



## Direct precipitation of Magnesite in the Cariboo Plateau Lakes, B.C. and Coorong Lakes, Australia

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### Summary

Magnesite ( $\text{MgCO}_3$ ) is a very stable carbonate mineral that can be used as a sink for  $\text{CO}_2$  sequestration. The formation of hydrated Mg-carbonates (e.g. hydromagnesite), which are hypothesized to dehydrate to magnesite, has been noted in various ultramafic mine tailings sites and has been studied as a promising technology for Carbon Capture, Utilization and Storage (CCUS) [1, 2]. In general, hydrated Mg-carbonates form more readily than magnesite. However, in laboratory studies, direct precipitation of low temperature magnesite has been achieved through the use of polystyrene microspheres possessing carboxyl functional groups [3] and on the surfaces of cyanobacteria [4]. Holocene magnesite is present in a carbonate playa near Atlin, B.C. [5], in Milne Lake in the Coorong region, Australia [6], and in Milk Lake in the Cariboo Plateau, B.C. [7]. We took water samples and sediment push cores from three lakes in the Coorong (Milne Lake, Pellet Lake and North Stromatolite Lake) and two lakes in the Cariboo Plateau (Last Chance Lake and Milk Lake) to determine the influence of aqueous geochemistry on the precipitation of carbonate minerals.

Both the Coorong and the Cariboo Plateau are excellent natural models for studying magnesite formation as there are adjacent lakes that containing either (1) magnesite and very high magnesium calcite (VHMC) or (2) aragonite, VHMC and/or hydromagnesite. Analysis of sediment and cyanobacterial mats using scanning electron microscope (SEM) shows no association between magnesite and microbial cells in the Cariboo Plateau lakes. These lakes have very high alkalinity ( $>180$  mM as  $\text{HCO}_3^-$ ), low Mg ( $<1.1$  mM) and Ca ( $<0.11$  mM) and a pH near 10. Lakes in the Coorong have moderate alkalinity (6.1–9.1 mM as  $\text{HCO}_3^-$ ), Mg (24–57 mM) and Ca (0.8–1.3 mM) concentrations and a range of pH values (8.7–10). In both regions, depth dependent trends in the mineral assemblages and calculated saturation indices strongly suggest all carbonates, including magnesite, are precipitated directly from lake water. Crystallite size determined using high resolution transmission electron microscopy and X-ray diffraction indicate the anhydrous carbonates, including magnesite, formed through a non-classical crystallization pathway. Understanding the geochemical conditions and non-classical crystallization pathways that produce magnesite and VHMC can be used in new technologies that promote the removal of anthropogenic  $\text{CO}_2$  through mineral carbonation.

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