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\subsection{Fate of the cyanobacterial toxin Microcystin-LR during bank filtration – column experiments and modelling}

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Over the past several years there has been an increasing interest in microcystins and other cyanobacterial toxins in surface waters and oxic groundwater. Since these compounds are strong hepatotoxic agents their presence in surface water is undesirable and can especially cause health problems if the contaminated surface water is used for drinking water abstraction by bank filtration. During the subsurface sediment passage microcystins are biodegraded by adapted microorganisms in a co-metabolic way together with other compounds – a process which causes depletion of oxygen in the sediment and production of anoxic zones in the underground. Presence or absence of oxygen as electron acceptor for microbial energetic metabolism is a crucial factor for degradation. Up to now most studies focused on the fate of microcystin under oxic conditions. But if during bank filtration anoxic zones occur, these approaches cannot be used for description and prediction of transport and degradation processes of microcystin in bank filtration sites.

For a better understanding of anoxic degradation of microcystins during subsurface sediment passage laboratory column experiments were designed to simulate the transport and degradation conditions in the aquifer. In small columns of about 20 cm length different cyanobacterial concentrations and potential electron acceptors are adjusted. The outflowing water was analyzed with respect to Microcystin-LR and the main ion concentrations. Transport and sorption parameters were investigated by flow experiments, and quantification of the main parameters was done by inverse modelling using a MATLAB inverse transport model.

Flow and sorption experiments reconfirmed that Microcystin-LR does not tend to sorb to the sandy material. Considering the anoxic degradation behaviour of the toxin the redox state of the system was assumed to be the most important factor and therefore varied during the experiments by adding supplemental nitrate or nitrite. The experiments showed that if nitrate is present in unrealistic high concentrations degradation of Microcystin-LR occurred much faster then without nitrate. Addition of saccharose as an extra energy source does not result in a decrease of microcystin, indicating, that anoxic biodegradation of Microcystin-LR is a co-metabolic process in which compounds that are easier to metabolize – like saccharose - are preferred by the present microorganisms.

Parameters of the degradation kinetics were quantified by creating an inverse MATLAB model basing on Monod kinetics with oxygen and nitrate as electron acceptors. First estimates were performed by direct modelling using the geochemical model PhreeqC.