Spectral Induced Polarization Signatures of Ethanol in Sand-Clay Medium

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Session 2. Preference: Oral

The spectral Induced Polarization (SIP) method has previously been investigated as a tool for detecting physicochemical changes occurring as result of clay-organic interactions in porous media. We performed SIP measurements with a dynamic signal analyzer (NI-4551) on laboratory columns to determine physics and chemistry-driven changes to the electrical properties as a result of varying ethanol (EtOH) concentration in a sand-clay matrix (98 % quartzitic sand and 2 % bentonite w/w). A series of background measurements was also performed on 1) the sand-clay matrix saturated with water without ethanol (0% EtOH v/v) and 2) a matrix of quartzitic sand without clay (0% bentonite) saturated with ethanol (EtOH 10 % v/v) to help discriminate the influence of ethanol on the electrical polarization effects. The SIP data showed that the phase response (ϕ) and the imaginary conductivity (σ'') are small (~ 0 mrad and ~ 1E-07 S/m , respectively) for measurements on the ethanol-saturated sand matrix while these values reach ~ 12 mrad and 0.00006 S/m in the water-saturated sand-clay matrix. However, these clay-driven polarization effects were significantly suppressed in the presence of ethanol. The ϕ response was reduced to ~ 7 mrad (σ'' ~ 0.00002 S/m) and ~ 3 mrad (σ'' ~ 0.00001 S/m) in the sand-clay matrix when saturated with EtOH 10% v/v and EtOH 20% v/v, respectively. Our results indicate the sensitivity of SIP measurements to clay-ethanol interactions in porous medium. However, unlike previous studies, our results suggest that clay-organic interactions suppress the polarization associated with the presence of clays.