Microbial CO_2 fixation can influence subsoil radiocarbon signatures in Amazon tropical rainforest soils

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Radiocarbon (^{14}C) is a crucial tool for tracing the global carbon cycle. Due it is half-life of 5730 years as well as the sudden increase of ^{14}C after nuclear weapon testing, it allows for dating past and present sources and sinks of ^{14}C in terrestrial and marine ecosystems, like the soil organic matter (SOM) pool. However, many processes, which control the distribution of radiocarbon through the soil profile, remain unclear. Microorganisms are an important source of SOM, especially in subsoils. We investigated the process of microbial CO_2-fixation, i.e. the microbial assimilation of pore space CO_2 for cell growth or maintenance, and its potential to influence the isotopic, i.e. radiocarbon and stable carbon isotope composition of microbial biomass and SOM in Amazonian rainforest soils. ^{14}C of organic matter in these soils decreased with depth, from values indicating a predominance of 'bomb' ^{14}C (Fraction Modern >1.0) at the surface to 0.58 Fraction Modern (mean ^{14}C age of ~4500 years) at 1 m depth.

Rates of CO_2 fixation were greatest at the surface and decreased with depth. Measured rates were constant over a time period of 7 to 90 days but did vary with soil moisture content and drainage, as well as the amount of C in microbial biomass. Extrapolated annually, these rates could replace all C in microbial biomass in decades (10-50 years) and all C in SOM in ~800 years.

16S rRNA targeted pyrosequencing of DNA extracted from plateau soils after incubation indicated that heterotrophic CO_2 fixation is likely to be the process responsible for CO_2 uptake, at least in surface soils.

The observed rates of CO_2 fixation prove that pore space $^{14}CO_2$ fixation into microbial biomass is sufficient to explain the radiocarbon signature of deep subsoil organic matter, assuming all other organic matter is inherited from sedimentary parent material.