

Weathering and carbonation of ultramafic rocks traced by Mg isotopes

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Mineral carbonation, the conversion of Mg-bearing silicate and hydroxide minerals to Mg-carbonate minerals, stores and binds atmospheric CO₂ and thus provides a potential pathway to mitigate anthropogenic climate change. We present new observations of the evolution of Mg isotope ratios during subtropical ultramafic rock weathering and associated magnesite formation at study sites in Eastern Australia.

Weathering of serpentinite is accompanied by the loss of Mg and the formation of secondary clay minerals in the saprolite. The concurrent increase of Mg isotope ratios suggests that incorporation of ²⁶Mg into clay mineral structures controls Mg-isotope fractionation during ultramafic rock weathering. The Mg-bearing clay in the saprolite has a $\delta^{26}\text{Mg}$ value of ~ 0.35 ‰, up to ~ 0.6 ‰ heavier than the ultramafic precursor.

In contrast, nodular, low-temperature magnesite hosted in ultramafic rock has significantly lower $\delta^{26}\text{Mg}$ (between -3.26 ‰ and -2.55 ‰) than magnesite and dolomite in hydrothermally altered ultramafic rock in the study area ($\delta^{26}\text{Mg}$ of -0.69 ‰ and -0.62 ‰). The strong enrichment of ²⁴Mg in nodular magnesite does not reconcile with direct precipitation of magnesite from meteoric fluids buffered by the ultramafic host rock [1]. Instead it suggests a multiple-step mechanism involving dissolution reprecipitation of pre-existing carbonate associated with fluid inter-species Mg isotope fractionation [2].

[1] Oskierski et al. (2013) *Geochim. Cosmochim. Acta* **122**, 226-246. [2] Schott et al. (2016) *Chem. Geol.* **445**, 120-134.