Spectral induced polarization of nanoporous media

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Nanoporous materials such as clays and concretes are relevant for the storage of oil, geothermal energy, CO_2, and nuclear waste in deep geological formations because of their high specific surface area and resulting low permeability that confer them remarkable confining properties. Their mineralogical nature and petrophysical properties can be in-situ identified and quantified using non-invasive geoelectrical methods such as spectral induced polarization (SIP). Despite their observed high chargeability, the SIP response of these nanoporous materials should also be better understood. In this work, SIP laboratory measurements on montmorillonite suspensions and concrete, and their interpretation using grain or pore (membrane) polarization models, are presented. We show that it is possible to explain their SIP response using the electrochemical properties of the double layer at the mineral surface and the Poisson-Nernst-Planck equation, to get the surface electrical and petrophysical properties such as grain or pore size distribution. Nevertheless, more work should still be done to better describe the pore-scale SIP response and a more general and upscaling approach is necessary to use mechanistic models to better interpret field-scale SIP measurements.