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Quantitative monitoring of the coseismic seismoelectric field relatively to salinity and saturation variation

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Resulting from an electrokinetic coupling generated under seismic excitation, the seismoelectric (SE) effect appears as a promising tool for porous media characterization. However, due to the incomplete understanding of the underlying physics, observations remained strictly qualitative for a long time. Eventually in the 1990's, Pride's robust explanation for the SE effect opened new prospects. Within a decade, a dynamic formulation of the coseismic transfer function had been given, that expresses the coseismic electric field E relatively to the acceleration \ddot{u} .

Our purpose is to confront this model to measurements carried out on a simple porous medium at lab scale. In this experiment, a seismic wave propagates within a 120l-sandbox, filled with unconsolidated monodisperse quartz sand, for varying water contents and fluid conductivities. The seismic wave is generated by a pneumatic source of wide frequency spectrum allowing for measurements at the kilohertz range. The sandbox is equipped with 20 accelerometers, 5 water-sensors and a 30 rods electrode array. All captors are placed with a maximum offset of 30cm to the source.

By changing salinity in the range [2-8mS/m] at constant saturation, we observed a decrease in the $|E/\ddot{u}|$ transfer function proportional to the salinity increase, as expected by Pride and already reported in literature. This proved the experimental setup to be suitable for further quantitative measuring, being in our case a SE monitoring under saturation variations. After a relaxation time, a dramatic increase in seismic velocities attested full saturation. The ensuing SE monitoring while draining, going from 100 to 35% water-content, showed a change in the sign of the E/\ddot{u} ratio consistent with Pride's predictions. In the meanwhile, seismic records exhibited velocity changes in agreement with a patchy evolution of the saturation