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Spectral induced polarization signature of contaminated soil

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Spectral induced polarization (SIP) signatures of porous media contaminated with non aqueous phase liquids (NAPL) were measured using an accurate impedance meter. The samples were prepared by mixing air-dried sand with 15% by weight of bentonite clay, tap water and either diesel fuel or motor oil. Next, the soil was packed in a column and left for 24 hr before electrical measurements were performed. For all the samples, water saturation was constant ($S_w = 0.47$) and the NAPL saturation was 0 (control), 5, or 15 percent. Counter-intuitively, the results show that addition of NAPL to the porous media resulted in an increase of the real part of the complex conductivity. Evidently, for each type of contaminant, an increase in the contaminant saturation resulted in an increase in the real part of the conductivity. The imaginary part of the complex conductivity showed a reversed behavior: higher NAPL saturation resulted in a reduction of the imaginary part of the complex conductivity. For both the real and the imaginary part of the complex conductivity, the effect of NAPL on the complex electrical conductivity was more significant for motor oil than for diesel fuel. In addition to the electrical measurements, we also performed an extraction experiment to examine the effect of the presence of NAPL on the electrical conductivity (EC) of the pore water. The results from the extraction experiment showed that addition of NAPL to the porous media resulted in an increase of the pore water EC. We argue that this increase in the real part of the complex conductivity is related to adsorption of organic polar compounds from the NAPL onto the mineral surface and the associated release of inorganic ions from the mineral surface to the pore water. These exchange processes affect both the surface and the pore water conductivity. In addition, we suggest that the decrease in polarization (associated with the imaginary part of the complex conductivity) of the NAPL contaminated porous media is related to stronger binding of the adsorbed NAPL polar compounds to the mineral surface. Ongoing experiments are targeted at further elucidating these phenomena.