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# Ambient temperature dissolution of antigorite from asbestos mine tailings for on-site mineral carbonation

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The carbonation of magnesium silicate minerals is a naturally occurring process that offers a pathway to reducing atmospheric CO2 levels. Magnesium silicate minerals are abundant, and carbonation reactions can be thermodynamically favorable. One promising site for implementing silicate carbonation is the abandoned Belvidere mountain asbestos mine in Vermont, which contains over 60 million tons of antigorite. The carbonation of these mine tailings has the potential to sequester over 30 million tons of CO2 into magnesium carbonate minerals.

Despite the thermodynamic favorability of antigorite carbonation at ambient temperatures, both antigorite dissolution and magnesite precipitation are slow processes. As a result, existing schemes for carbonation require high temperatures and pressures to overcome kinetic barriers. Such intense conditions are not only incompatible with in-situ carbonation at the Belvidere site but also decrease the potency of mineral carbonation as a negative emissions technology due to the high energy cost.

We present results from experiments directed towards developing a process for the carbonation of antigorite mine tailings at the Belvidere site at ambient temperatures. Focusing first on overcoming kinetic limitations to low-temperature antigorite dissolution, we conducted experiments at room temperature testing the effects of solution composition on Belvidere mine tailing dissolution. Using batch and flow-through reactors, we tested whether citrate (a magnesium chelating agent) and tiron (a silicon complexing agent) enhance dissolution over a range of pH conditions.

We show that dissolution rates in citrate and tiron solutions are approximately 4 and 30 times faster, respectively, than control experiments. In addition, the two species promote dissolution that is more stoichiometric than control experiments. As a result, antigorite dissolution in the presence of citrate or tiron can yield solutions oversaturated with respect to magnesite, even at circumneutral pH conditions. We will also present results from ongoing experiments testing whether periodically alternating between acidic and basic solutions enhances dissolution.

Our results illustrate that kinetic barriers to antigorite dissolution can be reduced at ambient temperatures, yielding magnesium-rich and magnesite-saturated solutions, a necessary first step for carbonation. These findings are applicable to a wide range of silicate minerals and provide a foundation for future studies into low-temperature mineral carbonation.