Mining environments as models for enhanced weathering: Lessons for understanding element cycling during CO_2 sequestration

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Enhanced weathering seeks to capitalize on the high reactivity of olivine, serpentine and alkaline earth hydroxide minerals with Earth's atmosphere as a means of trapping and storing CO_2 pollution within carbonate minerals [1, 2]. Weathering of Mg-silicates provides the requisite cation supply for production of Mg-carbonate minerals; however, utilisation of this process for CO_2 sequestration has potential to release large amounts of silica and potentially hazardous trace metal phases to the biosphere and hydrosphere [2].

Carbonation of the finely pulverised tailings produced by ultramafic-hosted mineral deposits may be leveraged by the minerals industry to offset its greenhouse gas emissions [3]. Furthermore, in the absence of demonstration scale deployments of enhanced weathering, mine tailings storage facilties represent useful analogues.

Here, we describe geochemical pathways for, and controls on, element cycling during Mg-silicate weathering in the context of several ultramafic-hosted mines in Australia and Canada. We use a combined observational, experimental and modelling approach to quantify element cycling, including rates of carbon mineralisation [4]. Our field-based observations and laboratory experiments demonstrate that during accelerated weathering: (1) uptake of silica by the biosphere (e.g., diatoms) is a significant sink for Si [5] and (2) Mg-carbonate weathering products have the previously unidentified capacity to sequester toxic trace metals in addition to CO_2. Thus, these same sinks will likely play an important role in managing element cycling in enhanced weathering systems.

[1] Schuiling & Krijgsman (2006) *Clim. Change* **74**, 349–354. [2] Hartmann *et al* (2013) *Rev. Geophys.* **51**, 113–149. [3] Wilson *et al* (2009) *Econ. Geol.* **104**, 95–112. [4] Bea *et al* (2012) *Vadose Zone J.* **11**. [5] Power *et al* (2011) *Geobiology* **9**, 180–195.