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On the use of a combined geophysical approach to estimate the seismoelectric amplitude dependence on water content

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Seismoelectric method is a promising tool for shallow geophysical and hydrogeophysical applications, needing its understanding for unsaturated conditions. Although a complete theory on seismoelectromagnetic coupling has been proposed for saturated porous media, such a theory for unsaturated media does not exist. We propose to investigate, at field scale, the influence of water content on the seismoelectric amplitudes.
On the studied site, the soil is composed of sand in the first 10 meters. Three different zones have been selected in this area to improve the probability of investigating the larger range of water content as possible. Three seismoelectric and seismic profiles of 10 meter long have been performed. Ten electrical dipoles formed by two brass electrodes separated by one meter were used for seismoelectrics, combined to ten 3-components geophones located at the center of each dipole for seismic.
The ratios between the longitudinal electrical field E_x and the soil acceleration $\ddot{u}_x$ have been deduced from the observations, considering longitudinal fast P-wave arrivals, and then analyzed as a function of water content sections inferred from GPR Common Mid Point acquisitions. The GPR data, collected using 250 MHz antennas, allows us to investigate water contents ranging from 0.1 to 0.22, corresponding to water saturation ranging from 0.3 to 0.7.
In this range, the observations are compared to theoretical models using the transfer function $E_x/\ddot{u}_x$ developed for saturated conditions, assuming different hypotheses for the unsaturated electrokinetic coupling at low frequencies.