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Temperature-dependence of CO_2 drawdown into Mg-bearing minerals in humidified air.

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Carbonation of ultramafic and mafic rocks can be used by the mining industry to capture and store CO_2 in carbonate minerals. Ultramafic and mafic tailings from mines that produce commodities including nickel, cobalt and diamonds, contain Mg-bearing minerals such as brucite [$Mg(OH)_2$], serpentine [$Mg_3Si_2O_5(OH)_4$] and iowaite [$Mg_6Fe^{3+}_2Cl_2(OH)_{16}\cdot 4H_2O$]. These minerals are variably reactive with carbon dioxide (CO_2) at Earth's surface conditions and can be used to mineralize and sequester this greenhouse gas. Here, we assess the impact of temperature (5, 20 and 40 °C) on the rate of CO_2 mineralization of brucite, lizardite (a serpentine mineral) and iowaite. At each temperature, mineral powders (~100 mg) were placed in a 7.5-litre flow-through reactor that was supplied with humidified laboratory air (0.042% CO_2; 100% RH) at ~200 mL/min. Replicate samples (n = 54) of each mineral were collected over 3 months and analyzed to ascertain the amount and rate of carbonation as a function of time, temperature, and mineral feedstock.

Preliminary X-ray diffraction (XRD) results show the formation of dypingite [$Mg_5(CO_3)_4(OH)_2\cdot 5H_2O$] alongside a progressive decrease in brucite abundance, indicating active carbonation over time. A shift in the 003 reflection of iowaite toward smaller d-spacings suggests chloride–carbonate exchange and transformation toward a more pyroaurite-like [$Mg_6Fe^{3+}_2(CO_3)(OH)_{16}\cdot 4H_2O$] composition. No new carbonate phases formed from lizardite within the 3-month timeframe of the experiment. Together, these mineralogical changes confirm that brucite and iowaite are converted into stable carbonate-bearing minerals by reaction with humidified air. Total Inorganic Carbon (TIC) measurements were used to quantify the extent and rate of CO_2 uptake as a function of time, temperature, and mineralogy.

The results of this study will help us estimate the carbonation kinetics of brucite, lizardite and iowaite in ultramafic ores and mine tailings under different temperature conditions relevant to large-scale deployment of CO_2 mineralization at mines across the globe.