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Prediction of atmospheric $\delta^{13}CO_2$ using plant cuticle isolated from fluvial sediment: Tests across a gradient in salt content

A. Hope Jahren[1]* and Nan Crystal Arens[2]

[1]University of Hawaii, Department of Geology and Geophysics, Honolulu, Hawaii, 96822, USA; [2]Hobart and William Smith Colleges, Department of Geosciences, Geneva, New York, 14456, USA
e-mail: jahren@hawaii.edu
**Corresponding author.*

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ABSTRACT

In order to test the assertion that the carbon-isotopic composition of the ancient atmosphere ($\delta^{13}CO_2$) can be reconstructed from the carbon-isotopic composition of fossil terrestrial plant tissues across a variety of environments, the $\delta^{13}C$ value of land-plant tissues isolated from modern fluvial sediments was compared to that of today's atmosphere. Plant stem and leaf fragments were isolated from organic carbon-rich sediments of the Black River in Jamaica, which drains a basin containing only C3 ecosystems. Sediment was sampled at 12 sites along a dissolved salt-content gradient, from the coastal plain to near its mouth, which allowed evaluation of the effect of salt influence on the organic carbon-isotope signature. Many properties of the sediment varied systematically with salt content (e.g., mass-percent carbonate, abundance of palynomorphs, $\delta^{13}C$ and $\delta^{18}O$ values of carbonate), confirming a significant and increasing marine influence closer to the mouth of the river. The $\delta^{13}C$ value of total organic carbon systematically decreased by ~2‰ with increased NaCl concentration, indicating the presence of a mixing line between marine and terrestrial organic inputs. In contrast, for leaf and stem isolates, there was no significant dependence of $\delta^{13}C$ value on NaCl concentration, suggesting that the isotopic signature of the integrated terrestrial contribution is independent of the salt content of the depositional environment. The mean values of all isolates retrieved from the sediments predicted a $\delta^{13}CO_2$ value of −9.7 (±1.0) for leaf material and −8.2 (±1.7) for stems. Both of these values are within ~1‰ of recent regional-scale measurements of atmospheric $\delta^{13}CO_2$ value.