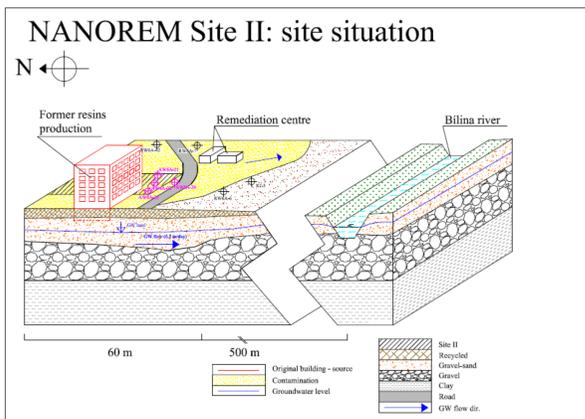


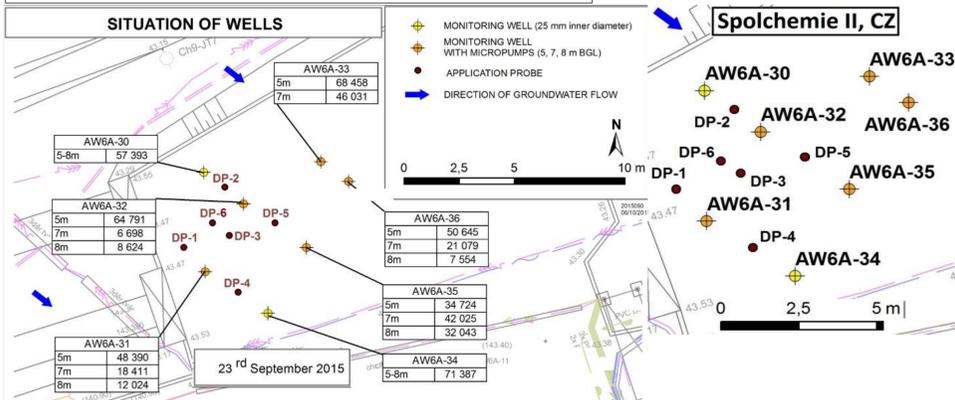
Site Characterization

Introduction

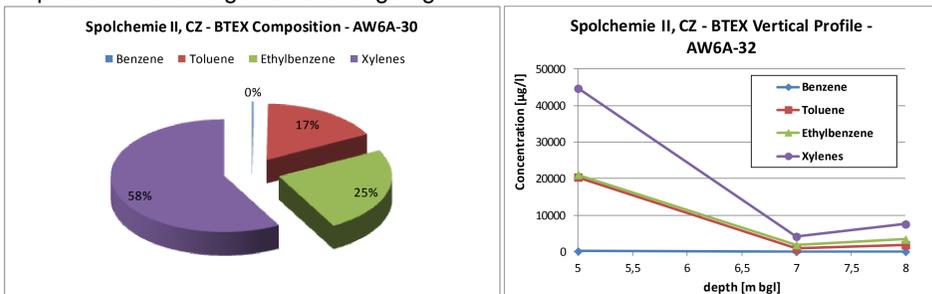
The main aim of this study is a verification of migration characteristics and remedial efficiency of the new types of iron oxide NPs (Nano-Goethite) using advanced procedures for monitoring both total iron and vertical stratification of contamination, including detail water sampling after infiltration. A stabilized slurry of coated nano-Goethite has been developed in the framework of the NanoRem project, progressing with particle design. A special coating procedure is applied, which provides the particles with better mobility, helping to target microbial contaminant degradation. The aim of the study is to test their mobility and reaction characteristics and to optimize their performance. One of the contamination plumes at the Spolchemie site was chosen as a NanoRem case study site to test iron oxide nanoparticles (NPs) for *in situ* remediation of BTEX. Site is situated in Ústí nad Labem, geologically in heterogeneous quarternary terrace of the river Bilina with hydraulic conductivity $K=1 \times 10^{-5}$ m/s.



The area of the site has been investigated in detail. Additional wells with micropumps have also been drilled and tracer tests undertaken during and after application for the evaluation of contaminants distribution and the nanoGoethite mobility.



A number of ground water monitoring campaigns have been undertaken before application and the regular monitoring of contaminants, inorganic species and present micro-organisms is ongoing.



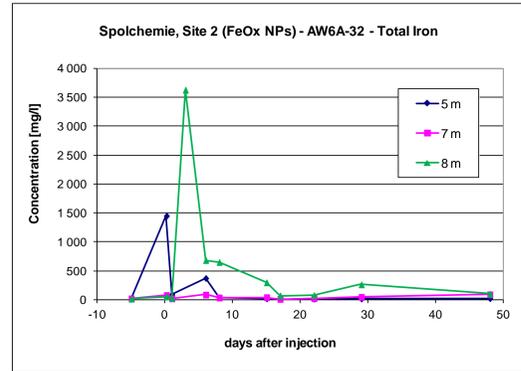
Application of **300 kg of nano-Goethite** took place in Spolchemie LNAPL NanoRem site, Czech republic. Concentration of injected suspension was approx. **5 g/l**, total injected volume was approximately **60 m³**. Continual **direct-push (DP)** application to 6 DP-probes (8 application horizons per each) took 85 hours.

