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# Fluctuations of Lake Lisan (the Dead Sea) during the last glacial: Implications for paleoclimatic changes of the Levant.

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Calcareous stromatolite crusts overgrowing beach gravels and stabilising piles of rocks were observed on shoreline terraces of Lake Lisan along the eastern coast of the Dead Sea. The stromatolite crusts are thick, massive and hard, with a dark-grey or white-grey finely-laminated structure, indicating that they are mostly calcareous organic build-up of cyanobacterial origin. Samples from these stromatolites have been analyzed using Stable Isotopes (δ13C & δ18O), AAS and XRD analysis. The samples range in altitude between -350 m and -19 m, representing the time interval of Lake Lisan (~ 80-19 ka BP) according to our U/Th dating. Since stromatolites grow in shallow water, they are very sensitive to minor shifts in rainfall and evaporation and therefore an excellent tool to track small changes in hydrology, in climate and in paleoenvironmental conditions of the lake basin.

Oxygen and carbon isotopic compositions of these stromatolites show a linear covariant trend with a strong positive correlation (r = 0.8) and large ranges of 7.85 and 6.78‰, respectively. This trend is most typical of primary carbonates formed in closed lakes. Isotopes analyses show low negative values of stromatolites from the lake highest stands at -76 m to -19 m, reflecting fresh water conditions of the lake basin at the last interglacial-glacial boundary (80-76 ka BP). The lowest values were derived from stromatolites at -103 to -119 m associated with the transgression of the lake to these high stands between 55 and 33 ka BP. The heaviest values were derived from stromatolites at -137 to -160 m indicating a change to dry climatic conditions in the Eastern Mediterranean that caused a subsequent drop of the lake level during MIS 2 (31-19 ka BP).

The Mg/Ca ratio and the XRD analysis of the stromatolites correlate also with transgression-regression phases of the lake. Dominance of calcite in stromatolites at -76 to 0 m and inferred low Mg/Ca ratios of the lake water (i.e. ~2) imply a high fresh water input of the lake during the highest stands period. A high Mg/Ca ratio of the lake water of >7 inferred from low-level stromatolite at -350 m and the existence of aragonite as the sole mineral reflect low fresh water

input and high evaporation rates that caused a lake level regression during H6, ~ 60 ka BP.

Inferred low Mg/Ca ratios of stromatolites at -247 to -101 m and the existence of calcite as a main mineral phase indicate wet climatic conditions of the eastern Mediterranean and lake level transgression to higher than -137 during MIS 3. The appearance of more aragonite in stromatolites at -137 to -154 m and the inferred high Mg/Ca ratio of the lake water points to a return to dry climatic conditions that caused a regression of Lake Lisan between 32 to 22 ka BP (MIS 2). However, the change in the mineral composition to pure calcite at -160 m in addition to the inferred low Mg/Ca ratio correlates well with the transgression of the lake to this level by the end of the LGM.