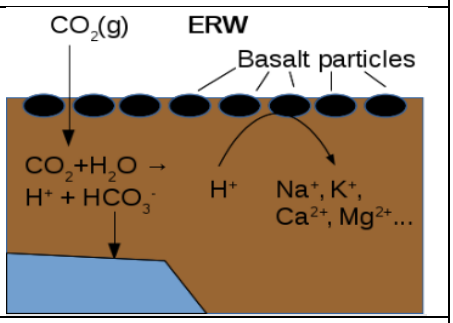
Keywords: Weathering, Sensing, CO_2

One Planet Research Theme:
Climate & Climate Change ☒ | Earth System Processes ☐ | Anthropocene ☐ | Environmental Informatics ☒

Lead Supervisor: Dr Ben Horrocks, Newcastle University

Key Research Gaps and Questions:

- Demonstration of the feasibility of monitoring enhanced rock weathering (**ERW**) in-place using ion-selective electrodes.
- Measurement of the rates of alkali metal ion release in soil column experiments.
- Quantitation of CO_2 to bicarbonate conversion.



Project Description:

Enhanced rock weathering (ERW) has been proposed to remove CO_2 from the atmosphere as bicarbonate and to supply nutrients to soil (alkali metal and alkaline earth cations), the latter providing potential co-benefits to plants by supporting their growth. This is a natural process whose rate is enhanced because it is implemented by spreading finely divided rock (basalt) with increased specific surface area on agricultural land. Dissolved CO_2 produces protons which exchange for metal ions in the silicate rock. The CO_2 is converted to bicarbonate, which is ultimately transported to the ocean, converted to carbonate, and immobilised in mineral form. ERW is gaining momentum as a scalable carbon removal technology because it integrates readily with existing agricultural practices, and the co-benefits for plants make it potentially attractive to stakeholders (e.g., farmers, landowners), facilitating uptake and adoption. Quantitation of the rates of CO_2 removal and release of nutrients is of great importance for geochemical models of ERW and for validation of the technology, as it will enable more accurate estimates of carbon removal by ERW. This has wider implications not only for estimates of climate change mitigation, but for the growing carbon removal and sustainable finance industries, given that payments for ecosystem services, such as carbon credits or green bonds, are contingent on verifiable amounts of carbon removed from the atmosphere.

We propose to develop chemical sensing protocols for the direct, in-situ determination of the ionic species involved that will allow continuous monitoring and provide data for their distribution in the soil. The main technology employed will be ion-selective electrodes (ISEs) and we have carried out preliminary lab-based work that indicates these sensors can observe the proton/cation exchange from rock dust samples suspended in water. A sensing system will be constructed that monitors simultaneously pH, temperature, ionic conductivity, the metal ions of interest and pCO_2 in the gas phase. Sensor development will be carried out for species which are not currently determined directly with sufficient selectivity (bicarbonate) or sensitivity (trace heavy metals) – the latter are a concern for ERW systems. The system will be tested under continuous monitoring in soil, leveraging mesocosm and field experiments set-up at NU Farms and by our collaborators at UNDO Ltd across their network of experimental study sites.

Prerequisites: We are looking for students with an interest in environmental issues and a background in chemistry, geochemistry, or analytical science.

For more information, please contact Dr Ben Horrocks (ben.horrocks@ncl.ac.uk).

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