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Organic matter composition of matrix-macropore interfaces in structured subsoils

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In structured soils, the interaction of percolating water and reactive solutes with the soil matrix is mostly restricted to surfaces of preferential flow paths. Surfaces of flow paths that are formed by cracks, decayed root channels or worm burrows are often covered by clay-organic coatings (i.e. cutanes), in which the outermost layer is mainly organic matter (OM). The composition of OM finally controls wettability, sorption, and transfer properties and thus may influence the water movement in structured soils. However, the in-situ local distribution of OM properties along such surfaces is largely unknown to date because experimental techniques to study the relatively thin and vulnerable coatings at intact structure surfaces were not available. The objective of this study was to analyze the local mm-scale OM distribution and composition at preferential flow paths of structured subsoils. We took samples from different soil types (Luvisol, Regosol, Stagnosol, Cambisol), of different geological provenance (till, loess, mudstone, limestone), and of different land use (arable, forest). The Fourier transformed infrared spectroscopy in diffuse reflectance mode (DRIFT) was used to determine spectral information in 1 mm steps along transects of 15 up to 65 mm length along the intact structural surfaces (cracks and biopores). The distribution of OM composition was characterized by evaluating the ratios of the absorption band intensities of the alkyl- (C-H-) and carbonyl (C=O-) functional groups (CH/CO), which represent a measure of the potential wettability of the OM of the surface. In general the CH/CO-ratios were higher for earthworm burrows and root channels as compared to crack surfaces and the soil matrix. Earthworm burrows of soils developed on loess (Haplic Luvisol) showed higher CH/CO-ratios than soils developed on till (Haplic Regosol, Albic Luvisol); the highest CH/CO-ratios occurred at worm burrows of both a Vertic Stagnosol and a Vertic Cambisol (mudstone, respectively). In case of the same structures and the same parent material, the CH/CO-ratios were higher for forest as compared to arable soil. The results suggest that the distribution of OM properties at flow path surfaces has to be considered for describing preferential flow and transport because they could affect sorption and mass transfer processes.