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Modern, Mg- and Si-rich microbialites from a mining pond in carbonated serpentinite

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Modern, Mg-rich microbialites have formed in the mine pit pond at the ultramafic-hosted Attunga Magnesite Deposit, an abandoned mine site that documents the natural conversion of Mg-silicate to Mg-carbonate rocks during weathering and hydrothermal alteration. The flat, cm-thick thrombolites cover the edge of the mining pond and have a cerebroid-pustular surface. They are poorly to non-laminated and consist of irregular clots attached to the carbonated serpentinite bedrock. The pores between clots are partly filled with soft, lightly cemented mineral detritus, including fossils, e.g., serpulid tubes. In addition to serpentine and magnesite from the bedrock and minor calcium carbonates, X-ray diffraction of bulk thrombolite shows hydromagnesite [$Mg_5(CO_3)_4(OH)_2$•$4H_2O$] and a poorly crystalline phase. Broad XRD peaks at ~23° and ~36° 2θ (CuKα), d-spacing at 4.5 Å, 2.5 Å, and 1.5 Å calculated from Selected Area Electron Diffraction maxima and microprobe analysis are consistent with a hydrated Mg-silicate phase, such as kerolite [$Mg_3Si_4(OH)_{10}$•nH_2O].

The hydrated Mg-silicate phase provides the main structural support for the thrombolite, often encapsulating remnants of filamentous cyanobacteria. Hydromagnesite, with a typical platy habit, occurs almost exclusively within the lightly cemented detritus in the pores of the thrombolite. Calcium carbonates are present as remnants of fossilised plants and microorganisms both in the clots and in the detritus. The pond water composition is consistent with run-off and weathering of the serpentinite/magnesite bedrock and is saturated with respect to both Mg-silicates and Mg-carbonates. Fluctuations of the water table are limited, likely due to groundwater inflow. However, stable H and O isotope ratios indicate evaporation of the pond water.

Despite high concentrations in the pond water, most of the Mg does not bind with CO_2 to form carbonates. Instead, Mg is incorporated into hydrated Mg-silicate phases, which may be related to localised transfer of carbon from pond water into microbial biomass. Hydromagnesite forms abiotically within thrombolite pores during evaporation of pond water and/or when heterotrophs release carbon during consumption of cyanobacteria biomass. The thrombolites represent an example of CO_2 sequestration by biomineralisation and illustrate the conditions required for Mg-carbonate and Mg-silicate formation in alkaline lakes.