Tracing the recharge history of groundwater –The En-Qedem thermal brine springs, Dead Sea shore

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The En-Qedem (EQ) hydrothermal saline spring system discharging at the western shore of the modern Dead Sea (DS) comprises the most significant source of brine that currently discharges into the lake with 8-13 MCM·y^{-1}, at maximum temperature of 46°C. Assuming a geothermal gradient of 19°C·km^{-1}, the EQ solution ascends rapidly from a depth of at least 950 m. The EQ, comprises a Ca-chloride brine with salinity half of the DS. The chemical composition of EQ brine has remained virtually uniform during the past 40 years, indicating a large groundwater reservoir. The brine is not a simple mixture between DS brine and meteoric water; rather it represents a former solution of the lake that intruded the surrounding aquifers. Here, we discuss the evidence for the potential source of the EQ brine and its age.

Pore-fluids extracted from cores drilled at the deepest bottom of the DS by ICDP (International Continental Drilling Program) represent in their composition the hypolimnion of the DS during the last 220,000 y and provide a clue to the history of EQ brine. At ~80 ka the Na/Cl ratio in the porewater was rather low (0.33) and similar to that of present day EQ. This low ratio is found after a prolonged period of salt precipitation that occurred during the last interglacial, when lake stand was very low. Then, during the last glacial period (70-14 ka) when Lake Lisan filled the basin, with more diluted brine and its level rose to high stands, the Na/Cl ratio increased due halite dissolution, reaching ~0.5 at ~25 ka.

The low Na/Cl ratio in EQ can be explained by either (1) penetration of the brine to the aquifer at ~80 ka and subsequent mixing of the brine with freshwater within the aquifer; or (2) penetration of low Na/Cl epilimniotic Lake Lisan brine derived from a lake's portion that did not dissolve halite because of its large distance from a potential halite source (Mt. sedom?). The latter scenario is corroborated by hydrologic considerations that require high lake stand for penetration of EQ brine into the aquifer and ages of the EQ brine as determined by 3 dating methods converging on a time of ~25 ka.