

CO₂ released when carbonate and silica products of mineral carbonation stored together

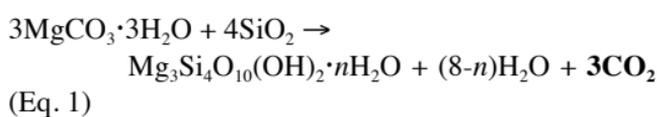
S.A. WILSON¹, B. MORGAN¹, I.M. POWER²,
C.A. BURTON¹ AND T.B. WILLIAMS³

¹School of Earth, Atmosphere & Environment,
Monash University, Clayton, VIC 3800, Australia
(*correspondence: sasha.wilson@monash.edu)

²Department of Earth, Ocean and Atmospheric
Sciences, The University of British Columbia,
Vancouver, BC V6T 1Z4, Canada

³Monash Centre for Electron Microscopy, Monash
University, Clayton, VIC 3800, Australia

CO₂ removal technologies, such as mineral carbonation, have potential to help mitigate the adverse effects of anthropogenic climate change. Mineral carbonation enhances the natural process of silicate weathering to produce silica and Mg-carbonates, the latter acting as long-term stores for CO₂. Here, we show that sequestered CO₂ is released back into the atmosphere when Mg-carbonate minerals and silica are stored together. Mg-carbonate minerals are hygroscopic and naturally draw atmospheric water vapour to their surfaces, leading to partial dissolution and production of high pH brines. Because the solubility of silica increases at high pH, this induces the production of the smectite mineral, stevensite, and liberates CO₂ as a gas (Eq. 1).



Significantly, we found this reaction goes to completion within 7–18 months of storage at high humidities and temperatures relevant to Earth's surface (23–75°C). It can occur in the absence of observable liquid water and proceeds via reaction of either hydrated or anhydrous Mg-carbonate minerals with amorphous silica, cristobalite or to a lesser extent quartz. The decarbonation reaction is much slower between magnesite (MgCO₃) and quartz, consistent with the greater stability of CO₂ trapping within the quartz-magnesite rock, listwanite [1, 2].

Our findings indicate that hydrated Mg-carbonate minerals should be separated from silica during industrial mineral carbonation. Our results also highlight the need to understand how coupling amongst the Mg, Si and C cycles influences the long-term stability of mineral stores for CO₂.

[1] Hansen *et al.* (2005) *Can Mineral* **43**, 225–239.

[2] Kelemen and Matter (2008) *PNAS* **105**, 17295–17300.