Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31026

Stable Isotopes of Gypsum Hydration Water in Hyper-Arid Negev Desert Soils as Proxies for Evaporative Conditions

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Stable isotopes of oxygen ($\delta^{18}O$) and hydrogen (δD) in gypsum hydration water ($CaSO_4 \cdot 2H_2O$) provide a promising tool for reconstructing evaporative conditions and moisture sources in arid environments. Pedogenic gypsum in Reg soils accumulates under limited moisture availability and minimal leaching, potentially preserving valuable hydroclimatic information. Here we present high-resolution measurements of gypsum hydration water stable isotopes of pedogenic gypsum found 10 to 50 cm below the surface in a Reg soil section from the Negev Desert (Israel) using a novel technique developed at the Geological Survey of Israel (GSI). This novel method enables isotopic analysis using significantly smaller gypsum samples (1 to 2 mg) than previous methods, overcoming previous limitations that required bulk sampling and thereby allowing for improved spatial resolution of isotopic variability within gypsum horizons. Preliminary results indicate substantial variability in $\delta^{18}O$ and δD values along the sampled profile and $\Delta\delta D/\Delta\delta^{18}O$ slopes that are linked to the isotopic composition of paleo-meteoric water, above-surface and sub-surface evaporation processes. Stable isotope measurements of accumulated modern rainfall in the Negev help establish the isotopic baseline for understanding shifts recorded in the paleo-meteoric water sources estimated from gypsum hydration water stable isotopes. Initial comparisons between rainfall and gypsum hydration water, together with $\Delta\delta D/\Delta\delta^{18}O$ slopes (2 to 5) suggest that the pedogenic gypsum formed from significantly evaporated waters, consistent with the expected trends in hyper-arid soil environments. These findings highlight the potential of gypsum hydration water as a geochemical archive for hydroclimate reconstructions in hyper-arid regions. High-resolution approach enables a detailed assessment of isotopic variability within gypsic horizons and provides new insights into the processes governing pedogenic gypsum precipitation, accumulation and post-depositional modification.