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Consideration of the first Fresnel zone characterisation while investigating on seismoelectric interfacial conversions

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Over the past years, seismoelectric field measurements have been developed at a previously investigated test-site. Recent improvements in our seismic triggering system enabled the systematic gathering of seismoelectric records, using various seismic sources, ranging from hammer to vibrator over weight-drops.

Those field data apparently displayed both the coseismic and the interfacial converted EM-waves. To first assess and then analyse dipole attributes of the latter, we compared three different approaches for calculating the electrical record along a surface profile induced by a vertical electric dipole at depth. The first basic approach consisted in a unique and constant vertical electric dipole placed at the center of the first Fresnel zone. The second approach relies on the discretisation of this first Fresnel zone and the summation of a multitude of constant vertical electric dipoles. The last approach involves a multitude of oscillating dipoles in addition to a discretised Fresnel zone. In all three approaches the free parameters, used to compute the vertical electric dipole, are the depth of the interface h and the adjusting amplitude parameter A, expressed in Volt. Amplitude A accounts for both the characteristics of the source and the interface (contrast of electric and hydraulic parameters).

Preliminary results show that the accuracy of the unique dipole approximation is limited: field observations are better accounted for using discretised Fresnel zone. The oscillating dipoles approach offers a slightly better correlation to field data but requires a much higher computation time. Hence the second approach, involving a discretised Fresnel zone with a multitude of constant vertical electric dipoles, seems most appropriate. RMS-analysis of amplitude distribution for identified interfacial converted EM-signals were conducted in order to determine the best fitting parameters (h, A). Field data acquired with various seismic sources, appeared to display similar values for the intensive parameter h and the extensive parameter A, once having the sources normalised by their respective seismic energies. This tends to show a linear dependence of the amplitude A on the seismic energy. It also hints at its ability to enclose global information qualifying the porous media.

To provide univocal and hence usable information, the sensibility of amplitude A to porosity, permeability and salinity has to be further investigated through modelling and lab observations.