PP024-0004 - Deltas in an estuary: clumped and triple oxygen isotope analyses reveal isotopically depleted headwaters in the early Eocene of Southern CA

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Live Chat with Presenter Ended 10 December 13:00

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Abstract

The $\delta^{18}O$ of carbonate minerals that form in the hydrosphere is widely used to investigate hydrologic processes in ancient high CO_2 worlds. However, a multitude of hydrologic processes can affect $\delta^{18}O$ values (mixing, evaporation, and distillation of parent waters; carbonate growth temperatures). We combine traditional carbon and oxygen isotopes with clumped (Δ_{47}) and triple oxygen isotopes ($\Delta'^{17}O$) in oyster shells (*Acutostrea idriaensis*) from the early Eocene to provide insights into the $\delta^{18}O$ of meteoric waters during hothouse climates. The oyster shells were collected from the Goler Formation of California, USA, near the transition from the terrestrial to marine environments. In addition to evidence from the geologic setting itself, we find isotopic evidence to suggest that the oysters lived in an estuary. $\delta^{18}O$ of growth water ($\delta^{18}O_{gw}$) is calculated using Δ_{47} temperatures and $\delta^{18}O$ of carbonate and ranges from -4.4 to -9.0 ‰ (SMOW). $\delta^{13}C$ values range from -0.5 to -6.0 ‰ (VPDB). A correlation exists between $\delta^{13}C$ and $\delta^{18}O_{gw}$ (r^2 of a linear model is 0.95); a mix of low $\delta^{13}C$ and $\delta^{18}O$ fresh water with high $\delta^{13}C$ and $\delta^{18}O$ ocean water can explain this isotopic covariation. $\Delta'^{17}O$ of growth waters (calculated from $\Delta'^{17}O$ of carbonate and Δ_{47} temperatures (–0.004 to +0.006 ‰ (SMOW-SLAP)) is consistent with a mix of fresh and ocean waters in $\delta^{18}O$ - $\Delta'^{17}O$ space, which we consider further evidence for an estuarine environment. We use these mixing relationships ($\delta^{13}C$ - $\delta^{18}O$ and $\delta^{18}O$ - $\Delta'^{17}O$) to estimate the $\delta^{18}O$ of the freshwater feeding the estuary. We find that $\delta^{18}O$ of freshwater is -15 ‰ or lower – an estimate that is >5 ‰ lower than what would have inferred using “only” clumped and traditional oxygen isotopes (-9 ‰). This estimate of $\delta^{18}O$ of fresh water is lower than the $\delta^{18}O$ of modern snowmelt springs in the Sierra Nevada. Isotopically depleted freshwater supports paleogeographic reconstructions of a Paleogene river that flowed southward along the moderately high-elevation eastern paleo-Sierra Nevada before turning west to the Pacific. This result highlights the potential for clumped and triple oxygen isotopes to enhance reconstructions of $\delta^{18}O$ of meteoric waters, which are critical for making comparisons with modeled predictions and will ultimately improve understanding hydroclimate in high CO_2 worlds.

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The Effects of Carbonate Decomposition on Clumped Isotopes from Heavily Altered Limestone Clasts in the Steen River Impact Structure Breccia.

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Clumped isotope geochemistry of carbonates formed in association with shallow water continental methane seeps at Prony Bay, New Caledonia and Elba, Italy

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How I Learned to Stop Worrying and Embrace Isotopic Disequilibrium in Carbonate Minerals

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Reconstructing precipitation $\delta^{18}O$ from lacustrine carbonates using $\delta^{18}O$, Δ_{47}, and $\Delta'^{17}O$: a modern case study from Junín, Peru with implications for paleoclimate

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