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Microbial diversity and spectroscopic study of the aragonite microbialites from the alkaline Lake Van (Turkey)

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Lake Van harbours the largest known microbialites on Earth.[1] The surface of these huge carbonate pinnacles is covered by coccoid cyanobacteria whereas their central axis is occupied by a channel through which neutral, relatively Ca-enriched, groundwater flows into highly alkaline (pH $\sim$9.7) Ca-poor lake water. In order to understand how carbonate precipitation occurs within these structures, we have carried out fine-scale mineralogical and microbial diversity analyses from surface and internal microbialite samples. Electron transmission microscopy reveals that carbonates form as rounded aragonite nanoprecipitates surrounded by a 5-10 nm thick amorphous calcium carbonate layer, which is known to be highly unstable under inorganic/abiotic conditions. A progressive mineralization of cells by the deposition of nanoprecipitates on their surface is observed from external towards internal microbialite areas. Scanning Transmission X-ray Microscopy (STXM) analyses at the C K-edge, and the N K-edge detect abundant calcified microbial cells with diverse shapes and suggest that aragonite precipitates along organic material, most likely exopolysaccharides. Molecular diversity studies based on 16S rDNA amplification shows indeed the presence of various bacterial lineages. To the exclusion of cyanobacteria, only found on the surface layer, the closest cultivated members to the Lake Van phylotypes are predominantly alkaliphilic and/or heterotrophic bacteria able to degrade complex organics.

These heterotrophic bacteria may thus play a crucial role in the formation of Lake Van microbialites by locally promoting carbonate precipitation.[2]

1. Kempe, S., Kazmierczak, J., Landmann, G., Konuk, T., Reimer, A.. and Lipp, A. Largest known microbialites discovered in Lake Van, Turkey. *Nature* **349**, 605-608 (1991).

2. López-García, P., J. Kazmierczak, K. Benzerara, S. Kempe, F. Guyot and D. Moreira. Bacterial diversity and carbonate precipitation in the microbialites of the highly alkaline Lake Van, Turkey. *Extremophiles*, *in press*.