Investigating bank infiltration using Gadolinium as anthropogenic tracer

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The use of Gadolinium complexes as a contrast agent in Magnetic Resonance Imaging (MRI) results in a Gd anomaly in the aquatic environment. Gd complexes are excreted by humans unmetabolized within 12h after application. Passing the sewage systems with almost no degradation, they successively reach surface waters, which make Gd a capable tracer for river bank filtration (RBF).

The investigated RBF system is located in a sub-alpine river valley in a rural catchment. The river is influenced by a waste water treatment plant, from which anthropogenic Gd permanently infiltrates into the glaciofluvial aquifer. The aquifer is characterized by high permeabilities and groundwater flow velocities. The field site was instrumented with ten rhizons along a transect in groundwater flow direction to allow for a high spatial and temporal monitoring resolution. Gd and conventional hydrochemical data from 12h composites samples were monitored over a period of ten days.

Rare earth element concentrations were measured using an on-line preconcentration system "SeaFAST" (ESI., USA), in combination with a QQQ-ICP-MS. A LOQ of 0.05 ng/L for Gd allowed a robust determination of the geogenic background. Geogenic Gd was estimated with the concentrations of Sm and Tb normalized by the UCC. Groundwater residence times within the transect were estimated based on ^{222}Rn measurements to be below seven days. Hydrochemical data indicated that groundwater is recharged exclusively by river water infiltration at all depths and that mixing with ambient groundwater is negligible. Temporal variability in the stream and the groundwater revealed the suitability of anthropogenic Gd to estimate groundwater travel times.