Monitoring System for remediation of a brownfield

K. Tsakirmpaloglou[1] , T. Martin[1] , O. Kaufmann[1] , P. Goderniaux[1]

(1) *Geology and Applied Geology, UMONS, Mons, Belgium*

keywords: ERT/IP monitoring, brownfield, remediation

The need of monitoring underground processes and locating targets with an easy and reliable way, led to the use of geoelectrical monitoring techniques. Geoelectrical methods are widely used in a variety of environmental fields and areas. These techniques are developed for assessing among others geotechnical, environmental or hydrogeological processes (Loke et al., 2013). A vast majority of geoelectrical instruments specially designed for monitoring are now in operation and allow the near real-time collection of large amounts of data which are later processed with specific time-lapse inversion algorithms.

The main purpose of this work is the design, implementation, operation and the interpretation of a geoelectrical monitoring system for a brownfield remediation pilot over an old cookery site. The brownfield where the research project is conducted lies in the suburbs of Charleroi city, in Belgium. The site was used as an industrial area, with coking operations. Both the soil and subsoil as well as the groundwater are heavily contaminated down to six meters deep, with heavy metals, cyanides, and hydrocarbons such as BTEX and PAH. The shallow geology mainly consists of three distinct layers. The first layer, from ground to four meters depth, is composed of sand, gravels, slag and shale. The second layer is mainly composed of clay alluvial, while the last layer consists of shale and clay. The piezometric level appears near the surface, at about 1.6 meters deep. Based on soil samples collected in boreholes, and on geoelectrical measurements we concluded that the area shows a high spatial heterogeneity of both subsoil nature and contamination.

The remediation experiment that is conducted in this zone aims at enhancing the biodegradation of hydrocarbons by indigenous bacteria and/or fungi with in situ heating. A set of vertical loop heat exchangers, placed into boreholes down to six meters deep, are used to heat the subsurface medium. To follow the evolution of the underground conditions during the heating experiment, a monitoring system composed of a set of piezometers and piezair for regular air and water sampling, grids of temperature sensors, as well as geoelectrical imaging facilities were installed. The purpose of the monitoring system is to implement 3D models of the subsoil as well as, to monitor the evolution of the electrical properties derived from the bio-degradation process through 4D imaging. Given the underground heterogeneity, especially the high resistivities in the top layer and the rather high conductivity of the saturated backfill, a design based on down-hole electrodes placed on a regular grid has been selected in order to maintain a good resolution at depth. From processing the IP inversion results, we were able to locate high values of changeability, centered around the water table where oxygen availability is higher. This, according to the chemical analysis results, could be connected to hydrocarbon contaminated areas. We were also able to interpret some of the resistivity anomalies as high contaminated areas in the light of chemical analysis conducted on soil samples as well as on water samples from the boreholes in the test zone.

Loke, M.H., Chambers, J.E., Rucker, D.F., Kuras, O., Wilkinson, P.B. (2013): Recent developments in the direct-current geoelectricalimaging method. Journal of Applied Geophysics, 95, 135–156. https://doi.org/10.1016/j.jappgeo.2013.02.017