Calcite Biomineralisation in the Caves of Nullarbor Plains, Australia

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In caves under the Nullarbor Plain, divers report extensive mantles of a biological material. The mantles are gelatinous and transparent and only can be seen because of the microcrystalline calcite associated with them. They cover the roof and walls of the partially and totally water filled passages to the limits of exploration.

The nature of these mantles was investigated using electron microscopy and DNA analysis. The microcrystalline calcite was examined using electron microscope techniques, X-ray diffraction, Fourier transform infrared spectroscopy, Raman spectroscopy and thermogravimetric analysis. The cave water was analysed for major ions and trace metals and modelled using geochemical modelling software.

Water analysis revealed high levels of sulfate and nitrate together with significant nitrite. The community structure showed a high proportion of novel phylotypes as well as a high abundance of Nitrospira relatives. The unusual community, the nitrite in the water, and the apparent absence of aquatic macrofauna, means these microbial structures may represent biochemically novel, chemoautotrophic communities dependent on nitrite oxidation.

The waters were slightly saturated with respect to calcite, suggesting the microbial mantles play a role in calcite nucleation and crystal growth. The calcite crystals were predominately spindle shaped with curved \(\{hk.0\}\) faces lying parallel to the c-axis. Calcite precipitated under conditions designed to mimic the inorganic solution chemistry of the cave revealed a different morphology to that observed in the cave samples. These differences suggest that the formation and growth of the microcrystalline cave calcite is influenced by the microbial mantles.