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Late Cenozoic environmental change in southwestern Tibet: Evidence from stable isotopes

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The uplift of the Himalayan-Tibetan Plateau has been suggested to be a major driving mechanism of regional and global climate change during the late Cenozoic. However, the timing history of the uplift of the plateau remains a matter of considerable debate because there are few direct indicators of paleo-topography in geological record. Reconstructing the paleo-environment and the elevation history of the plateau can improve our understanding of the linkage among tectonic, climatic and biotic changes. Here we report the results from isotopic analyses of a mid-Pliocene fauna recently uncovered from the Zanda Basin in southwestern Tibet. The $\delta^{13}C$ values of tooth enamel from fossil mammals show that these ancient mammals, just like modern herbivores in the area, fed primarily on C_3 vegetation and lived in an environment dominated by C_3 plants. Taking into account the changes in the $\delta^{13}C$ of atmospheric CO_2 in the past, the enamel-$\delta^{13}C$ values suggest that the average modern-equivalent $\delta^{13}C$ value of C_3 vegetation in the area in the mid-Pliocene was 0.5-1.1?lower than that of the C_3 biomass in the basin today, implying a reduction in annual precipitation by about 100-200 mm in the area since then (assuming the modern C_3 $\delta^{13}C$–precipitation relationship applied to the past). An increase in aridity is also supported by the enamel oxygen isotope data that show a significant shift to higher $\delta^{18}O$ values after ~3-4 Ma. Paleo-temperature estimates derived from a fossil bone-based oxygen-isotope temperature proxy as well as the carbonate clumped isotope thermometer for the mid-Pliocene are higher than the present-day mean annual temperature in the area. After accounting for late Cenozoic global temperature change, these paleo-temperature estimates suggest that the paleo-elevation of the Zanda Basin in the mid-Pliocene was similar to or slightly (less than ~1 km) lower than its present-day elevation. The results provide new insights into the environmental and tectonic evolution of the area from the mid-Pliocene to the present.

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