Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.22340

Stable Isotope Analysis of Fossilized Plants for C Cycling and N Soil Nutrient Availability During the Phanerozoic

ALEXANDRA M GRAJALES AND BENJAMIN W JOHNSON

Iowa State University

Presenting Author: grajales@iastate.edu

Plants play a crucial role in Earth's geochemical cycling. Plant growth is dependent on their ability to absorb and fix atmospheric carbon dioxide (CO_2) and obtain nitrogen (N) from soils. The combined reliance on C and N directly affects plant development and may reflect environmental and atmospheric conditions. Carbon and N in plants can have specific isotopic signatures that depend on nutrient source, which are recorded inside the plants cell tissue throughout maturity, death, and fossilization. One such signature is a correlation between the discrimination factor ($\Delta^{13}C$ = atmospheric $^{13}C_{CO2}$ - ^{13}C in leaf tissue) and leaf N content. Since N is necessary for building proteins involved in photosynthesis, low concentrations of N lead to a decreased photosynthetic rate causing a negative correlation between $\Delta^{13}C$ and N concentrations in leaf tissue [1]. Therefore, analyses of fossilized plant C and N composition may provide valuable constraints on the evolution of atmospheric $^{13}C_{CO2}$ and soil N availability through time. By knowing atmospheric $^{13}C_{CO2}$ and its relationship with N soil availability, further studies can be performed to understand the diverse plant lineages through time, as well as provide deeper insight into the evolutionary process behind the development of plant metabolic pathways. We completed isotopic and concentration measurements for C and N on 56 fossilized plants. All ^{13}C values from fossil material are within the range for modern C_3 photosynthetic plants (-21.7 to -36.8‰) and show a decreasing trend through time. Values of $\Delta^{13}C$ were then obtained using observed relationships between $\Delta^{13}C$ and N concentrations per area in modern trees. The $^{13}C_{CO2}$ of the atmosphere was determined from these calculations and results are consistent with existing records for evolving atmospheric $^{13}C_{CO2}$, where $^{13}C_{CO2}$ has been slowly decreasing towards the present. These preliminary results indicate that fossilized plant tissue is a potential proxy for atmospheric $^{13}C_{CO2}$ during the Phanerozoic, that can help fill the gaps in existing proxy records.

[1] Sparks & Ehleringer (1997), *Oecologia,* 109