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Release and transport of mobile organic matter and biocolloids: A combined physicochemical and microbiological study

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Biogeochemical interfaces within the aggregate system of soils are “hot spots” of microbial activity and turnover of organic matter. We explore turnover, release and transport of mobile organic matter (MOM), micro-organisms (bio-colloids) and organo-mineral associations using a novel experimental approach employing two-layer columns experiment with matured soil under unsaturated flow conditions. The top layer was spiked with phenanthrene as a tracer for studying the decomposer communities involved in the decomposition of aromatic compounds that derive from lignin in natural systems. Columns were irrigated with artificial rain water with several flow interrupts of different durations. Physicochemical and chemical parameters as well as the microbial community composition were analysed in effluent samples and in soil slices. Release of MOM from the columns was in general controlled by non-equilibrium. Export of total and dissolved organic matter differed significantly in response to the flow interrupts. Effluent comprised organic and organo-mineral components as well as vital competent cells. By molecular biological methods we were even able to show that bacterial consortia exported are rather divers. Depth distribution of the bacterial communities associated with the immobile solid phase indicated high similarities in bacterial communities of the different depth layers and treatments. According to phenanthrene high affinity to the immobile phases, only a small fraction was subject to downstream transport with a strong decrease of the amount residing at the solid phase Our experiments directly prove that intact and competent microorganisms and even communities can be transported under unsaturated flow conditions. Moreover, we found that the dominant carbon source will impact not only the activity of specific microbial taxa but also their mobilization and transport. While total contribution of microbial organism to the mobile organic matter pool seems to be small, the fact that microbes will be mobilized and passively transported to downstream compartments helps to understand the processes that result in the inhabitation of pristine surfaces, thereby resulting in the establishment biogeochemical interfaces and initiation of aggregation in downstream compartments in the vadose zone.