INTEGRATED FIELD ASSESSMENT OF CONTAMINANT FATE AND TRANSPORT IN THE UNSATURATED AND SATURATED ZONE

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The study site

The field site is an industrial complex in which different activities have taken place throughout the years. Such activities comprise among others coke production and dye manufacturing. Some of these factories are still active.

Methodology for the unsaturated zone

![Methods and results](image)

**Methodology for the chemical and isotopic survey**

**Step 1: Selection of sampling sites on the regional scale**
Selection of sampling wells based on most recent contaminant data and ideal locations for sampling (figure 1).

**Step 2: Soil and groundwater sampling for chemical and isotopic analyses**
Collection of samples for sulfate isotopic analysis to determine contaminant sources and pathways and identify various reactive processes (figure 2).
- Collection of samples for cyanide isotopic analysis and cyanide speciation for identification of cyanide sources and pathways and understand the various reactive processes in soil and groundwater.
- For saturated zone studies, the approach consist in the chemical and isotopic analysis of the various contaminants present on site. The expected outcome of such data interpretation and modelling is the characterization of geochemical processes and contaminant sources at a megasite scale.

**Step 3: Data interpretation and modelling**
Characterization of geochemical processes, contaminant sources and interpretation of regional scale isotopic patterns.
- Calculation of contaminant dispersion and identification of plumes extents using numerical groundwater flow and transport models developed for the regional scale.

**Step 4: Development of a methodology for megasite assessment**
Establishment of methodologies for identifying sources and relevant transformation and natural attenuation processes for a complex release of contaminants at a megasite scale that will lead to improved contaminant site assessment.

**Step 5: Installation of the vadose monitoring system**
(a) A flexible sleeve is installed in an slanted borehole with the aim of capturing a tracer infiltrated throughout undisturbed material above the borehole. The flexible sleeve has two types of monitoring units installed within its entire length.
- Flexible Time Domain Reflectometry probes (FTDR), which contain stainless steel waveguides installed in the outer wall of the flexible sleeve to measure vadose zone pore water.
- Vadose Sampling Ports (VSP), containing a ceramic plate and a sampling cell that capture vadose pore water.

**Step 2: Geophysical measurements of the wetting front via cross-borehole geophysics**

- Four boreholes containing 24 stainless steel electrodes spaced 0.60m are installed for cross-hole ERT measurements that will capture the transport through the vadose zone of the applied tracers at the land surface.

**Step 3: Combination of cross-borehole and surface geophysics to develop a 3D model of solute transport in the vadose zone**
(a) A grid of 8x6 electrodes with spacing of 0.60m together with two lines of 2x electrodes will be combined with cross-borehole geophysics for obtaining 3D images of the distribution and transport of the tracer in the vadose zone.

**Step 4: Development of a quantitative model of solute distribution and transport in the vadose zone of the study site**
The model is expected to combine time-lapse images of tracer distribution and transport in the vadose zone with quantitative measurements of tracer flux and mixing with the water table.

**References**