

Evaluating the link between mineralogy and alkalinity generation for carbon sequestration potential in mine sites

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This research explores the estimated potential for CO₂ sequestration of tailings from four different metal mine sites owned by Teck Resources in the Americas. The primary objective was to determine which deposits were more promising for carbon mineralization based on the solubility and alkalinity generation potential of their tailings. Two moles of H⁺ need to be neutralized in order to transform CO₂ into CO₃²⁻, which then bonds with divalent cations (calcium and magnesium) that must be leached from non-carbonate minerals to achieve net sequestration of CO₂ as alkalinity or solid minerals. For this reason, tailing minerals identified in the samples had their alkalinity generation tested. The mineralogy of 33 samples across four mine sites was determined using quantitative powder X-ray diffraction. Hydroxide-bearing minerals were of particular interest due to their acid neutralization potential. The following minerals of interest were identified in the samples and tested: clinocllore, diopside, forsterite, biotite, phlogopite, magnesite and calcite. Carbon mineralization is an acid neutralization reaction that generates carbonate alkalinity from the weak acid, carbonic acid. A subset of these minerals were reacted with a 0.08 mol/L H₂SO₄ solution as a screening tool for acid neutralization potential. Experimental results were plotted in a diagram correlating (a) the molar proportion of divalent cations (Mg and Ca) leached and (b) the molar proportion of acid consumed by the dissolution of each mineral. This not only estimates the amount of divalent cations that can be released into solution but also the amount of CO₂ that could be removed by the generation of alkalinity. This tool can be used by the mining industry to identify unconventional minerals that both release cations and generate alkalinity so that carbon sequestration processes can be more efficient.