

Suitability of Hydrated Magnesium Carbonates as Hosts for Atmospheric Carbon Dioxide: An *In-Situ* Powder Diffraction Study

Bree Morgan¹, Ian C. Madsen¹ and Siobhan A. Wilson²

¹CSIRO Process Science and Engineering, Clayton Sth, VIC, 3169, AUSTRALIA

²School of Geosciences, Monash University, Clayton, VIC 3800, AUSTRALIA

With growing concerns over the likely contribution of carbon dioxide (CO₂) to rising global temperatures, the need to reduce atmospheric concentrations of this greenhouse gas is becoming increasingly urgent. One proposed strategy for lowering CO₂ concentrations is by sequestration during industrially controlled precipitation of magnesite (MgCO₃); an environmentally benign mineral which is stable over geological time periods. The strategy is hindered by MgCO₃ precipitation being kinetically inhibited under ambient conditions. While enhancing MgCO₃ formation with increased temperatures and pressures is technologically feasible, it is not currently financially viable owing to low carbon taxes and CO₂ prices.

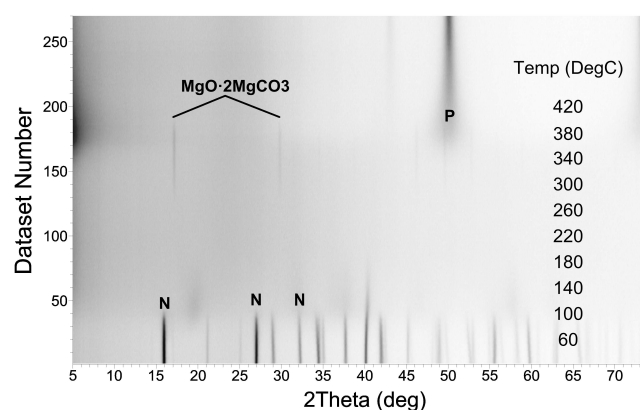


Fig.1. Raw laboratory powder diffraction data showing the thermal decomposition (30–550°C) of nesquehonite viewed down the intensity axis. **N**= Nesquehonite, **P** = Periclase

Hydrated magnesium carbonate minerals, such as nesquehonite (MgCO₃·3H₂O), represent promising alternatives to *ex-situ* CO₂ sequestration in magnesite. They readily precipitate at the low temperatures (<100°C) that dominate the Earth's surface and can sequester significant quantities of atmospheric CO₂ [1]. While the breakdown of nesquehonite at ~100°C (Figure 1) infers its stability over a majority of global surface temperatures, the decomposition kinetics of hydrated magnesium carbonates exposed to non-thermal environmental stressors are poorly understood. This information is crucial

to understanding the stability of these minerals on the millennial timescales needed to mitigate atmospheric CO₂ pollution.

Utilising *in-situ* powder diffraction, our study will provide novel kinetic and mechanistic insights into decomposition of hydrated magnesium carbonates at varied pH, humidity, salinity and concentrations of organic/inorganic ligands. This represents the wide range of environmental conditions that may exist at surface disposal sites for the minerals. Understanding the mechanisms and kinetics of hydrated magnesium carbon decomposition is critical to ensuring their suitability as long-term mineral stores for CO₂. The outcomes of our research will facilitate effective monitoring and predictions for long-term stability of CO₂ storage in geological hosts.