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RECONSTRUCTING PALEOALTIMETRY WITH D/H MEASUREMENTS OF LIPID BIOMARKERS

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Paleoelevation is a crucial variable in tectonics and climate research. Observation-based estimates provide a real-world benchmark to compare with models of mountain formation and help constrain the complex interactions driving uplift, denudation and climate. A striking example of their value is provided by the Cenozoic history of the Himalaya. Different models of the Himalayan orogen result in markedly different predictions of area and elevation histories for the Tibetan plateau. For example, thickening and northward expansion of the Tibetan plateau as a simple function of India-Asia convergence predicts a time-transgressive history of uplift, with regions near the Himalayan front experiencing uplift earlier than regions further to the north. In contrast, models that invoke convective removal of the mantle lithosphere predict rapid uplift of large regions at discrete time intervals. Estimates of past elevations are one of the few means to test different models of the uplift history of the Tibetan plateau.

Rowley et al. (2001) established the theoretical basis for using the stable isotopes of oxygen and hydrogen in precipitation for paleoaltimetry. Subsequently, this technique and closely related approaches have been applied to carbonate-based $\delta^{18}O$ records from different localities. However, no studies have investigated the hydrogen isotope composition of precipitation for quantitative paleoaltimetry reconstructions, primarily because there are few substrates that preserve the D/H ratio of precipitation, surface or groundwater. Here we use the δD composition of *n*-alkanes from epicuticular plant waxes to reconstruct the δD of precipitation in Cenozoic basins that have been elevated as part of the Tibetan plateau. These precipitation δD ratios are converted to estimates of paleoelevation using the isotope-altitude relationship derived from a simple thermodynamic model that calculates the isotopic composition of water vapor and precipitation as an air parcel is lifted in the atmosphere (Rowley *et al.*, 2001).

Samples of Cenozoic lacustrine limestones from the Lunpola and Hoh-Xil basins on the Tibetan Plateau were analyzed for plant-wax δD paleoaltimetry. *n*-Alkane distributions exhibit a short-chain maximum with no odd/even preference (OEP) and a long chain maximum (C_{29} or C_{31}) with a strong OEP. The long- and short-chain maxima and OEP are typical of modern lake sediments that receive organic material from both terrestrial plants (C_{29-33}, high OEP) and aquatic sources (C_{16-18}, low OEP). Low thermal maturity of the samples is indicated by sterane and hopane maturation indices while preservation of the D/H signal is documented by the D/H offset between *n*-alkyl and isoprenoid biomarkers (Pedentchouk *et al.*, 2006).

Simultaneous molecular δD and carbonate $\delta^{18}O$ determinations (Rowley & Currie, 2006) of meteoric water composition from the Lunpola basin show excellent agreement despite their distinct source waters (precipitation vs. lake water), materials (calcite vs. organic molecules), modes of incorporation (mineral precipitation vs. biosynthesis) and diagenetic pathways. The similarity of the paleoaltimetry results from both the carbonate $\delta^{18}O$ and biomarker δD analyses provides strong support for the presence of an unaltered precipitation signal in both archives. We have also analyzed molecular D/H ratios on Miocene samples from the Hoh-Xil basin for which no other paleoaltimetry data are available. Our results for these samples indicate elevations >3.5 km, demonstrating the basin was near its present elevation by the late-Miocene. By comparison, Cyr et al. (2005) reconstructed late-Eocene elevations for the Hoh-Xil basin of < 2 km based upon the $\delta^{18}O$ of lacustrine limestones. This difference in elevation is consistent with uplift of the basin ~25 Ma, as predicted by scaling plateau width to India-Asia convergence (Rowley & Currie, 2006). Our results show that lipid biomarker D/H ratios can be used to reconstruct paleoelevation. In addition, our findings support a time-transgress model for plateau growth that scales the width of the plateau to the convergence of the Indian and Eurasian lithospheric plates.

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