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How does hydrocarbon decrease the electrical resistivity of soils?

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To gain information about hydrocarbon (HC) contaminations by common methods requires time consuming sampling and sample analysis and delivers only sparse spatial information. Hence, it is desirable to use non-invasive imaging methods for prospecting and monitoring HC contaminations. The method applied in this study is called spectral induced polarization (SIP) and measures the complex resistivity in dependence of frequency.

The influence of low hydrocarbon (HC) concentrations (especially relevant for biological remediation) on the frequency dependent electrical properties of soils is exemplarily investigated for n-hexadecane (LNAPL) und phenanthrene (DNAPL). To this, SIP measurements on clean and contaminated model soils (sand and sand-kaolinite-mixtures) are compared. The contamination with the non-conductive, non-polar HC resulted in a decrease of the soil resistivity (in contrast to the expected weak increase).

How does it work? The resistivity decrease can be explained by the (ab)sorption of HC to the water immediately adjacent to the inner solid surface. The (ab)sorption of HC still requires a corresponding “desorption” of water molecules and ions from the near surface water. As a result, the resistivity of the bulk water and consequently of the whole rock is decreased. According to the introduced approach HC sorption and hence the influence on the electrical properties depends on the size of the inner surface area and on the hydrophobicity of the HC. Therefore, the electrical properties of soils with small surface areas like middle and coarse grained sands are hardly influenced by low HC concentrations. In contrast, the spectral behaviour of soils with large inner surface areas can be appreciably changed by HC.