



## **Electrical Properties of NAPL contaminated unsaturated soil**

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The electrical properties of NAPL contaminated partially saturated porous media is investigated both experimentally and theoretically. In laboratory setting we used an LCR meter to measure the phase angle of NAPL contaminated partially saturated soil. In addition, using COMSOL multiphysics, we study the effect of NAPL on the electrical properties of partially saturated porous media at the pore scale.

Experimental results for low frequencies (20-600 Hz) measurements show that the addition of NAPL to porous media leads to an increase in the phase angle of the contaminated samples. As the low frequency response of porous media is attributed to electrochemical polarization, we explain our results in terms of electrochemical processes such as diffusion and migration of ions. Specifically, we argue that since the application of external electric field leads to movements of ions around the electrical double layer, and as NAPL “bubbles” interfere to the ion movements, an increase in polarization occurs. This analysis is supported by the numerical model that demonstrates an increase in the relaxation time (the time to establish electrical equilibrium) of our NAPL contaminated pore scale model.

At high frequencies (600 Hz to 1000 KHz) a decrease in the phase angle of the contaminated treatment (compare to the clean treatment) was observed. As at high frequencies interfacial polarization is considered the governing mechanisms, we argue that the replacement of air with NAPL (which possess higher dielectric constant) is the main reason for the observed electric response.