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Postsedimentary incorporated root and rhizomicrobial remains influence composition of loess organic matter – an approach based on lipid molecular proxies

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Organic carbon (Corg) in loess-paleosol sequences is frequently used to study paleovegetation and paleoenvironmental change during Quaternary, assuming that loess organic matter derived from aboveground biomass of synsedimentary vegetation. Contrary to this traditional hypothesis, recent studies showed that postsedimentary deep-rooting plants can contribute considerable amounts of organic matter (OM) to the subsoil via roots and associated microbial biomass. This becomes evident when regarding rhizoliths, a special type of pedogenic carbonates formed by encrustation of roots with secondary $CaCO_3$. The carbonate crust led to preservation of former root tissue, allowing assessment of rhizosphere processes and OM accumulated during the root's lifetime. We hypothesized that rhizosphere effects in loess-paleosol sequences can be quantified at a molecular level.

At the late Pleistocene Nussloch section, rhizoliths occur locally abundant. Several transects, comprising rhizoliths, surrounding loess (rhizoloess) up to a distance of 10 cm from rhizoliths, and root-free reference loess, were sampled between 1 and 13 m depth and analysed for their C, n-alkane and fatty acid composition. These lipid fractions are frequently used to assess and quantify OM remains in sediments because of their relative recalcitrance.

Rather uniform lipid composition in reference loess indicated its origin from grass aboveground biomass. In contrast, lipid composition of rhizoliths showed strong variation with depth, impeding a general source attribution of rhizoliths. However, several proxies including C27 as most abundant long chain n-alkane in some rhizoliths, as well as low values of average chain length and carbon perference index, indicated that rhizoliths were formed around roots of shrubs or trees. First results indicated that the former rhizosphere extended up to several cm from preserved rhizoliths. High variation in rhizolith abundance (up to 190 m-2) and size (mm to 5 cm in diameter) with depth are the reason why portions of rhizomicrobial deposits in rhizoloess, i.e. overprint of LOM, and radius of former rhizosphere are dissimilar with depth and depend on amount of preserved root remains.

These results raise the importance of deep-rooting plants as a possible source for the deep subsoil organic carbon pool. Attention should be paid to the potential of root and rhizomicrobial remains to overprint original LOM composition, thus entailing uncertainties in paleoenvironmental studies.