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Identification of significant transport processes for organic micropollutant classes during soil aquifer treatment (SAT) – a controlled field experiment

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Supplementing existing water resources with alternative sources of water is a challenge in semi-arid areas, as deterioration of water quality must be avoided. Soil aquifer treatment (SAT) can greatly improve the quality of the injected water by attenuation of organic pollutants via sorption and degradation processes. However, only little is known about the specific transport processes of organic micropollutants under artificial recharge conditions. Organic micropollutants such as pharmaceuticals and their metabolites exhibit a wide range of chemical properties and may undergo very different environmental processes resulting in specific reactions within specified environments. In the presented study fate and transport processes of 25 organic micropollutants (iodinated contrast media, antihypertensive agents, antibiotics, anticonvulsants, lipid regulators, anti-inflammatories, antihistamines and analgesics) were investigated under SAT conditions in a controlled field experiment. Secondary treated effluent (STE) containing the compounds of interest was introduced into the aquifer by an infiltration pond and shallow wells in the vicinity were used for water quality monitoring. By means of strategic sampling procedure and a specialized multi-residue analytical method based on high-performance liquid chromatography / tandem mass spectrometry (LC/MS-MS) 3 main transport processes were identified:

1. Transport of non-polar compounds according to their respective octanol-water distribution coefficient (Kow)
2. Cation exchange
3. Colloidal transport

Identification of transport processes 2 & 3 was not expected to act as a transport controlling process. Results of the positively charged beta-blockers sotalol, atenolol and metoprolol gave clear evidence for cation exchange processes of the compounds with the aquifer material. Correlation of turbidity and concentrations of macrolide antibiotics (clarithromycin, erythromycin and roxithromycin) demonstrated the colloidal transport of the respective compounds. Concentrations of almost all micropollutants decreased with increasing soil passage. However, since compounds transported by processes 2 & 3 can be re-mobilized by changing water chemistry, the importance of a diligent characterisation of aquifer material and raw water is apparent for risk assessment.

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