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Peridotite dissolution kinetics, carbonation, and hydrogen generation under highly acidic conditions

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Geologic sequestration is being investigated as a method to dispose of highly concentrated waste acid produced by carbon capture technologies. If coupled with carbon sequestration in ultramafic rock formations, waste acid storage may promote enhanced carbon mineralization by accelerating the dissolution rates of ultramafic minerals. To assess the feasibility of coupled subsurface acid co-injection and carbon mineralization in ultramafic reservoirs, we calculated the dissolution rates of ultramafic minerals and a peridotite from the Coquihalla Serpentine Belt in British Columbia, Canada. Time series fluid chemistry changes were monitored during the dissolution of separates of olivine, serpentine, diopside, labradorite, and brucite in highly acidic fluids (pH 0-1). Alkalinity generated by olivine and serpentine dissolution raised the fluid pH by up to 3 and 4 units, respectively, indicating that carbonate mineral precipitation may be feasible under highly acidic initial conditions.

We then examine the dissolution of an extensively serpentinized peridotite under subsurface conditions to understand the potential and limitations in upscaling to multimineralic formations. A 23 ºC, 50 bar batch reaction of Coquihalla serpentinized harzburgite with acidified artificial seawater (pH 1) and supercritical CO_2 is being conducted in a flexible gold cell reactor. Hydrogen generation consistent with additional serpentinization was observed during the six-week period of peridotite dissolution. Once the solution achieved near-equilibrium conditions, supercritical CO_2 was injected into the reactor until reaching a partial pressure of 40 bar. Evidence of potential peridotite carbonation is being monitored with fluid characterization from discrete sampling intervals. If observed, we will quantify the rate and extent of carbon mineralization to better understand the feasibility of coupling waste acid sequestration with geologic carbon storage.