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Vadose zone studies at an industrial contaminated site: the vadose zone monitoring system and cross-hole geophysics

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In order to improve risk characterization and remediation measures for soil and groundwater contamination, there is a need to improve in situ vadose zone characterization. However, most available technologies have been developed in the context of agricultural soils. Such methodologies are not applicable at industrial sites, where soils and contamination differ in origin and composition. In addition, most technologies are applicable only in the first meters of soils, leaving deeper vadose zones with lack of information, in particular on field scale heterogeneity.

In order to overcome such difficulties, a vadose zone experiment has been setup at a former industrial site in Belgium. Industrial activities carried out on site left a legacy of soil and groundwater contamination in BTEX, PAH, cyanide and heavy metals. The experiment comprises the combination of two techniques: the Vadose Zone Monitoring System (VMS) and cross-hole geophysics.

The VMS allows continuous measurements of water content and temperature at different depths of the vadose zone. In addition, it provides the possibility of pore water sampling at different depths. The system is formed by a flexible sleeve containing monitoring units along its depth which is installed in a slanted borehole. The flexible sleeve contains three types of monitoring units in the vadose zone: Time Domain Transmissometry (TDT), which allows water content measurements; Vadose Sampling Ports (VSP), used for collecting water samples coming from the matrix; the Fracture Samplers (FS), which are used for retrieving water samples from the fractures. Cross-hole geophysics techniques consist in the injection of an electrical current using electrodes installed in vertical boreholes. From measured potential differences, detailed spatial patterns about electrical properties of the subsurface can be inferred. Such spatial patterns are related with subsurface heterogeneities, water content and solute concentrations.

Two VMS were installed in two slanted boreholes on site, together with four vertical boreholes containing electrodes for geophysical measurements. Currently the site is being monitored under natural recharge conditions. Initial results show the reaction of the vadose zone to rainfall events, as well as chemical evolution of soil water with depth.