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Reconstructing paleocatchments by integrating stable isotope records, sedimentology, and taphonomy: A Late Cretaceous case study (Montana, United States)

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ABSTRACT

Robust isotopic reconstructions of climate, elevation, and biology require a reasonable capture of the range of isotopic variability across a paleolandscape. Here, we illustrate how integrating multiple proxies derived from a variety of paleoenvironments aids in this effort. We determined $\delta^{18}O$ and $\delta^{13}C$ values from lake and soil carbonates, unionid shells, gar scales, and crocodile teeth from multiple depositional environments (lakes, soils, ponds, streams, and large rivers) spanning a 300 km proximal-to-distal transect within the Late Cretaceous foreland basin of Montana. Two major patterns emerge. First, environments with less hydrological energy display higher $\delta^{18}O$ and lower $\delta^{13}C$ values than large rivers, which indicates greater input from local precipitation compared to high-altitude runoff, and a relatively larger contribution of degraded vegetative matter to the dissolved inorganic carbon load. Second, proxies with seasonal biases toward late spring and summer growth display lower $\delta^{18}O$ and $\delta^{13}C$ values in the basin proximal setting compared to the distal coastal setting, which is linked to the rainout history of vapor masses moving across the foreland basin. Overall these isotopic patterns mirror those in modern catchments, support hypotheses of monsoonal rainfall within the basin, and suggest a hypsometric mean elevation of ~2.6 km within the Sevier orogenic belt. Furthermore, our results indicate a potential to subdivide freshwater paleoecosystems to refine paleobiologic studies of habitat preference and migration patterns.