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Speleothems reveal hydrothermal events in Late Miocene groundwater aquifers in Israel

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Clumped isotopes (D_{47}) in speleothems is a powerful tool in studying paleotemperatures in which cave calcite was deposited. When applied to phreatic speleothems (that grow below groundwater level) speleothem paleotemperatures can reflect hydrothermal events, if these took place during calcite deposition. Here we use clumped isotope technique in Israeli Late Miocene phreatic mamillaries to determine the temperature in Late Miocene groundwater paleo-aquifers.

Three sites were studied: the Burma-Road Cave speleothem sequence in central Israel (elevation 410 m, 31°48'09" N/035°01'30"E) and two sites at Ma'ale-Meyshar Caves in southern Israeli Negev Desert: site 3 on elevation 480m, 30°29'40"N/34°55'56"E, and site-8 on elevation 630 m, 30°30'25"N/34°56'38"E. On Burma-Road Cave site a section of mamillaries composed of three layers is exposed. LA-ICP U-Pb chronology of the mammillary sequence layers is as following, layer F from 10.45±0.38 Ma to 9.45±0.30 Ma, layer E is 8.38±0.76 Ma, and layer D from 5.63±0.25 Ma to 5.13±0.36 Ma. Above the mamillaries, vadose flowstone layers C and B aged 2.48±0.15 Ma to 1.68±0.09 Ma are located. At Ma'ale-Meyshar site-3 phreatic mamillaries aged from 9.04±0.45 Ma to 6.65±0.62 Ma are found, whereas on site-8 a vadose flowstone that grew between 8.09±0.65 Ma and 6.57±0.19 Ma is exposed, indicating that the Late Miocene groundwater level was located between sites 3 and 8.

The paleotemperatures in layer F of Burma-Road Cave mamillaries varied between 35±4˚C and 44±3˚C (average 40˚C). In layer E, the temperatures decreased to 27±3˚C - 29±5˚C, at layer D the temperatures were between 23±4˚C and 25±3˚C, dropping to 14±2˚C - 21±3˚C in the vadose flowstone layers C and B. At Ma'ale-Meyshar Caves the paleotemperatures in the mamillaries of site-3 varied between 39±2˚C and 52±2˚C (average 44˚C), being much cooler in the flowstones of site-8, varying between 24±3˚C and 36±4˚C (average 28˚C). The relatively high temperatures in Late Miocene under the groundwater table (35˚C-52˚C) could be a result of magmatic intrusions, together with increased groundwater circulation along the faults. The decreasing trend in temperatures of Burma-Road speleothems from 8.38±0.76 Ma (27˚C -29˚C) to 1.68±0.09 Ma (14˚C -21˚C) could be partly related to a Miocene – Quaternary climate cooling.