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Integration of Induced Polarization Imaging, Ground Penetrating Radar and geochemical analysis to characterize hydrocarbon spills

Adrian Flores Orozco (1), Ingrid Kreutzer (1), Matthias Bücker (1), Frederic Nguyen (2), Thilo Hofmann (3), and Gernot Döberl (4)

(1) Vienna University of Technology, Austria. Geophysics research Group (adrian.flores-orozco@geo.tuwien.ac.at), (2) ArGEnCo Department, Applied Geophysics, University of Liege, Belgium , (3) University of Vienna, Austria. Department of Environmental Geosciences, (4) Environment Agency Austria, Austria. Department for Contaminated Sites

Because of their capability to provide spatially continuous data, Induced Polarization (IP) Imaging and Ground Penetrating Radar (GPR) have recently emerged as alternative non-invasive methods for the characterization of contaminated sites. In particular, the IP method has demonstrated to be sensitive to both, changes in the chemical composition of groundwater as a result of dissolved pollutants, and to the geometry of the pore space due to the occurrence of contaminants in non-aqueous phase liquids (NAPL). Although promising, an adequate interpretation of the IP imaging results requires geochemical information obtained from the analysis of soil and water samples. However, to date just rare studies have investigated the IP response at the field scale due to different contaminant concentrations. To demonstrate the advantages of an integrated geophysical and geochemical site investigation, we present studies from different hydrocarbon-contaminated sites. We observed a linear correlation between the polarization effect and the contaminant concentration for dissolved contaminants in the saturated zone. A negligible polarization effect was observed, however, in areas associated with the occurrence of contaminants in NAPL. Compared to the contaminant distribution obtained from the geochemical analysis only, the images obtained from time-domain IP measurements significantly improved the delineation of the contaminant plume. As a first step, GPR data collected along the same profiles provided complementary structural information and improved the interpretation of the IP images. The resolution of the electrical images was further improved using regularization constraints, based on the GPR and geochemical data, in the inversion of IP data.