Multidisciplinary approach to characterize natural degradation of PCE

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Background

In this study, we investigate natural degradation of tetrachloroethylene (PCE) and its metabolites at the Hagfors site, western Sweden. The site is heavily contaminated; however, degradation occurs even though the conditions are not ideal for the microbes.

To investigate the contamination and degradation status we are using an interdisciplinary approach. Primarily, we are using Direct Current resistivity and Induced Polarization (DCIP) tomography, a combined method to visualize the subsurface conditions and changes over time (see Fig. 1). In order to be able to interpret the geophysical models analyses of Physical- and BioGeoChemical (PBGC) properties and Compound-Specific Isotope Analysis (CSIA) are performed to characterize the chemical status and microbial degradation of PCE and metabolites.

We are searching for members the Dehalococcoides genus, known to degrade the pollutants. We will perform DNA extraction and PCR on filtered samples of groundwater, and hope to find Dehalococcoides from the same areas where we have enrichment of 13C and thereby quantify the degradation.

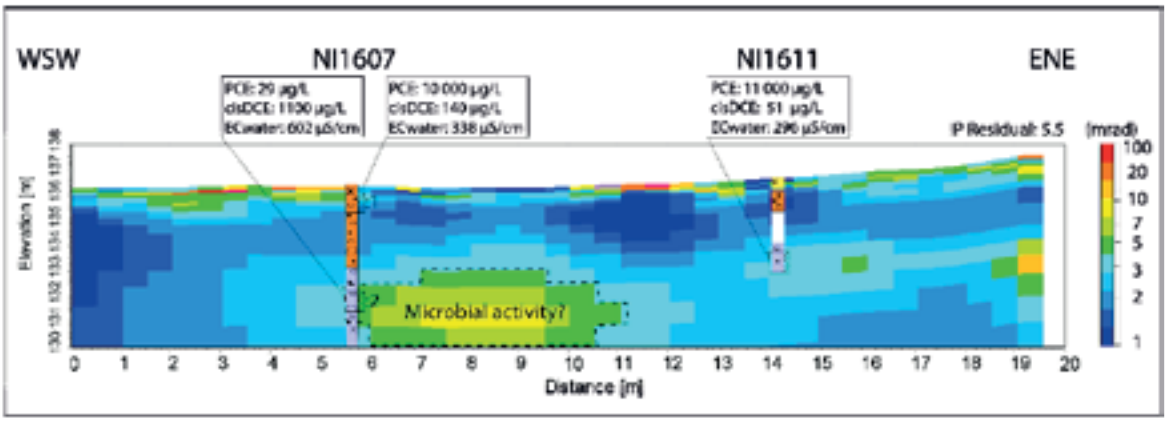

Fig. 1. Data of Induced Polarization over an area highly contaminated with PCE and an ongoing degradation.

Then we will compare the results with the DCIP models to see if the degradation is taking place in the area of the anomaly outlined in Fig. 1. We will also look into the

possibility that the anomaly can be explained by the concentrations of pollutants or major ions in the groundwater.

The application of using the DCIP for monitoring remediation of PCE contaminations in combination with PBGC characterization and CSIA is a new approach.

Aim

This survey is part of the research project MIRACHL, which has the overall objective to use DCIP tomography as a monitoring tool of in situ remediation. By investigating an unaffected plume with natural degradation, we aim to understand the geophysical signals from in situ remediation. With our combined approach, we aim to retrieve a comprehensive coverage of the underground by the DCIP and by measuring the microbial activity via CSIA, qPCR and concentration analyses in pinpointed areas, understand and explain anomalies in the DCIP. If this is done through time, changes can be observed and degradation/reaction processes verified and possibly reduce uncertainties and costs for monitoring the in-situ remediation. We can then also deliver a more informative overview of the action underground for presentation and discussion with stakeholders.

Conclusion

The DCIP and groundwater concentration results indicates so far that natural attenuation occurs preferably in two zones in the studied area. At the present we are performing analyses for CSIA and microbial DNA and PCR to verify the microbial activity and degradation in the area. These results will be used to compare with ground water chemical concentrations and DCIP results to verify or discard if the DCIP anomalies shown are connected to microbial degradation or not.