Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.4063

Is the CO_2 hunter a green, black or white mineral?

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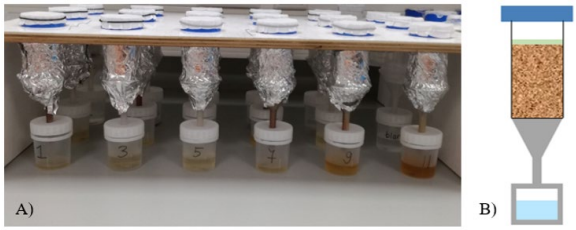

Figure 1: A) Experimental set-up. B) Schematic drawing of a soil column.

Enhanced weathering involves the spreading of crushed silicate minerals aimed at long-term carbon dioxide (CO_2) sequestration. This negative emission technology may co-benefit agricultural productivity by increasing soil pH and releasing nutrients. Silicate minerals and rocks differ in their *enhanced weathering potential*, i.e. their potential for CO_2 sequestration and soil quality improvements. However, studies comparing minerals for this dual potential are lacking. Therefore, we quantified and compared the *enhanced weathering potential* for the increasingly studied olivine, basalt, and wollastonite, and two minerals that have not been investigated in this context yet, anorthite and albite. A down-flow soil column experiment was specifically designed for soil and leachate analyses (Figure 1). Each silicate was applied on a bare sandy soil (125 g kg^{-1} soil). Water additions every two to four days resulted in outflow of leachate, in which pH, alkalinity, dissolved organic and inorganic carbon, base cations, and nickel (Ni) concentrations were measured. After two months, soils were also analysed for these parameters.

Depending on the calculation method, highest CO_2 capture was measured for albite weathering (3.69 g CO_2 kg^{-1} soil, using magnesium mass balances) or olivine weathering (1.39 g CO_2 kg^{-1} soil, using alkalinity and carbonate measurements). Furthermore, high CO_2 sequestration was shown for wollastonite and anorthite weathering, when expressed as CO_2 capture per mineral reactive surface area. However, full carbon budgets indicated net CO_2 emissions from basalt amended soils. All treatments increased soil pH and base saturation, with the highest responses for olivine and wollastonite. Soil Ni concentrations remained within micronutrient levels, while wollastonite and especially olivine weathering induced Ni^{2+} leachate concentrations exceeding groundwater quality thresholds, thereby reducing the *enhanced weathering potential* of both minerals.

Our results showed a high *enhanced weathering potential* for albite and olivine weathering, while wollastonite and anorthite weathering require further research. This study highlights the importance of measuring I) both organic and inorganic carbon budgets to assess net CO_2 sequestration, and II) Ni leaching from soils to monitor possible adverse side effects. We conclude that enhanced weathering using albite and olivine, and potentially anorthite and wollastonite, is promising for the transition towards net negative emissions.