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Using laboratory investigations to reveal the palaeohydrological implications of aragonite laminae deposition in the endorheic Dead Sea and its precursors under different climatic conditions

Yoav Ben Dor[1], Tomer Flax[1], Itamar Levitan[1], Achim Brauer[2,3], Yehouda Enzel[1], and Yigal Erel[1]

[1]Institute of Earth Sciences, The Hebrew University of Jerusalem, Jerusalem 91904, Israel
[2]Section Climate Dynamics and Landscape Evolution, GFZ German Research Centre for Geosciences, Potsdam 14473, Germany
[3]Potsdam University, Department of Earth Sciences, Potsdam 14476, Germany

The sedimentary record of the endorheic Dead Sea and its precursors comprises aragonite laminae that make up an environmental archive extending into the Pleistocene, partially in annual resolution. Nevertheless, despite the importance of resolving the conditions that facilitate aragonite precipitation in the Dead Sea, contradictions exist between recent studies that utilized modern observations and the late Pleistocene geological record. The implications of aragonite precipitation in the Dead Sea and in its late Pleistocene predecessor Lake Lisan were investigated in this study by mixing natural and synthetic brines with a synthetic bicarbonate solution representing flood water entering the lake (4mM), with and without additions of extracellular polymeric substances (EPS). This was followed by measurements of aragonite precipitation incubation, rates, yields. Aragonite precipitation took place within days to few weeks after mixing of the brine with the synthetic bicarbonate solution and its incubation time was proportional to bicarbonate concentrations, while precipitation rates were also influenced by ionic strength. The addition of EPS inhibited aragonite precipitation for several months, which provides a reasonable explanation for the proposed summer-time precipitation of aragonite during the late Pleistocene glacials. We suggest that under increased inflow, increased biological activity would result in increased EPS production that could inhibit aragonite precipitation for several months. Finally, previous estimates of the freshwater inflow required to provide the carbonate for a uniform aragonite lamina of a typical thickness deposited during glacials are unreasonably high. This can be resolved by various processes: (1) Patchy aragonite deposition over limited segments of the lake's floor; (2) Supply of additional carbonate to the lake from aeolian dust and recycled dust deposits; (3) Carbonate production through the oxidation of organic carbon by sulfate-reducing bacteria at the hypolimnion. Altogether, these results indicate that aragonite laminae thicknesses are insufficient to quantitatively reconstruct the hydrological balance for the entire lake, but may still be valuable for identifying climatic periodicities over a continuous record in a specific study site.