

## 4.62.24

**Reduction of As(V) in the aquifer – a tracer test at the Cape Cod Site**

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Groundwater contamination with arsenic causes huge sanitary risks for several hundred thousands of people in India and Bangladesh. Groundwater measurements indicate that iron reduction in the aquifer coincides with high arsenic concentration levels in the water. In order to elucidate the processes of arsenic mobilisation under anaerobic conditions we performed different experiments in the laboratory and in the field

A tracer experiment with permanent As(V) input into the iron reduction zone of the aquifer was done in close cooperation with scientists from the USGS at the Cape Cod Site near Boston. The project was funded by the DFG and supported by the USGS Toxic Substances Program. At the Cape Cod Site a vertical redox zonation can be observed in the aquifer due to a contamination by sewage waters. A specific test site consisting of 11 deep multilevel sampling wells was installed in order to study the geochemical conditions in anoxic zone.

The anoxic water is characterized by high concentrations of iron and H<sub>2</sub>S could be smelled in the pipes before the water was sampled. The reduction of As(V) was studied injecting As(V) continuously into the anoxic layer of the aquifer over a period of four weeks. During this input, small oxygen concentrations entered the aquifer and oxidised ferric iron, so that As(V) accumulated at the solid ferrous iron phase. A mobilisation of As(III) could be observed when anoxic conditions re-established only a few days after the input was stopped. Sulfate reduction seems trigger the reduction of arsenic and iron, whereas specific arsenic reducing microorganisms or a significant mediation of hydrogen concentrations in the groundwater could not be detected.

Recent studies focus on laboratory experiments to find out pathways and kinetics of As(V) reduction by dissolved sulfide. A PHREEQC model has been built up to demonstrate the coupling of arsenic mobilisation by reduction and the transport of As(III) and As(V).

## 4.62.31

**Properly verified flow and transport model as a basis for management of groundwater quality**

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Visual Modflow and MT3D codes were used to model flow and transport in the Tertiary sandy aquifer in Cracow area, southern Poland. Hydrogeochemistry and environmental tracers were investigated as part of the 5th Framework Program of EC (Project EVK1-CT1999-0006), related to the determination of baseline groundwater quality.

The conceptual model with a grid size 250 m × 250 m, adopted for steady-state flow and transient tracer transport modeling has the following characteristics: five layers (Quaternary sands, Badenian clays, upper permeable sands, clays and lower permeable sands) underlain by impermeable sediments. Transport modeling has been performed for SF<sub>6</sub> and tritium. Weighted mean yearly values of tritium content in precipitation were used as input data. For SF<sub>6</sub>, the concentrations of this tracer at the water table, in thermodynamic equilibrium at 9°C with atmosphere, corrected for elevation of the recharge area, were used.

The flow and transport model developed for the studied system was calibrated using hydraulic heads and fluxes, mainly through fitting of transmissivity (T) data. In the next step, the transport of SF<sub>6</sub> and tritium through the system was performed. The concentrations of SF<sub>6</sub> and tritium, calculated using MT3D, were in some cases different from the measured concentrations. These differences originate mostly from the fact that solute transport is governed by the values of hydraulic conductivity (K), thickness (m) and effective porosity (n). Different pairs of “K” and “m” values may lead to identical T-values and n is an additional important parameter. Recalibration of the model with the aid of observed SF<sub>6</sub> and tritium values yielded better agreements, though for some abstraction wells no full agreement was obtained. Independently whether a further improvement is possible or not depending on the grid size and detailed knowledge of the hydraulic parameters, the tracer data yield direct information on the mean age of water, which is an important parameter for the estimation of potential hazard by anthropogenic pollution. In conclusion, environmental tracers are indispensable for modeling directed at a proper management of groundwater systems, especially with respect to groundwater quality.

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