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In the long term root-related priming can lead to carbon loss and chemical alterations in the deep subsoil

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Recent publications and reviews concern the major importance of the deep subsoil for carbon (C) storage and cycling in terrestrial environments. However, the subsoil (below A horizon) and especially the deep subsoil (> 1m) is a target not easy to study and especially the relevant processes therein. Therefore, in the current study we focussed on recent and ancient root systems extending in terrestrial sediments until 9 m depth below the present surface and more than 7 m below the present soil. We sampled rhizosphere in the direct vicinity of the roots and with increasing distance (up to 10 cm) from visible root remains, and determined the root frequency in different depths. Additionally, sedimentary material without visible root remains was sampled for each of these depth intervals, and all samples were analysed for C contents and lipid composition. Main aim of the study was to obtain information of root effects on C content and composition in the deep subsoil.
The loess-paleosol sequence of Nussloch (SW Germany) with a Cambisol on its top was chosen as a key site as recent and ancient roots were easy to assess and to differentiate. Furthermore, two sites near Sopron (NW Hungary) were sampled for recent tree roots rooting deeply (at least 4 m) into loess sediment. All samples were investigated for Corg, Ccarb and extractable lipid contents and the lipid composition.
The frequency of recent roots strongly decreased with depth in the Nussloch profile until zero at 2 m depth below the present soil surface as recent tree vegetation was rather young (<7 years). In comparison to this, ancient tree root remains, frequently visible as carbonate precipitates surrounding the former roots, could be observed continuously until 9 m depth with the largest frequency (∼200 roots m-2) at 2-3 m depth. However, only root remains of a diameter larger than 1 mm were counted, thus highly underestimating fine root remains, which were not counted throughout the profile due to their high frequency (»10,000 m-2). In the rhizosphere of former and recent roots, Corg tended to slightly decrease compared to reference sediment. Ccarb contents revealed in some depths slight changes in the rhizosphere. Especially the precipitates surrounding the former roots were strongly enriched in Ccarb although the investigated sediments were rich in carbonate (20-40 mass-%). Taking into account the rhizolith frequency (only of the carbonate precipitates >1 mm), the bulk density, the carbon concentrations and the estimated extension of the rhizosphere, a decrease of more than 1 kg C m-2 was determined in the rhizosphere by comparison to root-free loess. The C loss was mainly related to the more depth intervals with densely occurring large root remains (>20 m-2) at a depth of less than 5 m, whereas in larger depth intervals with a lower frequency of root remains C contents slightly increased in the rhizosphere.
Despite the high C storage in deep subsoil, root related processes might alter the chemical composition in the subsoil and can result in C loss in the long term.