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Emerging Organic Contaminants - Influence of flow velocity and sediment on transport in groundwater

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The presence of pharmaceuticals in the environment is of emerging public concern. Still, the transfer and fate of these and other emerging organic contaminants (EOCs) in water bodies are not well known yet. Improving the understanding of observed concentration patterns in heterogeneous and dynamic field studies requires the knowledge of crucial processes and parameters that are, however, difficult to determine at complex field sites. Therefore, laboratory experiments can help to identify sorption and biodegradation parameters for various hydrological conditions. The objective was to determine sorption parameters and degradation rates of selected pharmaceuticals in well controlled laboratory experiments. In particular, the impact of flow velocities and sediment type on sorption and degradation rates of selected compounds was studied. Column experiments were performed at three different flow velocities, under abiotic and biotic conditions, and applying conservative (bromide, uranine) and reactive tracers (selected EOCs).For the experiments three different sediment types were selected (coarse quartz sand; medium sand; sandy loam). From tracer breakthrough curves and mathematical modelling reactive transport parameters were determined. Observed concentrations and recoveries of atenolol and clofibrate were low and indicating that sorption and degradation highly influence their transport in the sandy loam. Diclofenac, caffeine and carbamazepine were also affected by sorption and degradation but to a lesser extent than atenolol and clofibrate. Sulfamethoxazole, ketoprofen and antipyrine were recovered almost completely, revealing less impact of these transport processes. Biodegradation was negligible for all the compounds because results from biotic and abiotic column experiments were similar. Different retardation factors of the compounds emphasize the importance of considering chemical and sediment properties when assessing sorption of these compounds. We also found that most of the compounds were not influenced by different flow velocities. Only peak values and recoveries of atenolol were decreasing from the highest flow rate tested to the lowest flow rate tested. This impact was not visible for the modelled degradation rates and retardation factors revealing that not the flow velocity but the mean transit time was the most important factor influencing its transport.