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Groundwater-saline lakes interaction - The contribution of saline groundwater circulation to solute budget of saline lakes: a lesson from the Dead Sea

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Saline lakes act as base level for both surface water and groundwater. Thus, a change in lake levels is expected to result in changes in the hydrogeological system in its vicinity, exhibited in groundwater levels, location of the fresh-saline water interface, sub-lacustrine groundwater discharge (SGD) and saline water circulation. All these processes were observed in the declining Dead Sea system, whose water level dropped by $\sim$35 meters in the last 50 years.

This work focuses mainly on the effect of circulation of Dead Sea water in the aquifer, which continues even in this very rapid base level drop. In general, seawater circulation in coastal aquifers is now recognized as a major process affecting trace element mass balances in coastal areas. Estimates of submarine groundwater discharge (SGD) vary over several orders of magnitude (1-1000000 m3/yr per meter shoreline). These estimates are sensitive to fresh–saline SGD ratios and to the temporal and spatial scales of the circulation. The Dead Sea system is an excellent natural field lab for studying seawater–groundwater interaction and large-scale circulation due to the absence of tides and to the minor role played by waves.

During Dead Sea water circulation in the aquifer several geochemical reactions occur, ranging from short-term adsorption–desorption reactions and up to long-term precipitation and dissolution reactions. These processes affect the trace element distribution in the saline groundwater. Barite and celestine, which are supersaturated in the lake water, precipitate during circulation in the aquifer, reducing barium (from 5 to 1.5 mg/L), strontium (from 350 to 300 mg/L) and the long-lived 226Ra (from 145 to 60 dpm/L) in the saline groundwater. Redox-controlled reactions cause a decrease in uranium from 2.4 to 0.1 μg/L, and an increase in iron from 1 to 13 mg/L.

228Ra (t1/2=5.75 yr) activity in the Dead Sea is $\sim$1 dpm/L and increase gradually as the saline water flows further inland until reaching steady-state activities ($\sim$27 dpm/L) with the aquifer sediments. The decrease in 226Ra and increase in 228Ra in the circulation process provide a robust method for calculating the amount of Dead Sea water circulating in the aquifer. This process can affect trace element concentrations in the Dead Sea and emphasize the potential of long-term seawater circulation in mass balances of saline water bodies.