The stable carbon isotope composition of soil organic carbon and pedogenic carbonates along a bioclimatic gradient in the Palouse region, Washington State, USA

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Abstract

Isotopic signatures of soil components are commonly used to infer past ecologic and climatic shifts in the soil record. The theory behind the fractionation of isotopes that occurs during ecosystem processes is well understood; however, few isotopic studies have explored ecosystem relationships in modern soils. We discuss relationships of stable carbon isotopic signatures in plant tissue, soil organic carbon (SOC), laboratory-respired CO2, and modern carbonates at 10 sites (seven containing pedogenic carbonates) along a C3-dominated climatic gradient (mean annual precipitation (MAP) ranging from 200 to 1000 mm) in the Palouse region of eastern Washington state.

A horizon soil organic carbon (SOC) *É¬*13C values varied from -24.3‰ to -25.9‰ PDB. Values in the arid portion of the gradient (200 to approximately 500 mm MAP) generally decreased and linear regression of SOM 13C vs. MAP was significant ($r2=0.71$, $p=0.02$). Trends in plant-13C of two grass species (*Agropyron spicatum* and *Festuca idahoensis*) found throughout this portion of the gradient were similar to that of SOC. Mean pedogenic carbonate *É¬*13C values varied from -4.1‰ to -10.8‰ PDB. Linear regression was significant for carbonate 13C vs. MAP ($r2=0.79$, $p=0.007$), estimated above-ground productivity ($r2=0.88$, $p=0.002$) and soil carbon content ($r2=0.83$, $p=0.004$). Carbonate *É¬*13C values at the most arid site exhibited higher variability than other sites (presumably due to greater spatial variation in plant respiration vs. atmospheric diffusion). Our data suggest that carbon isotopic relationships among ecosystem components may prove useful in determining ecosystem level properties in modern systems, and potentially in ancient systems as well.

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