Goldschmidt Conference, Boston, MA, August 12-17, 2018

The carbon isotope value of whole wood versus cellulose as a proxy for environmental change

William E. Lukens, Peace Eze, and Brian A. Schubert

School of Geosciences, University of Louisiana at Lafayette, Lafayette, LA 70504

The carbon isotope ($\delta^{13}C$) value of modern and fossil wood is widely used an indicator of atmospheric and climatic change. To expedite high-resolution sampling and generate long-term records, many workers measure the $\delta^{13}C$ value in whole wood, rather than in chemically extracted cellulose. Comparison of these records in annually dated cores of living trees suggests a constant offset between cellulose and whole wood, but it is unknown how this offset changes during wood decomposition. Fossil wood typically contains less cellulose than modern wood, and is mostly composed of chemically resistant lignin; these diagenetic changes might affect the $\delta^{13}C$ value of whole wood and consequently, interpretations of environmental change.

Here we present new $\delta^{13}C$ data on cellulose and whole wood from well-preserved fossil (mummified) wood samples recovered from Eocene to Holocene aged sediments and compare these data to cellulose and whole wood $\delta^{13}C$ values compiled from the literature (n = 867 pairs). We find a significantly larger offset (whole wood – cellulose) in fossil wood compared with modern wood (2.4 ± 0.5‰ versus 1.4 ± 0.5‰, respectively; $p < 0.0001$), consistent with loss of ^{13}C-enriched cellulose, and corroborated by lower cellulose yields in the fossil samples. The calculated slope values (whole wood versus cellulose), however, do not differ significantly from 1 for either dataset, suggesting that the offset is independent of $\delta^{13}C$ value, and therefore not affected by atmospheric CO_2 levels, climate, or plant type.

Although the offsets differ between modern and fossil wood, the consistency of these values across a wide range of ages and environments suggests that relative changes in $\delta^{13}C$ value of whole wood preserve environmental change during growth. We test this hypothesis via an empirical model for seasonal climate based on intra-ring $\delta^{13}C$ patterns and show that calculated seasonal climate is indistinguishable when using cellulose versus whole wood. This work demonstrates significant potential for extracting paleoenvironmental information from fossil wood of varying preservation states.