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Investigations in the hyporheic zone of a low permeable riverbank

Stefan Banzhaf (1), Andreas Krein (2), and Traugott Scheytt (1)

(1) Technische Universität Berlin, Department of Applied Geosciences, Hydrogeology Research Group, Ackerstrasse 76, 13355 Berlin, Germany (s.banzhaf@tu-berlin.de), (2) Centre de Recherche Public - Gabriel Lippmann, Department of Environment and Agro-Biotechnologies (EVA), rue du Brill 41, 4422 Belvaux, Luxembourg

The interaction of groundwater and surface water in the hyporheic zone has attracted both hydrogeologists and hydrologists worldwide. The investigation of this complex system is of great interest as a lot of processes are observed which are relevant for the quality of both water bodies, influences by processes like retardation and degradation of contaminants. For example processes in the hyporheic zone affect the use of bank filtration for drinking water supply. However, this hyporheic zone is not yet fully understood in its function. A unifying model does not exist which encourages further research in this field. Furthermore most studies of hyporheic processes focus on the riverbed only and investigate sediments which have a high hydraulic permeability.
In the present field study in the Grand Duchy of Luxembourg the hydraulic and hydrochemical interactions of surface water and groundwater in the riverbank of an alluvial stream were investigated (BANZHAF et al., accepted). Hydraulic conductivities in the riverbank are low and the aquifer is confined. Gauged surface water levels and groundwater levels were recorded over several months to observe potential effluent and influent aquifer conditions. Water samples were taken under different hydraulic conditions in the stream and three observation wells in the riverbank. These samples were analysed for inorganic parameters and selected dissolved pharmaceuticals. The recorded groundwater levels in the riverbank responded almost without delay to changes in stream stage which is very dynamic with a range of nearly two metres. Frequent changes from effluent to influent aquifer conditions were observed during the investigation time. The detection of selected ions and pharmaceutical compounds support the assumption that the pharmaceuticals enter the riverbank via the stream only. The chosen trace elements are therefore suitable as anthropogenic tracers for groundwater and surface water interactions at this field site. They prove that water exchanges also take place in riverbanks even where the hydraulic conductivity is low and for this reason indicate the existence of a hyporheic zone in the investigated section of the stream.
In the next step of the study two multilevel observation wells were installed at the field site in Luxembourg in order to gain more detailed information about potential zoning or preferential flow paths in the riverbank. The wells both have three filter screens at different depths which each have a screen length of 10 cm. The uppermost screen is located below the lowest observed water level and the other two 1 and 2 m below the first, respectively. These wells also were sampled and analysed for ionic contents and some pharmaceuticals. One well shows depth-dependent trends for selected ions and pharmaceuticals whereas the other delivers indifferent results, which are probably due to inhomogeneities in the riverbank.
To investigate the transport behaviour of the pharmaceutical compounds detected on-site column experiments with sediment from the field site are currently conducted under defined conditions in the laboratory.

BANZHAF, S., KREIN, A. & SCHEYTT, T. (accepted). Investigative approaches to determine exchange processes in the hyporheic zone of a low permeability riverbank. Hydrogeology Journal.