Characterization of surface conductivity of clays

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Abstract. Clay minerals are extensively used in a wide range of applications. They are a key component in the production of ceramics, concrete, drilling fluids, molding sands, paints, and paper. Furthermore, clay formations can be used as radioactive waste repository. However, the hydrodynamic regime within such kind of storage should be considered due to possible interactions with groundwater. Electrical resistivity tomography can be used as one of the monitoring methods. A conclusive interpretation of field data requires reliable knowledge on the electrical properties of clays that are gained in laboratory experiments. The main purpose of this study is the investigation of the electrical properties of clay samples with a special focus on the contribution of surface conductivity. The influence of water content on complex conductivity values for four clay powder samples was investigated by the spectral induced polarization method. Experiments were conducted with kaolinite, illite, bentonite clays, and a breccia containing saponite (~ 90%). We also employed density, cation exchange capacity and specific surface area measurements to characterize the samples. The measured complex conductivity spectra indicate a decrease of the real part of electrical conductivity with rising water content for the illite, bentonite and saponite breccia samples. The electrical conductivity of kaolinite does not show any significant changes with water content. Kaolinite indicates an iso-conductivity situation with similar conductivities of the solid and liquid phases, whereas the total conductivity of the other three samples is dominated by the contribution of surface conductivity. The imaginary part of electrical conductivity increases with water content. Moreover, we observed an increasing porosity and decreasing surface conductivity with increasing water content. Finally, the ratio between imaginary conductivity and surface conductivity increased with increasing water content (i.e. with a decrease of clay content).