



Self-potential technique in the study of contamination of Trecate (Italy) and Zeitz (Germany) test sites

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The remediation of sites contaminated by hydrocarbon, due to blow out, leakage from tank or pipe and oil spill, is an environmental problem because infiltrated oil can persist in the ground for a long time and the existing methods are invasive and expensive. In the last years there was a growing interest in the use of geophysical methods for environmental monitoring (Greenhouse et al., 1993; Daily and Ramirez, 1995; Lendvay et al., 1998; Atekwana et al., 2000; Chambers et al., 2004; Song et al., 2005; French et al., 2009), and there have been several recent study that correlate self-potential signals to subsurface contamination (Perry et al., 1996; Naudet et al., 2003; Naudet et al., 2004).

In the framework of the EC-FP7 funded research project ModelPROBE (model-driven soil probing, site assessment and evaluation, Grant No. 213161), a particular attention is given to the self-potential (SP) method because it is sensitive to contaminant chemistry and redox processes generated by bacteria during the biodegradation phase (Atekwana et al., 2004; Naudet and Revil, 2005). We show the results of the SP investigations conducted at two project test sites: Trecate (Italy) and Zeitz (Germany), characterized by crude oil and benzene pollution respectively.

Trecate site was affected in 1994 by crude oil contamination from a well blowout. The investigations include surface SP surveys and in-hole measurements, in time-lapse mode. Three SP surveys (October 2009, March 2010 and October 2010) have been conducted at the site, both in the heavily contaminated and uncontaminated regions. Great changes are observed between SP data collected at different time instants. In particular we found mostly negative electrical potential at October surveys, when rice fields were still flooded, while we measured mostly positive electrical potential at March survey. An examination of the corrected data indicates that negative electrical signal may be attributed to the infiltration movement of water in the un saturated zone (electrokinetic potential), while the positive electrical signal may be related to oxidation-reduction phenomena (Electrochemical potential - bacterial activity). Moreover some correlations seem to exist between SP measured in-hole and Eh measurements. Zeitz test site represents a hydrogenation plant founded in 1938 to produce gasoline and lubricants for German industry during the Second World War. Production ended when the plant was heavily bombed and facilities destroyed in 1944/1945. Damage to tanks and pipelines resulted in large volumes of contaminants seeping into the soil and reaching the groundwater table. The contaminant concentrations in the groundwater were extremely high and reached 1000 mg/L of benzene (Schirmer et al., 2004). A surface SP survey was conducted at the site, both in the contaminated and uncontaminated regions. In particular we found positive electrical potential, with higher anomalies in correspondence of the heavily contaminated zone. Moreover a SP profile acquired at the excavated trench in the contaminated area, validates the results even if it shows higher electrical potential signal. The next SP survey will be conducted after remediation in order to analyze the correlation between electrical potential measurements and the contamination state.

In conclusion our results confirm that SP can have a key role in the definition of hydraulic and contamination state, therefore a direct link between contamination and SP signal is being studied by laboratory experiment, under controlled conditions.

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