Non-classical crystallization of anhydrous Ca and Mg carbonates from the Coorong Lakes, Australia

MAIJA J. RAUDSEPP[1]*, SIOBHAN A.WILSON[1], BREE MORGAN[2] AND STEWART FALLON[3]

[1] Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB, Canada
(*correspondence: raudsepp@ualberta.ca)
[2] School of Geosciences, University of Sydney, Camperdown, NSW, Australia
[3] Research School of Earth Sciences, Australian National University, Canberra, ACT, Australia

The Coorong Lakes in Australia have long been studied as model environments for low temperature dolomite formation [1]. We took sediment push cores from three Coorong Lakes (Milne Lake, Pellet Lake and North Stromatolite Lake), which collectively cover ~6000 years of carbonate deposition in these shallow ephemeral lakes. Each lake has a different mineral assemblage of Ca and Mg carbonates, which includes aragonite, calcite, very high magnesium calcite (VHMC), Ca-bearing magnesite and/or hydromagnesite.

Our scanning electron microscope (SEM) imaging reveals that VHMC from the Coorong Lakes consists of spherical, sub-micrometre aggregates of nanocrystals, whereas aragonite and magnesite have typical tabular and rhombic habits, respectively. Our high resolution transmission electron microscopy (TEM) analyses and Rietveld refinement results using X-ray diffraction (XRD) patterns show that all anhydrous Ca and Mg carbonates are composed of 5–10 nm crystallites. The crystallite size of these carbonate minerals does not change with depth in the lake sediments, suggesting the carbonate nanocrystallites are stable for thousands of years; they neither fuse nor undergo Ostwald ripening. The formation of nanometre-sized crystallites is characteristic of a non-classical pathway, whereby carbonates crystallize from an amorphous precursor to form mesocrystals via oriented attachment [2]. Understanding pathway dependence in the formation of Ca and Mg carbonates can provide environmental and geochemical constraints on the precipitation of these minerals. Our work on the Coorong Lakes suggests that non-classical crystallization may be a natural pathway for abiological formation of carbonate sediments.

[1] Rosen *et al.* (1989) *GCA*, **53**, 661-669. [2] De Yoreo *et al.* (2015) *Science,* **349**, aaa6760.