Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.22250

Shifts in the Dead Sea water sources since the last deglaciation: Insights from uranium isotopes

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The populated south Levant region, situated at the interface of the Mediterranean climatic zone and the Sahara Desert belt, is vulnerable to drought under a warming climate. Paleoclimate studies can help picture present and future changes in regional hydroclimate that is not available from relatively short instrumental records. The lacustrine records from the Dead Sea, recovered by the Dead Sea Deep Drilling Project (DSDDP), provide a detailed lithological history of climate variability in the Levant, generally characterized by wet glacials and dry interglacials. Here, we analyzed $^{234}U/^{238}U$ activity ratios of authigenic minerals (aragonite, halite, and gypsum) in the DSDDP core to track shifts in water source to the Dead Sea basin since the last deglaciation. During the hyperarid Bølling–Allerød and the beginning of Holocene, marked by thick halite deposition, the $^{234}U/^{238}U$ activity ratios of authigenic minerals decreased from ~1.5 to 1.1–1.3. The notable declines indicate a shift in water sources from the north and west (Jordan River and Mediterranean-sourced rainfall, $^{234}U/^{238}U$: ~1.5–1.7) to the eastern and southern catchments along with flash floods ($^{234}U/^{238}U$: ~1.0–1.2). Given that Mg^{2+} in the Dead Sea is conservative and its concentration ($[Mg^{2+}]$) is directly proportional to the lake volume, water budgets of different sources were estimated based on porewater $[Mg^{2+}]$ and a two-component isotope-mixing equation. Our results suggest a dramatic reduction in the Jordan River's runoff, the primary freshwater source in the south Levant, by one to two orders in the arid periods compared to the modern level. This is probably due to a decrease in wintertime cyclonic activities. Additionally, a doubling in the southeasterly runoff was observed during the Younger Dryas-Holocene transition and the relatively wet period (9.5–8.3 ka) that coincided with the Mediterranean sapropel event (S1). This increased southeasterly source may be related to the resumption and intensification of the African summer monsoon.