Modeling the seismoelectric electrokinetic coupling: a new approach to up-scale the frequency-dependent effective excess charge density

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Seismoelectric signals result from an electrokinetic coupling phenomena that can be modeled through two approaches: the coupling coefficient or the effective excess charge density. The traditional approach is based on the frequency dependent coupling coefficient that can relate differences in pressure to differences in electrical potential. The second approach is more recent and is related to the description of the excess charge that is effectively dragged by the pore water displacement relatively to the mineral surface. In this contribution, we propose a new model to obtain the frequency dependent effective excess charge density. The electrokinetic coupling is mechanistically up-scaled considering the pore as a straight capillary. This approach, called flux-averaging, takes into account the inertial term of the Navier-Stokes equation to explain both the dynamic permeability and the effective excess charge density dependence with oscillation frequency. The frequency dependent coupling coefficient can then be calculated from this result. The model results are then successfully compared to previous models and published data. This work is a first step to predict seismoelectric electrokinetic coupling in much more complicated porous media in saturated and partially saturated conditions.