



Morphotectonic Chronology of the Dead Sea Rift's Western Margin: Insights from U-Pb Dating of Speleothems

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The development of the Dead Sea Transform (DST) coincided with a vertical uplift of the transform margins, forming the main N-S mountain ridge of Israel, as well as a subsidence of Dead Sea pull-apart basin. So far only minor parts of these events have been accurately dated. Karst processes that started after marine regression, led to the formation of karst aquifers in the carbonate lithologies of Cenomanian to Eocene age. The vertical tectonics (mountain uplift and Dead Sea Valley subsidence) caused the caves to be gradually uplifted above the regional groundwater level. In the current study, we used Laser Ablation (LA) U-Pb chronology of phreatic and vadose cave calcite to determine the timing of vertical tectonic stages: the marine regression, onset of karst processes, and transition of the caves from the groundwater up to the vadose zone. U-Th chronology was used for dating the youngest calcites. Phreatic and vadose calcite samples were collected from sites with similar altitudes and a spatial extent of ~150 kilometers on N-S transect along the western DST margin. In-situ LA U-Pb chronology of calcite, along with calcite $\delta^{18}\text{O}$ values ranging between -16‰ and -9‰ (VPDB), fluid inclusion (FI) $\delta^{18}\text{O}$ - δD analyses and associated d-excess values of 9‰ to 29‰ (VSMOW) indicates that meteoric waters infiltrated into the aquifer since Late Eocene – Early Oligocene (35.1 ± 0.3 Ma to 29.17 ± 0.4 Ma), marking the timing of sea regression and onset of meteoric water infiltration into the aquifer. The onset of vertical tectonics in the region during the early Miocene, caused an initial uplift of the caves above water table and deposition of first vadose speleothems around 20 Ma. The average uplift rate of the western margin of DST was approximately 26 m per million years, which increased to 120 m per million years from 6 Ma to the present. This change appears to correspond with a few degrees shift in previously parallel sinistral strike slip movement of the Dead Sea Transform, introducing an extensional component and leading to the development of the pull apart basin.