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Characterizing cation release for assessing carbon capture and storage reactivity of Ultramafic Mine Tailings

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Characterizing cation release for assessing carbon capture and storage reactivity of Ultramafic Mine Tailings

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Carbon capture and storage via mineral carbonation using solid wastes from hard-rock mining are one of the many strategies to mitigate anthropogenic climate change. Mineral carbonation involves the liberation of cations through dissolution and the subsequent carbonate minerals precipitation to permanently capture and store CO_2. To enable low-cost carbonation, technologies that work at atmospheric conditions need to be targeted. Some of the challenges associated with mineral carbonation at such conditions are that the reaction rate measured in the field exceeds the rate predicted by the stoichiometric dissolution rate measured in the lab. Moreover, the heterogeneous nature of tailings makes the characterization of reactivity and capacity for carbon sequestration crucial but challenging.

In this study, we examined dissolution of typical ultramafic minerals (i.e., Brucite [$Mg(OH)_2$], serpentine[$Mg_3Si_2O_5(OH)_4$] and forsterite [Mg_2SiO_4]) and tailings (i.e. nickel and diamond tailings) via flow-through leaching experiments. The results demonstrate tailings dissolve faster during the nonstoichiometric, early-stage of dissolution. Readily leachable, loosely bounded cations, termed “labile cations,” contribute to the fast dissolution and are controlled primarily by mineral content. Labile cations released from serpentine exceed that in olivine because nonstoichiometric dissolution persists for longer. More importantly, these results suggest that the carbon mineralization potential of tailings can be estimated from mineral content. Additional batch dissolution experimental techniques were investigated as a faster and more economical test of reactivity. Results from batch dissolution experiments are comparable to flow through dissolution experiments, suggesting that with sufficient information on the mineral content of mine tailings, they can serve to characterize the labile cation content for carbon mineralization.