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Characterisation and monitoring of in situ remediation of chlorinated hydrocarbon contamination using an interdisciplinary approach (MIRACHL)

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To meet future challenges in urban development with sustainable planning of cities, more housing is built via densification. This is done by expanding housing into often contaminated industrial sites. Growing concerns are the 2000 sites in Sweden contaminated with carcinogenic chlorinated hydrocarbons (dry-cleaners and industrial solvents).

The main remediation technique in Sweden is the costly and micro-ecologically damaging excavation and landfilling, i.e. moving the pollutants from one site to another. This strategy leads to large transports and exposure of dangerous compounds. SEPA recommends the use of in-situ methods, because an increased use thereof will lead to large savings for clean-up, and contribute to EU Water Directive requirements and to reach our national environmental objectives. A major challenge for in-situ remediation is to monitor the underground processes and verify its effectiveness. In this project, we work with an integrated monitoring by combining 4D (time-lapse) geophysical measurements using the Direct Current resistivity and time-domain Induced Polarization (DCIP) method, with smart biogeochemical analyses and Compound Specific Isotope Analyses (CSIA) to better understand and follow in-situ remediation processes.

Earlier investigations suggest that degradation of chlorinated hydrocarbons takes place in zones next to the free phase plume. In order to verify what the detected DCIP anomalies are due to, the groundwater may be sampled for physiochemical characterisation and verification of microbiological activity of bacterial indicator species (**P**hysical and **B**io**G**eochemical **C**haracterisation, PBGC). We will implement two types of groundwater monitoring; in-situ measurements of redox conditions via an oxidation-reduction potential/pH/temperature/electrical conductivity loggers as well as classical groundwater sampling and analysis of the contaminants, degradation products and general characterisation of groundwater constituents. Detection and enumeration of indicator species, such as *Dehalococcoides sp,* can be done by molecular methods such as quantitative

polymerase chain reaction using species specific primers (e.g. Hargreaves *et al.* 2013 and Hedman *et al*. 2013).

The continuous DCIP observations during the remediation will together with the smart sampling and analyses help follow the development underground. Today, the monitoring of the remediation action and confirmation on "good enough" is very uncertain, due to the current investigation techniques with point source monitoring. With our combined approach, we aim to retrieve a comprehensive coverage of changes underground through time, possibly reduce uncertainties and costs for monitoring the in-situ remediation and deliver a more pedagogic image of the action underground for presentation and discussion with stakeholders.

References:

Hargreaves, S.K. et al. Reaction-and sample-specific inhibition affect standardization of qPCR assays of soil bacterial communities. *Soil Biology and Biochemistry* 59 (2013): 89-97.

Hedman, J. et al.(2013). Overcoming inhibition in real-time diagnostic PCR. *PCR detection of microbial pathogens* , 17-48.