3D Imaging of Hydrocarbon Contamination Plumes from Geoelectrical Data

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Summary

The results of this study demonstrate the usefulness of imaging contamination plumes in three-dimensional space from geoelectrical data.

Introduction

In this study, the land owner and regulators assumed that a given land area was contaminated from a source that was an old abandoned multi-purpose pipeline. Using a 120-channel multi-mode geoelectrical data acquisition and imaging system, contamination plumes were easily identified and more precisely localized than with any other known method.

Theory/Method

Geoelectrical measurements have been widely used in near-surface investigation and assessment of petroleum hydrocarbon contamination. However, unambiguous detection of hydrocarbon contamination is the most difficult task for geoelectrical method at suspiciously hazardous sites. The difficulty is two-fold: 1) the low level of resistivity contrasts that the contaminants may provide against the background soils, 2) precise identification and assessment of sources of contamination plumes.

Due to costs estimations, the operator wanted to use an approach that would have less environmental impact and be less costly than extensive excavation along the pipeline and across the entire site.

The data was collected in an agricultural field north of Edmonton using a 120-channel multi-mode geoelectrical data acquisition and imaging system. The imaging in 3D of the contamination plumes allowed for the precise spatial delineation of the plumes and the calculation of the volume of earth to be remediated. Some contamination plumes extended to depth of 12 metres below ground level. Groundwater flow in the vicinity of the contamination plumes was also interpreted and mapped from the geoelectrical data. Results were compared to monitoring well samples.

Existing drill hole data was used to calculate the geoelectrical thresholds of faint variations of conductivity related to hydrocarbon contamination. Those thresholds were used to constrain the three dimensional imaging of the geometry of anomalies.

Groundtruthing was conducted with drill holes. The magnitude and spatial location of the contamination plumes identified by the geoelectrical survey and imaging method correlated with the results provided by the drill holes.

Conclusions

This study revealed that the sources of the contamination plumes were not related to the pipeline. The virtual scan of the site by the geoelectrical survey showed a clear picture of old abandoned oil wells and buried mud pools from which leaked contaminants were transported across the site following groundwater and geological pathways.

Geoelectrical measurements using a 120-channel multi-mode imaging is an environmentally conscious and financially feasible method to obtain accurate details of a near-surface assessment of petroleum hydrocarbon contamination.

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