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Salt facies and budgets as environmental indicators in the Dead Sea

Yael Kiro (1), Steven L Goldstein (1), Mordechai Stein (2), Javier Garcia-Veigas (3), Elan J Levy (4), and Boaz Lazar (5)

(1) Lamont-Doherty Earth Observatory, Columbia University, United States (ykiro@ldeo.columbia.edu), (2) Geological Survey of Israel, 30 Malkhe Israel street, Jerusalem 95501, Israel, (3) Serveis Cientificotècnics, Universitat de Barcelona, 08028 Barcelona, Spain, (4) Department of Geological and Environmental Sciences, Ben-Gurion University of the Negev, Beer Sheva, Israel, (5) Institute of Earth Sciences, the Hebrew University, Jerusalem, 91904, Israel

Deep drilling in the Dead Sea reveals thick sections of halite that precipitated during the last three interglacials, when lake levels were low. Pore water and halite fluid inclusions show an increase in Mg concentration and a decrease in Na/Cl ratio during precipitation of halite, both during the last interglacial and the beginning of the Holocene. A mass balance based on the thickness of the halite layers and the changes in the chemical composition of the brine has been developed in order to calculate the change in the lake levels. Results indicate a drastic decrease in fresh water input, with the average discharge at 30% and 50% of the modern over thousands of years during the last interglacial and early Holocene, respectively. However, packages of detritus alternating with the halite indicate wetter episodes over intervals of centuries to a few millennia with conditions similar to the present-day, as well as more severe conditions with ∼10% of the modern discharge over periods of decades to a few centuries.

The different facies of halite in the core are well preserved. The lake level calculation based on the salt budget shows that although the lake level decreased drastically, the lake was always >100 m depth, and the absence of significant halite dissolution supports this conclusion. Thus, the halite reflects deep-water facies. There are two main halite crystal types. Small cumulate crystals that are formed on the lake surface, which alternate with bottom-growth crystals with relatively scarce fluid inclusion bands. The frequency of the crystal alternation varies between seasonal and multi-year changes and reflects the hydrological and limnological regime. The small cumulate crystals require that the lake surface was supersaturated with respect to halite, indicating high evaporation and possibly a thermally stratified water column. The bottom-growth crystals are formed only when it is not disturbed by the “rain” of cumulate crystals, with a lower degree of supersaturation to halite, suggesting greater fresh water input and a mixed water column. Thus, frequent alternations between cumulates and bottom growth reflect seasonality, where cumulates are formed during summer and the bottom-growth crystals during winter. Overall, the variability of halite facies reflects a spectrum drier to wetter conditions and provides a high resolution record during the driest intervals in the region’s history.