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Reconstructing the triple oxygen and hydrogen isotope composition of paleo-lakes from gypsum hydration water: application to lakes in the southern Iberian Peninsula

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The structurally-bound hydration water of gypsum ($CaSO_4 \cdot 2H_2O$) preserved in lake sediments can be used to reconstruct the isotopic composition ($^2H/^1H$, $^{17}O/^{16}O$ and $^{18}O/^{16}O$) of lake water at the time of gypsum crystallization [1]. Compared to other lacustrine minerals (e.g., carbonates), a key advantage of gypsum is that the isotope fractionation factors between the fluid and hydration water are nearly independent of temperature (4–35 °C) and salinity below 150 g L^{-1} [2]. Here, we apply this approach to investigate the d^2H, $d^{17}O$ and $d^{18}O$ of paleo-lake water using gypsum from the sediments of several lakes in the southern Iberian Peninsula. Gypsum crystallization occurred during different periods in each lake, depending on their hydrological characteristics (e.g., watershed size) and interactions with groundwater. Some lakes precipitated gypsum during the late Glacial (27–18 ka) and the Pleistocene-Holocene transition (18.5-7.5 ka), whereas most of the investigated lakes did so during at least some stages of the late Holocene (<4-5 ka). The isotopic variability reconstructed from gypsum reveals pronounced differences in evaporative conditions between the late Glacial and the Holocene. In addition, other major hydroclimatic events of the deglaciation and the late Holocene, including the Younger Dryas, the 8.2 ka event, the Roman Warm Period, and the Medieval Climate Anomaly, are also recorded in the gypsum. Altogether, our dataset highlights the strong potential of stable isotopes in gypsum hydration water for paleoclimate reconstructions.

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