

Triple oxygen and hydrogen stable isotopes of gypsum hydration water in sub-actual playa-lakes sediments: Implications for paleoclimate reconstructions

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Triple oxygen and hydrogen stable isotopes of evaporating water bodies show different sensitivities to environmental parameters (e.g. temperature, relative humidity, etc.). Recent studies have demonstrated that under certain conditions, structurally-bound hydration water of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) of lacustrine sediments preserves its original isotopic composition and can be used to reconstruct the stable isotopes of paleo-water and estimate paleoclimate conditions. Here, we investigate the reliability of this approach for ephemeral lake systems of the Andalusian lowlands (southern Iberian Peninsula). We compare the isotope composition ($\delta^{17}\text{O}$, $\delta^{18}\text{O}$, $\delta^2\text{H}$ and derived parameters $^{17}\text{O}_{\text{excess}}$ and d-excess) of sub-actual gypsum from the lake beds and short cores to modern isotopic compositions of lake waters through the year.

Gypsum recorded a wide range of lake water isotopic compositions, i.e., $\delta^{18}\text{O}$ from -4.5 to 10.7‰ and $^{17}\text{O}_{\text{excess}}$ from -10 to -97 per meg. This agrees with values of the modern lakes that vary seasonally over 25‰ for $\delta^{18}\text{O}$ and up to 150 per meg for $^{17}\text{O}_{\text{excess}}$. When plotting $^{17}\text{O}_{\text{excess}}$ vs. $\delta^{18}\text{O}$, several data clusters and evaporation trajectories are observed for both, the gypsum-forming water and the modern lakes, unlike when using the conventional $\delta^{18}\text{O}$ and d-excess parameters. The isotopic values of the modern lake water and those of obtained from gypsum, describe similar evaporation trajectories that cannot be explained by a simple pan evaporation model. For some lakes, a permanent or temporary water input, through direct precipitation, runoff or groundwater discharge, is needed to match the analytical data and the model. In most cases, gypsum seems to record the isotopic composition of lake water in late spring and early summer, before the lakes dry up. We discuss the potential and drawbacks of triple oxygen and hydrogen isotopes of gypsum hydration water for quantitative paleoclimate reconstructions from playa-lakes in this region.

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