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Reconstruction of diagenesis in Southern Levant Eocene sedimentary rocks by Laser Ablation-Mass-Spectrometric (LA-MS) U-Pb chronology

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The Eocene-Oligocene sedimentary succession in the eastern Mediterranean (Israel) records the dramatic transition from a deep-sea environment to aerial exposure known as the Oligocene unconformity in the Middle East. This study aims to understand the subsurface structures for environmental and economic applications. We examine the efficiency of LA-MS U-Pb chronology in reconstructing the diagenetic history of a carbonate sequence, enabling the timing of rock diagenetic events by dating micron-scale rock components in thin sections recovered from subsurface and submarine rocks. The results show a set of U-Pb ages of nummulite benthic foraminifera and carbonate secondary cements extracted from Eocene outcrops in northern and southern Israel. The chronology of primary nummulites and secondary cements assists with identifying a possible time gap between the nummulite age and the cement. While many fossils contain low levels of radiogenic lead resulting in ages with high uncertainty, some fossils and secondary cements are more radiogenic, providing more accurate chronologies.

In the southern region, the ages of nummulite benthic foraminifera in Eocene Formations are from 52.76±4.56 Ma to 46.9±0.72 Ma, whereas the secondary cement ages are 40.21±3.04 Ma, 35.01±1.03 Ma, 32.06±0.21 Ma to 24.91± 1.83 Ma old, as well as younger cements of 21.13±1.72 Ma to 17.5±1.92 Ma. Some nummulites and other fossil fragments show ages of the secondary cements, indicating alteration during the diagenesis. In the northern region, the nummulite ages were around 40.6±2.12 Ma, with calcite secondary cements dated to 36.35±4.83 Ma.

These results demonstrate that marine sedimentary rocks can be reliably dated using LA-MS U-Pb. Secondary calcite cements are usually more radiogenic than the original rock components. Late Eocene – Early Oligocene alteration events could be a result of landslides on continental slope, releasing fluids that circulated through the rocks. Late Oligocene and Miocene alteration stages could occur because of karst processes after the sea regression on Eocene-Oligocene boundary.