Ultramafic rock carbonation between 40° and 255° C

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Carbonation of ultramafic rocks variably leads to the formation of silica-carbonate (listvenite), talc-carbonate (soapstone) or magnesite deposits, thereby providing insights into carbon cycling in marine and terrestrial hydrothermal systems, gold and magnesite mineralisation and pathways for sequestration of atmospheric CO_2.

We present petrography, geochemical and isotope (C, O, Δ_{47}) compositions to constrain the formation conditions of the Piedmont magnesite deposit, NSW, Australia. Cross-cutting relationships suggest that the deposit has developed in a pre-existing, late Permian to Early Triassic listvenite alteration zone in Palaeozoic serpentinite [1]. The listvenite precursor consists of ferroan magnesite (average Mg# = 0.91) and quartz (± fuchsite ± chlorite ± dolomite ± sulfide) formed between 165° and 255° C [1]. Cryptocrystalline, pure magnesite (Mg# = 0.98) displaces the listvenite assemblage at temperatures between 40° and 100° C, and is in turn cross-cut by late sparry veins (170° to 195° C), consisting of quartz, zoned ferroan magnesite (Mg# = 0.90) and dolomite. Except for quartz growing from veinlets within the cryptocrystalline magnesite, clumped isotope temperatures of magnesite and fluid inclusion homogenisation temperatures in co-existing quartz [2] are in good agreement. The $\delta^{13}C$ and $\delta^{18}O$ of magnesite and dolomite generally increase with decreasing formation temperature from listvenite to sparry veins to cryptocrystalline magnesite. The calculated fluid $\delta^{18}O$ indicates involvement of meteoric water but does not identify distinct fluid sources for listvenite, sparry veins and cryptocrystalline magnesite formation.

[1] Ashley (1997) Geol. Soc. Austral. Spec. Pub. 19, 212-225. [2] Ashley (1995) Centre for Isotope Studies North Ryde, Res. Rep. 93-94, 12-18.