

Speleothems-derived geochronologic constraints on the timing of Late Miocene uplift along the Dead Sea Transform western margin

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The timing of vertical motions associated with the Dead Sea Transform (DST) plate boundary separating the Arabian plate from the Sinai sub-plate is not yet firmly established. We use phreatic and vadose carbonate cave deposits (speleothems) to constrain paleo-groundwater levels along the western margin of the DST and provide proxies for the timing of large-scale incision and tectonic uplift.

Phreatic speleothems form below the groundwater level and incrust the walls, floor and ceiling of caves by uniform calcite overgrowth with minimal gravitational effects on the overgrowth thickness. A cave that contains both phreatic and vadose speleothems can be used to constrain temporal trends in the groundwater level, potentially driven by uplift, river incision or base level subsidence. In this study, we utilize novel LA-ICP-MS U-Pb geochronology, to date this transition in five cave complexes stretching along 150 km of the DST western shoulder from the Judean Mountains to the central Negev. The present-day groundwater level is located hundreds of meters below the caves.

74 U-Pb ages from 35 speleothems were obtained. U-Pb ages of phreatic speleothems from all five locations start at 14-9 Ma and end abruptly around 6 Ma. In contrast, vadose speleothems continue to grow intermittently until the Late Quaternary. These results indicate that after 6 Ma groundwater levels decreased abruptly and did not flood the caves again. We associate this post 6 Ma signal with enhanced incision along the western shoulder of the Dead Sea by rivers and canyons flowing towards the Dead Sea and the Mediterranean. The Late Miocene period also marks the initiation of a thick sedimentary sequence which start to accumulate in the Dead Sea basin itself, suggesting rapid subsidence of the basin relative to its shoulders.