Characterization of ultramafic mine tailings reactivity for carbon capture, utilization, and storage

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Carbon dioxide (CO_2) can be sequestered in mine tailings that have a high Mg content (e.g. ultramafic Ni, diamond, Pt and Cr tailings) through the liberation of Mg cations and precipitation of carbonate minerals containing atmospheric CO_2. This serves to reduce mine site CO_2 emissions, and generates co-benefits including dust mitigation, tailings stabilization, and toxic metal encapsulation. The CO_2 sequestration potential of a waste material is dependent on the proportion of the Mg ions that are loosely bound, fast reacting, and readily leached at atmospheric conditions, 'labile Mg'. This labile Mg then reacts with carbonate anions in solution to form hydrated magnesium carbonate minerals that permanently stores CO_2. Our previous laboratory experiments showed labile Mg can be sourced from the bulk dissolution of highly reactive trace minerals such as brucite [$Mg(OH)_2$] and certain hydrotalcites [e.g. iowaite $Mg_6Fe_2(OH)_{16}Cl_2 \bullet 4H_2O$], and from the surface reactions of magnesium silicates [e.g. serpentine $Mg_3Si_2O_5(OH)_4$].

Here, we conduct flow-through dissolution experiments to evaluate the variability of labile Mg release rate for brucite [$Mg(OH)_2$] and serpentine [$Mg_3Si_2O_5(OH)_4$] using various acids. Results show that mineral structure is the most important factor determining release rate of labile Mg, with brucite dissolution release consistently faster than serpentine. Secondly, labile Mg release rate is dependent on the dissolution mechanism, with proton acivated dissolution (e.g. HCl or HNO_3) occuring at a lower dissolution rate than for certain inorganic ligands (e.g. HCO_3^- and $H_2PO_4^-$), agreeing with the findings for bulk dissolution of brucite conducted under similar conditions [1]. Dissolution of labile Mg on serpentine surfaces is promoted by the presence of the same inorganic ligands as for brucite. Given that serpentine is volumertically more abundant in ultramafic mine tailings, the presence of inorganic ligands in the dissolution environment could potentially increasing reactivity and carbon sequestration rates in some tailings.

[1] Pokrovsky et al. (2005) *Geochim. Cosmochim. Acta* **69**, 905-918.