

Passive carbon sequestration associated with wollastonite mining, Adirondack Mountains, New York

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ABSTRACT

Crushed ore in Adirondack wollastonite mines (New York) shows textural evidence for wollastonite dissolution and cementation by calcite and opal. The reaction $\text{CaSiO}_3 + \text{CO}_2 = \text{CaCO}_3 + \text{SiO}_2$ is a model reaction for silicate weathering and carbonation that has not been characterized in the field until now (outside of controlled experiments). Cemented samples from the Lewis and Fox Knoll mines contain up to 3% and 6% calcite, respectively, and contain modern ¹⁴C. Carbon isotope ratios have an organic signature at both mines but more strongly at Lewis ($\delta^{13}\text{C}$ from -9‰ to -29‰ VPDB), which, along with observed filamentous biofilms, supports a microbial role in mineralization.

Differences are seen between wollastonite weathering in these mines vs. wollastonite weathering in lab experiments and field studies of carbonate formation in other rock types. Grains surrounded by reaction products reach complete dissolution here, indicating that passivation by jacketing is not important at the field sites. Also, dissolved ions do not all form in situ reaction products, suggesting that solutes are leaving the system. A key finding of this study is the strong organic $\delta^{13}\text{C}$ signature of calcite cements at the Lewis mine, which also show higher calcite content per years of exposure compared to cements at the Fox Knoll mine. Although microbial fractionation complicates isotopic assessment of atmospheric CO₂ sequestration, our findings suggest sequestration rates are enhanced by geomicrobiological activity.

Keywords: Wollastonite weathering, silicate carbonation, carbon sequestration, carbon isotopes, geomicrobiology, acid precipitation; Isotopes, Minerals, and Petrology: Honoring John Valley