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Retention and stabilization of C-14 labeled dissolved organic carbon in two soil horizons with contrasting contents of pedogenic oxides

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The knowledge about retention of dissolved organic carbon (DOC) in mineral soil horizons and its subsequent stabilization against microbial decay is scarce and based almost solely on batch experiments. We hypothesized that the content of pedogenic oxides is a major control of DOC retention and stabilization in soils. We proved our hypothesis in a soil column experiment using 14C labeled DOC from leaf litter leachate and two mineral horizons with either large (Bl; oxide-rich) or small (EBrg; oxide-poor) contents of pedogenic Fe and Al oxides (Fe oxides: 0.4 vs. 22.3 g kg-1, Al oxides: 2 vs. 5.6 g kg-1). After 53 days of leaching we calculated a complete C budget of the applied 14C tracer. In the soil columns 49% ($\pm$2.4%) and 31% ($\pm$1.5%) of the applied DOC was retained in the Bl horizon and EBrg, respectively. In the oxide-poor soil the retention of DOC decreased only to roughly two third in comparison to the oxide-rich soil although the stocks of Fe oxides were 3% of those in the oxide-rich soil. However, the difference in DOC retention in the oxide-poor soils was similar to the difference in the stocks of Al oxides. We found indications that besides sorption on Al oxides also precipitation of DOC by Al might be an important mechanism of DOC retention in these acidic soils having a pH of less than 4. Mineralization of the retained DOC was only 3% in both soils. Therefore, the applied DOC from leaf litter was effectively stabilized against microbial decay in both soils. Stabilization of DOC could be directly related to the proportion of its retention in the soil. Stabilization occurred despite large C contents in the soil of up to 43 g kg-1. Our experiment highlights the importance of pedogenic oxides for retention and stabilization of DOC in mineral soils. Our results indicate that relatively small contents of pedogenic oxides are sufficient for effective retention and stabilization. Aluminum oxides might be more important for stabilization of DOC than Fe oxides at least in soils with small contents of pedogenic oxides.