Ancient calcified roots reveal long-term rhizomicrobial activity in the deep subsoil

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Deep-rooting plants potentially store large amounts of CO_2 in the subsoil[1]. Root-associated microorganisms, however, might enhance carbon (C) mineralization and thus entail net C loss. Organic matter stabilization and destabilization processes have been studied for the topsoil, but are largely unknown for the subsoil[2] at depths >> 2 m, including soil parent material. Calcified roots (rhizoliths), which form under arid to semihumid climate as a typical feature of terrestrial sediments, offer the possibility to study long-term effects of root penetration due to the preservation of root and rhizomicrobial remains.

The current study comprises several state-of-the-art techniques like bacterial DNA and lipid molecular proxies to trace remains of microbial biomass in ancient root systems throughout a loess-paleosol sequence in SW Germany. This sequence has been penetrated by several generations of roots since the last glacial maximum. Phospholipid fatty acids, DNA and intact polar glycerol dialkyl glycerol tetraethers argue for the presence of microorganisms in the rhizosphere not only of living but also ancient (≥ 3 ka) roots. Especially in depths with high rhizolith abundances (up to 200 m^{-2}), rhizomicrobial degradation led to a decrease in bulk C, whereas net C enrichment occurred in the rhizosphere at depth intervals of lower root feature abundances due to lower microbial activity. Thus, in terrestrial sediments poor in organic C, penetration by deep-rooting plants can entail long-term OM dynamics and consequently C depletion or stabilization, depending on root abundances.

[1] Kell (2012) *Phil. Trans. R. Soc. B* **367**, 1589-1597. [2] Rumpel & Kögel-Knabner (2011) *Plant Soil* **338**, 143-158.