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Use of ultramafic rocks for enhanced rock weathering purposes: an experimental study

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To attain negative CO_2 emissions necessary to limit the global temperature increase, the use of CO_2 capture and storage mechanisms, such as enhanced rock weathering (ERW), is vital. ERW, whereby naturally occurring weathering processes are enhanced through crushing and spreading of chemically reactive rock flour in e.g., marine coastal environments, has shown promising results.

The study evaluates the use of ultramafic rock units from southwest Greenland (Seqi Ultramafic Complex and Fiskenæsset Anorthosite Complex) as possible material sources for ERW in conditions where pH>7, allowing for an immediate long-term stability of the alkalinity produced. This is done through lab-based experiments mimicking the possible use on crop fields (low ionic strength water) and coastal conditions (high ionic strength water), highly relevant for possible future use of ERW in Denmark.

Dunite from Seqi contains >91 vol% olivine with an average Fo>$Fo_{92\pm0.3}$. The sample used displays minimal signs of alteration at surface conditions while metamorphic processes have resulted in the presence of Mg-rich amphibole (app. 2 vol%) and trace concentrations of phyllosilicates such as phlogopite, talc, and chlorite (total volume <5%). The sample was crushed (with an average grain size of 116 μm) and placed in a temperature controlled shaking bath to add the effect expected from physical erosion and maximise the dissolution potential. The experiments were performed as triplicates at atmospheric P_{CO2} and pH conditions around pH 9, as controlled by dunite dissolution, at 22±2°C.

The results include measurements of cation release, alkalinity, pH and electrical conductivity and the changes observed in one dataset is complimentary across the various datasets allowing for a robust evaluation of the dissolution efficiency and thus the potential for CO_2 uptake. After six months, the dissolution of the original material is continuous, consistent with its disequilibrated nature at Earth's surface conditions. A decrease in the dissolution rate is not observed, indicating that the physical effect from rounding is minor when shaking is applied as would be the case in a high-energy environment such as a coastal environment.

Similar experiments are currently explored using Fiskenæsset anorthosites containing >93 vol% plagioclase with an average An > $An_{87\pm0.5}$.