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Down-core Calibration Test Evaluating Compound Specific δD of Organic Matter as a Reliable Water Isotope Proxy in Closed-Basin Lakes Over Time

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Investigating past climate using lake water isotopes (δD_L) requires developing robust quantitative paleoclimate proxies. Compound specific hydrogen isotopes of lacustrine organic matter (δD_{OM}) have been shown to record lake water δD_L using spatial calibrations of core tops, soils, plants, and laboratory growth experiments. However, it is unclear whether δD_{OM} is influenced by changes in lake biogeochemistry and volume, and how well the isotopic signal is preserved in lake sediments through time. The objective of this study is to conduct a down-core calibration test, to assess how well down-core sedimentary compound specific δD_{OM} of different organic molecules record δD_L throughout changes in lake volume and chemistry and early diagenesis. In this study, we attain an independent estimate of the historical evolution of δD_L of two desiccating closed-basin lakes, by modeling the historically documented changes in lake volume, and analyze δD_{OM} in organic molecules from sediment cores from these lakes. The studied closed-basin lakes are Chenghai and Daihai in south and north China, which have no outflow and where water leaves only through evaporation. Over the past century, diversion of head waters has led to a hydrological imbalance in these lakes, where evaporation exceeded input, and the lake volumes have been reduced by ~ 50%. Using the documented drying history, we modeled the δD_L of the lakes through time, which show a substantial δD_L enrichment (~30‰). This isotopic shift is ~6–10 times greater than the analytical uncertainty of δD_{OM} (typically 3–5‰), making it ideal for recording δD_L during significant hydrological changes. We retrieved two short sediment cores from these lakes and constructed age models for each. Samples extracted from these cores are analyzed for compound-specific δD_{OM}, focusing on biomarkers such as phytol, phytane, pristane, *n*-alkanes, and fatty acids. Comparison between the modeled lake water δD_L and compound specific δD_{OM} enable assessing the ability of compound specific δD_{OM} to record lake water δD_L during biogeochemical changes of the lake and will also help determine the preservation of lake water isotopic signals over time.