Magnesite formation during thermal decomposition of hydrated Mg-carbonates in a closed system: Winning back the CO_2

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Carbon mineralisation is a promising technology for mitigating global warming by trapping atmospheric CO_2 within the structures of carbonate phases. Although highly-stable magnesite ($MgCO_3$) is thermodynamically favoured to form at the Earth's surface, its precipitation from solution is inhibited by kinetics. Instead, magnesite forms via stepwise decomposition of hydrated Mg-carbonate minerals, such as nesquehonite ($MgCO_3 \cdot 3H_2O$). It is therefore of fundamental importance to understand the decomposition pathways of these metastable hydrated phases, particularly given that they have recently been suggested as alternative long-term sinks for CO_2 [1, 2].

Here, we investigate thermal decomposition of dry nesquehonite within (a) an open vs. a closed system, and (b) with or without an external CO_2 source. Nesquehonite permanently releases structural CO_2 to form periclase (MgO) during decomposition in an open system at high temperatures (>300°C) when no external source of CO_2 is provided. Significantly, when confined to a closed sysem, CO_2 released from nesquehonite (and other metastable decomposition products) is reincorporated into the crystalline mass by magnesite formation.

This study improves the current understanding of nesquehonite decomposition and magnesite formation under varied environmental and engineered conditions, and explores a novel, stepwise route for CO_2 capture in $MgCO_3$. Winning back the CO_2 generated during nesquehonite decomposition has the advantage of initial CO_2 capture in a low-temperature (and low-cost) mineral, followed by conversion of this metastable store into a permanent CO_2 sink.

[1] Ballirano *et al*. (2010) *J. Hazard. Mater*. **178,** 522–528. [2] Morgan *et al*. (2015) *Int. J. Greenh. Gas Control* **39**, 366–376.