- Monitoring system contains 2 narrow hydrogeological monitoring wells (45 mm diameter) and **3 micropump wells** (each equipped in 5, 7 and 8 m bgl).
- Monitoring of groundwater (GW) includes GWL measurement, physico-chemical parameters measurement and following laboratory analysis: BTEX, total and dissolved iron, TOC, TIC, selected inorganic parameters and concentration of microorganisms.

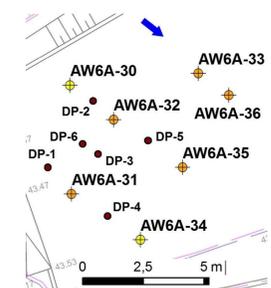
Conclusions

The mobility of stabilized nanoGoethite and its distribution was confirmed in the most of aquifer horizons. The differences of BTEX concentration between wells in inflow area (AW6A-30, AW6A-31 and AW6A 32) and outflow zone (AW6A-35 and AW6A-34) of the pilot site are clearly visible not only in the layer with maximum groundwater velocity speed but also in all of the monitored depths .

Pilot Application - Results

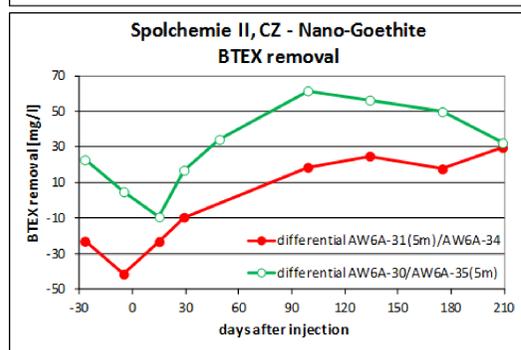
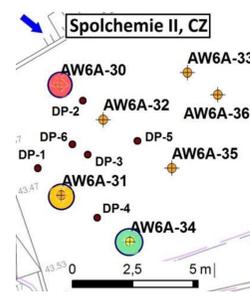
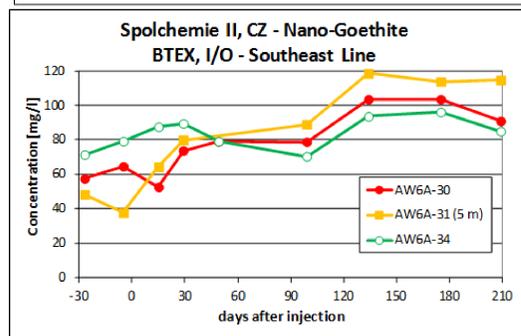
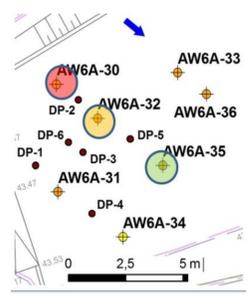
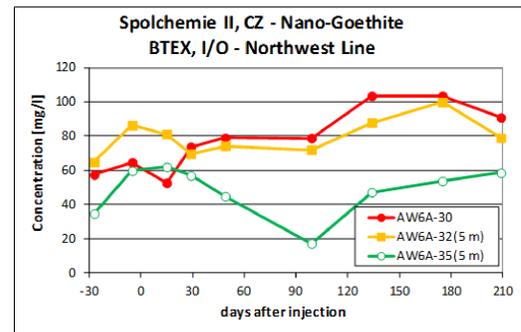


Tracer tests - example

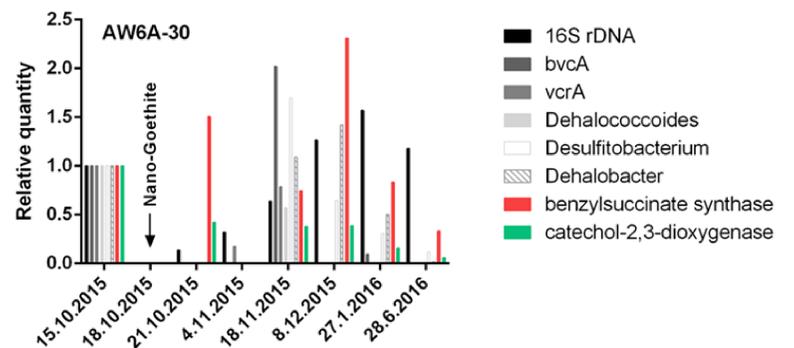


Tracer tests made during infiltration of nanoGoethite confirmed the mobility of FeOx NPs. The distribution was not homogenous vertically although the distribution during infiltration was proportional to each horizon.

Contamination



The figures document the total removal of BTEX in the subsurface reactor created after NanoGoethite application. Although the concentration of BTEX are still very high, even on the wells of outflow line, the differentials between wells in inflow and outflow area are evident and the trend has been confirmed by long term monitoring.



Benzylsuccinate synthase gene level was slightly affected (increased) by the application and remained rather stable throughout the experiment but the level of the enzyme for the aerobic BTEX degradation pathway catechol-2,3-dioxygenase remained low even after 8.5 months after Nano-Goethite injection. .

