Increased aridity across the Pliocene and Pleistocene is thought to have had a major influence on human evolution in Africa. However, there are few proxies for aridity that record the specific environments in which hominins lived. The δ¹⁸O values of fossil teeth are commonly used as aridity proxies, but this approach is limited because the δ¹⁸O values of waters that animals ingest are influenced by multiple factors besides aridity, including rainfall amount, moisture source, elevation and continentality. The measurement of δ¹⁷O along with δ¹⁸O values can provide additional constraints on the factors that influence oxygen isotopes in biominerals and the waters from which they form. The relationship between δ¹⁸O and δ¹⁷O varies between equilibrium and kinetic processes, such that evaporation (a process involving kinetic fractionation) has a distinct triple oxygen isotope signature. Δ¹⁷O is the deviation from an expected relationship between δ¹⁸O and δ¹⁷O, defined as Δ¹⁷O = δ¹⁷O - 0.528 x δ¹⁸O, where δ¹⁸O = 1000 x ln(δ¹⁸O/1000 + 1). Δ¹⁷O values of waters (e.g., meteoric waters, leaf waters) become more negative as evaporation increases.

We analyzed Δ¹⁷O values of teeth from Africa and the US to explore 1) whether there is a clear leaf water Δ¹⁷O evaporation signal and 2) the influence of input water δ¹⁸O on this signal. We targeted teeth from herbivores with different water use strategies (giraffe, hippo, elephant, wildebeest, hartebeest, oryx, deer, beaver and bison) across gradients in aridity and in local meteoric water δ¹⁸O values. Teeth range in Δ¹⁷O from -0.29 to -0.13‰ and from 30.9 to 47.1‰ for δ¹⁸O (VSMOW). Evaporation-sensitive taxa (ES) have more negative Δ¹⁷O values than evaporation-insensitive taxa from the same location. This difference increases as MAP decreases. This relationship is mostly independent of the δ¹⁸O values of local meteoric water. We observe a decrease in Δ¹⁷O values of ES teeth with decreasing MAP, as expected from a Δ¹⁷O body water model. The observed range in enamel Δ¹⁷O values is similar to that of leaf water Δ¹⁷O values (≤0.3‰), but much larger than the typical range of Δ¹⁷O values observed for meteoric waters at mid and low latitudes (≤0.06‰). Given these relationships we view Δ¹⁷O as a promising tool for reconstructing aridity, specifically when δ¹⁸O values of local meteoric water are not known.