Characterization of glacial rock flour and assessment of its enhanced weathering potential

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Glacial meltwater annually transports several megatons of sediments carrying clay-sized mineral particles, referred to as glacial rock flour (GRF), to proglacial environments or the ocean. We characterized GRF of marine deposits from the Greenlandic Ice Sheet meltwater exports in Western Greenland. The GRF showed a median size range of 2–11 µm and a BET surface area range of 10–20 m^2g^{-1}. Based on scanning electron microscopy, GRF was found to be composed mainly of the primary bedrock minerals oligoclase (13.2–31%), quartz (6.5–25%), biotite (7.2–28%), anorthite (6.0-13%), K-feldspar (2.2-7.4%), amphiboles (5.7-11%) and muscovite (1.2-1.9%). This mineralogy and grain size characteristics suggested GRF to be an excellent candidate for enhanced weathering. Therefore, the carbon capturing efficacy of GRF from an uplifted Holocene marine deposit (BET surface area 15 m^2g^{-1}) near Nuuk, Greenland was investigated. We compared its dissolution kinetics in deionized water in equilibrium with the ambient pCO_2 of 0.00040 atm and with an increased pCO_2 of 0.05 atm. The electrical conductivity and pH of the continuously-stirred suspension were measured at regular intervals, and aliquots from it were filtered and analysed for Si, Na, Ca, Mg, K, Al, P, S and Fe. A higher pCO_2 facilitated a higher cation-release rate and after 1000 hrs, resulted in alkalinities ~0.6 mEqv L^{-1}. Less than 1% of the total solid pool of major cations and Si was released during the experiment, and all cation-release curves reached a plateau except Si, which showed a continuous increase. Al and Fe in the solution maintained low values indicating immediate scavenging by secondary minerals.