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Comparative Study of a Sulfate Tracer Monitoring Experiment Using Geoelectrical and Hydrogeological Survey Techniques

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Reactive walls within the groundwater zone or the infiltration of reactive additives are applied within the frame of Enhanced Natural Attenuation (ENA) remediation procedures for groundwater contaminations based on current state of the art. The cooperation project KOPOXI (Development of an in-situ groundwater remediation procedure supporting natural contamination remediation processes within a contamination plume using a combination of permanently installed oxidizer emission wall and oxidant injections), funded by the German Federation of Industrial Research Associations (AIF), was established with the research focus on an application of the innovative combination of both, a permanently installed subsurface reactive wall and additional injections of reagents with the aim to substantially increase remediation efficiency carried out at a pilot site characterized by hydrocarbon contaminations.

Therefore, innovative monitoring strategies for the observation and subsequent process driven optimization of reagents injection procedures are required to be verified and adapted. These monitoring approaches are based on the acquisition of highly spatial-resolved in-situ hydraulic data within observation wells combined with borehole geophysical surveys in order to determine the spatial and temporal extent of the reagents.

Sulfate injections represent the supplement of potential reactive oxidants for remediation. Hence, a tracer test using 350l magnesium sulfate solution was conducted in a medium-scale experiment. The field set-up consisted of one injection well and four fence-lined observation wells for sampling and in-situ measurements of electrical conductivity and temperature. Additionally, 48 borehole electrodes for geoelectrical monitoring were installed at the PVC casing of the four observation wells. A single geoelectrical measure¬ment was carried out once per hour and consisted of a set of 642 borehole electrode configurations. The tracer was injected within a depth between 12.5 to 15.5 m b.g.l. over a period of 100 minutes. Three weeks before injection the geoelectrical observations had been started obtaining a data set including the resistivity variations due to natural processes within aquifer and to estimate the influence of disturbances caused by accompanying hydrogeological measurements. The whole experiment lasted 2 months.

First results of the experiment display a distinct decrease in apparent resistivity data observable within the first measurements after injection. Hence, the test reveals the suitability of geophysical monitoring in terms of process observation. The geoelectrical measurements provided valuable data for a comprehensive interpretation of hydraulic processes driven by the tracer behavior within the aquifer.