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TRIPLE OXYGEN ISOTOPES IN TEETH: IMPLICATIONS FOR RECONSTRUCTING PALEOARIDITY

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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 $\delta^{18}O$ values of fossil teeth are commonly used as aridity proxies, but this approach is limited because the $\delta^{18}O$ values of waters that animals ingest are influenced by multiple factors besides aridity, including rainfall amount, moisture source, elevation and continentality. The measurement of $\delta^{17}O$ along with $\delta^{18}O$ values can provide additional constraints on the factors that influence oxygen isotopes in biominerals and the waters from which they form. The relationship between $\delta^{18}O$ and $\delta^{17}O$ varies between equilibrium and kinetic processes, such that evaporation (a process involving kinetic fractionation) has a distinct triple oxygen isotope signature. $\Delta^{17}O$ is the deviation from an expected relationship between $\delta'^{18}O$ and $\delta'^{17}O$, defined as $\Delta^{17}O = \delta'^{17}O - 0.528 \times \delta'^{18}O$, where $\delta' = 1000 \times \ln(\delta/1000 + 1)$. $\Delta^{17}O$ values of waters (e.g., meteoric waters, leaf waters) become more negative as evaporation increases.

We analyzed $\Delta^{17}O$ values of teeth from Africa and the US to explore 1) whether there is a clear leaf water $\Delta^{17}O$ evaporation signal and 2) the influence of input water $\delta^{18}O$ 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 $\delta^{18}O$ values. Teeth range in $\Delta^{17}O$ from -0.29 to -0.13‰ and from 30.9 to 47.1‰ for $\delta^{18}O$ (VSMOW). Evaporation-sensitive taxa (ES) have more negative $\Delta^{17}O$ values than evaporation-insensitive taxa from the same location. This difference increases as MAP decreases. This relationship is mostly independent of the $\delta^{18}O$ values of local meteoric water. We observe a decrease in $\Delta^{17}O$ values of ES teeth with decreasing MAP, as expected from a $\Delta^{17}O$ body water model. The observed range in enamel $\Delta^{17}O$ values is similar to that of leaf water $\Delta^{17}O$ values (≤0.3‰), but much larger than the typical range of $\Delta^{17}O$ values observed for meteoric waters at mid and low latitudes (≤0.06‰). Given these relationships we view $\Delta^{17}O$ as a promising tool for reconstructing aridity, specifically when $\delta^{18}O$ values of local meteoric water are not known.

Session No. 102

T195. Paleoenvironmental Reconstruction of Hominin Sites: New Methods, New Data, and New Insights I
Monday, 2 November 2015: 8:00 AM-12:00 PM

Room 324 (Baltimore Convention Center)

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