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Electrokinetic Fields and Waves: Theory, Experiments and Numerical Modeling

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The investigations encompass both experimental and theoretical studies of coupling between electromagnetic and poroelastic fields. First, we experimentally investigate the streaming potential (SP) coefficient. This coefficient gives rise to the coupling of mechanical and electromagnetic fields. The normalized experiments and the theoretical amplitude results of this dynamic SP coefficient are in good agreement with each other. In addition, measurements of the dynamic permeability correlate well with the computed amplitude and phase as predicted by the model. Second, we have formulated a full-waveform electrokinetic wave propagation model. The model predictions are compared with laboratory measurements of a seismic wave of frequency 500kHz that generates electromagnetic signals. We hereby only focus on the coseismic fields and hence neglect the interface response. The measured coseismic electric field is accurately predicted by the model in terms of traveltime, waveform and amplitude, confirming the electrokinetic theory that underlies this model. Third, a novel application of electrokinetic prospecting is studied by computer simulations; seismoelectric interferometry. In seismics and electromagnetics, the principle of interferometry has already been proven to be beneficial for imaging purposes. Interferometry using coupled seismic and electromagnetic waves for imaging purposes, can provide both seismic resolution and information about the pore fluid content. A well-known challenge in seismoelectric field surveys is the weak interface response. Using strong sources is one of the suggested solutions. However, this is not always possible and therefore it would be desirable to be able to use the principle of interferometry and hence to replace these strong sources by receivers. Interferometry implicitly stacks over many background sources, thus strong signals can possibly be obtained by recording sufficiently long to overcome the weak signal-to-noise ratio. Numerical examples show that in order to retrieve the 1-D coseismic and interface responses in a layered model correctly, the presence of only seismic sources at a single boundary location is sufficient.
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