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Trace compounds in groundwater as indicators for transport processes on the catchment scale

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Transport processes on the catchment scale are usually difficult to quantify due to the multitude of processes that influence these processes. Laboratory experiments help to elucidate the general type of process but upscaling is of these results leads to ambiguous interpretation. Therefore, a combination of field scale experiments and additional laboratory column experiments yielded best results for interpretation of occurrence of trace compounds in groundwater.

Due to the multitude of compounds introduced into the aquatic system via sewage treatment, agriculture, or atmospheric input, many organic and inorganic compounds can be detected in groundwater and surface water in trace concentrations. Pharmaceutically active substances and metabolites are found at concentrations up to the microgram/L-level in groundwater samples from the Nuthegraben lowland area south of Berlin (Germany). Among the compounds detected in groundwater are clofibric acid (blood lipid regulator), diclofenac (anti-inflammatory), carbamazepine and primidone (both antiepileptic drugs). Pharmaceuticals are measured up to the mg/L range in surface and groundwater. However, concentrations detected in groundwater are generally much lower and there is significant variation in the distribution of pharmaceuticals in groundwater.

Groundwater and surface water was sampled for the main ions, for organic carbon and selected trace substances. Experiments in the laboratory were conducted using sediment material from the Berlin area to evaluate the transport and sorption behavior of selected drugs in the aquifer under conditions comparable to those in the Nuthegraben area. Results of the column experiments show that clofibric acid exhibits no degradation and almost no retardation (Rf = 1.1). Diclofenac shows quite high retardation at lower pH values indicating that most of diclofenac was sorbed in the unsaturated zone. Carbamazepine shows no degradation in the soil column experiments but significant retardation under the prevailing conditions. Based on carbamazepine and primidone concentrations we conclude that groundwater has been effected significantly by former land use practices whereas actual land use has only minor influence. The hydrochemical zones in groundwater, an aerobic zone near the groundwater surface and anaerobic conditions downstream lead to a specific set of compounds detected in the different zones, especially due to their different degradation behavior in these zones.