Complex conductivity of soils

The complex conductivity of soil remains poorly known despite the growing importance of this method in hydrogeophysics. In order to fill this gap of knowledge, we investigate the complex conductivity of 71 soils samples (including 4 peat samples) and one clean sand in the frequency range 0.1 Hertz to 45 kHz. The soil samples are saturated with 6 different NaCl brines with conductivities (0.031, 0.53, 1.15, 5.7, 14.7, and 22 S m\(^{-1}\), NaCl, 25°C) in order to determine their intrinsic formation factor and surface conductivity. This dataset is used to test the predictions of the dynamic Stern polarization model of porous media in terms of relationship between the quadrature conductivity and the surface conductivity. We also investigate the relationship between the normalized chargeability (the difference of in phase conductivity between two frequencies) and the quadrature conductivity at the geometric mean frequency. This dataset confirms the relationships between the surface conductivity, the quadrature conductivity, and the normalized chargeability. The normalized chargeability depends linearly on the cation exchange capacity and specific surface area while the chargeability shows no dependence on these parameters. These new data and the dynamic Stern layer polarization model are observed to be mutually consistent. Traditionally, in hydrogeophysics, surface conductivity is neglected in the analysis of resistivity data. The relationships we have developed can be used in field conditions to avoid neglecting surface conductivity in the interpretation of DC resistivity tomograms. We also investigate the effects of temperature and saturation and, here again, the dynamic Stern layer predictions and the experimental observations are mutually consistent.