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Near surface geophysical techniques on subsoil contamination: laboratory experiments

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Hydrocarbons contamination of soil and groundwater has become a serious environmental problem, because of the increasing number of accidental spills caused by human activities. The starting point of any studies is the reconstruction of the conceptual site model. To make valid predictions about the flow pathways following by hydrocarbons compound is necessary to make a correct reconstruction of their characteristics and the environment in which they move. Near-surface geophysical methods, based on the study of electrical and electromagnetic properties, are proved to be very useful in mapping spatial distribution of the organic contaminants in the subsurface. It is well known, in fact, that electrical properties of the porous media are significantly influenced by hydrocarbons because, when contaminants enter the rock matrix, surface reaction occur between the contaminant and the soil grain surface.
The main aim of this work is to investigate the capability of near-surface geophysical methods in mapping and monitoring spatial distribution of contaminants in a controlled setting. A laboratory experiment has been performed at the Hydrogeosite Laboratory of CNR-IMAA (Marsico Nuovo, PZ) where a box-sand has been contaminated by diesel. The used contaminant is a LNAPL, added to the sand through a drilled pipe. Contaminant behaviour and its migration paths have been monitored for one year by Electrical Resistivity measurements. In details, a Cross Borehole Electrical Resistivity Tomography techniques were used to characterize the contamination dynamics after a controlled hydrocarbon spillage occurring in the vadose zone. The approach with cross-borehole resistivity imaging provide a great advantage compared to more conventional surface electrical resistivity tomography, due to the high resolution at high depth (obviously depending on the depth of the well instrumented for the acquisition). This method has been shown to provide good information on the distribution of electrical properties of the subsoil at high depths and, in some cases, a detailed assessment of dynamic processes in the subsurface environment (Binley et al., 2002).
Our study confirms the link between hydrocarbons contamination and geoelectrical signal and the capability of cross-hole electrical resistivity tomographies to realize a non-invasive characterization of LNAPL contamination of the media. Although, the electrical behaviour is much more complex and the relation with the contaminants depends also by time of investigation.