Geophysical monitoring of bio-remediation using the Direct Current resistivity and time-domain Induced Polarization (DCIP) method

Aristeidis Nivorlis, Ph.D. student
Lund University, mail: aristeidis.nivorlis@tg.lth.se

Torleif Dahlin, Professor, Lund University
Matteo Rossi, Assistant Lecturer, Lund University
Sofia Åkesson, Ph.D. student, Lund University
Charlotte Sparrenbom, Senior Lecturer, Lund University

Background
Important work has been done in locating, characterizing and treating contaminated ground. Very often sampling techniques are performed which can provide very detailed and accurate data, however such information comes with low spatial distribution and high cost. Geophysical methods provide continuous models of the subsurface, and can be used as a tool to interpolate and extrapolate punctual data, and thereby increase the spatial distribution of the information. One method that is of particular interest in this context is Direct Current resistivity and time-domain Induced Polarization (DCIP). The combination has the potential to increase the reliability by reducing the risk of missing important zones, and at the same time reduce the cost.

In Alingsås, a dry-cleaning facility was operated for many years, and huge amounts of the solvent PCE was spilled into the ground. This contributed to an increasing concentration of PCE over the years until the use of PCE was stopped, resulting in the formation of a DNAPL plume beneath the building.

It is common that remediation takes place by excavating and moving the contaminated soil, but this only migrates the problem and is costly. Furthermore, in Alingsås this is not an option because of the amount of the contaminated mass and the fact that it is underneath the largest operating Swedish cleaning facility. In such cases, in situ remediation techniques appear as the only viable option. There are however concerns about how to control the result of the remediation and a need for new methods with spatial coverage.

Aim
A lot of studies have been done about the characterization of the subsurface, especially when it comes to the contaminants, however our main interest is the changes that take place due to the remediation. Can they be monitored by geophysical tools, and to which extent can geophysical tools provide reliable information about the level of success of in situ remediation techniques?

For that purpose, a fully autonomous and automatic monitoring system was installed in Alingsås, to perform frequent automated measurements and to provide information about the changes in the subsurface. Apart from the DCIP data the system has the potential to monitor several other parameters (soil temperature/moisture, rainfall, air temperature, groundwater level, water conductivity, redox potential, etc.) by using external sensors, to make it possible to obtain a better understanding about changes caused by other processes (i.e. rainfall) and how they can affect the measurements.

All those data are transferred daily on our server in Lund and are being processed to evaluate the data quality and extract useful information about changes into the subsurface. By evaluating the complimentary data, provided by the external sensors, we can take changes from external processes into account. The remaining events should then be compared with sampling data, such as isotope analysis, to verify our hypothesis.

Conclusion

It is expensive and time consuming to control the remediation result via sampling and analyses with high spatial resolution at regular intervals. With DCIP we can acquire dense data, in space and time, that hopefully can help following and better understand the changes due to the remediation.

The geophysical data should be ideally acquired, analyzed and verified with automated routines as part of a larger monitoring system. It is of great importance, especially in the early stage, to verify events that appear to show interesting changes with sampling data to evaluate the level of reliability of the system.