

Simple yet Efficient:

Magnetic Separation for Toxic Metal Mitigation in Enhanced Olivine Weathering Geoengineering

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Project description

Amidst the pressing global challenge of rising carbon dioxide (CO₂) levels, there's an urgent need for inventive solutions to effectively capture and sequester CO₂ from the atmosphere. Enhanced Olivine Weathering (EOW) holds immense potential as a groundbreaking technique for carbon dioxide removal (CDR), but it is still in the research phase.

EOW involves mining, grinding, and spreading mineral olivine ((Mg, Fe)₂SiO₄) on the Earth's surface, capitalizing on olivine's natural weathering process to sequester atmospheric CO₂ as dissolved bicarbonates (HCO₃⁻). **However, a significant challenge facing EOW is the presence of high levels of toxic metals in olivine, primarily nickel (Ni) reaching levels of up to 3000 µg g⁻¹, and chromium (Cr), reaching levels of up to 1000 µg g⁻¹.** The release of these metals during large-scale EOW applications poses a significant environmental risk to ecosystems, demanding thorough consideration.

Our preliminary laboratory experiments with EOW have already shown that substantial quantities of Ni and Cr are adsorbed by Fe oxides, such as magnetite (Fe₃O₄), formed during olivine weathering (through the oxidation of the Fe(II) component of olivine). While this adsorption process restricts the mobility of toxic metals, successful implementation of EOW in real-world scenarios requires a method to entirely remove these minerals from the system. Our proposal introduces a simple yet groundbreaking solution: the use of a magnetic separator to effectively separate magnetic Fe oxide minerals (e.g. magnetite) from olivine. Magnetic separators are widely utilized in the mining industry to extract magnetic fractions from various sources. The application of magnetic separators in EOW has never been explored, but this straightforward and innovative approach holds the potential to resolve the Ni and Cr challenge.

Project Objectives:

The goal of the project is to test a lab-scale replicate of a magnetic separator (µ-Jones) to separate magnetic Fe oxide minerals from olivine. The µ-Jones magnetic separator has already been designed by Wetsus (project partner). The design consists of two steel plates with seven vertical 4 cm-high/1.5mm long teeth. The ridges are 2 mm apart and made magnetic with 2 * 3 Nd-Fe-B permanent magnets of ~1.3 T (creating a magnetic field of ~1.3 T on the ridge and ~0.3 T in between the teeth)¹[1]. For the project, the bright mind student tasks will include:

¹ Prot, T., et al., *Magnetic separation and characterization of vivianite from digested sewage sludge*. Separation and Purification Technology, 2019. **224**: p. 564-579.

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- Designing a simple batch experiment to react olivine with artificial seawater and rainwater.
- Determining the concentration of Ni and Cr in the reacted olivine samples.
- Passing the reacted olivine sample through the μ -Jones magnetic separator.
- Collecting the magnetic Fe oxide minerals and measuring the concentration of Ni and Cr to calculate the fraction that has been separated

Job requirements

Applicants for this project should have a background in geochemistry and a strong interest in nature-based solutions for addressing climate change.