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Impact of phenanthrene on the properties of biogeochemical interfaces in soil: A two-layer column study

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Biogeochemical interfaces in soils (Totsche et al. 2010) are the "hot spots" of microbial activity and the processing of organic compounds in soils. The production and relocation of mobile organic matter (MOM) and biocolloids like microorganisms are key processes for the formation and depth propagation of biogeochemical interfaces in soils (BGI). Phenanthrene (PHE) has been shown to affect microbial communities in soils (Ding et al. 2012) and may induce shifts in MOM quantity and quality (amount, type and properties of MOM). We hypothesize that the properties of BGI in soil change significantly due to the presence of PHE. The objectives of this study are (i) to evaluate the effect of PHE on soil microbial communities and on MOM quantity and quality under flow conditions with single- and two-layer column experiments and (ii) to assess the role of these processes for the physicochemical, mechanical and sorptive properties of BGI in soils. The soil columns were operated under water-unsaturated conditions. The top layer (source layer, SL, 2 cm) is made of sieved soil material (Luvisol, Scheyern, Germany) spiked with PHE (0.2 mg/g). The bottom layer (reception layer, RL, 10 cm) comprised the same soil without PHE. PHE-free columns were conducted in parallel as reference.
Release and transport of MOM in mature soil of a single-layer column experiment was found to depend on the transport regime. The release of larger sized MOM (>0.45 μm) was restricted to an increased residence time during flow interruptions. Steady flow conditions favor the release of smaller MOM (<0.45 μm). Compared to the reference, in the two-layer column experiments higher OC concentrations were detected in the effluent from PHE spiked columns after enhanced flow interruptions (26d, 52d). That indicated the PHE influenced production or mobilization of MOM. Parallel factor analysis of fluorescence excitation and emission matrices revealed the presence of a constant DOM background and two new unknown components in the effluent, probably PHE metabolites. The emergence of new components emphasizes the role of metabolization processes in the release of MOM. The identification of key microbial actors and communities are currently in progress.

Totsche, K.U. et al. (2010): Biogeochemical interfaces in soil: The interdisciplinary challenge for soil science. J. Plant Nutr. Soil Sci., 173(1), 88-99

Ding, G.-C., Heuer, H. & Smalla, K. (2012): Dynamics of bacterial communities in two unpolluted soils after spiking with phenanthrene: soil type specific and common responders. Front Microbio 10.3389/fmicb.2012.00290.