

Effect of water saturation on seismoelectric coupling : A laboratory study

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Seismic waves propagating in a porous medium, under favorable conditions, generate measurable electromagnetic fields due to electrokinetic effects. It has been proposed, following experimental and numerical studies, that these so-called "seismoelectromagnetic" couplings depend on pore fluid properties. The theoretical frame describing these phenomena are based on the original Biot's theory, assuming that pores are fluid-filled. We study here the impact of a partially saturated medium on amplitudes of those seismoelectric couplings by comparing experimental data to an effective fluid model. We have built a 1 m-length-scale experiment designed for imbibition and drainage of an homogeneous silica sand ; the experimental set-up includes a seismic source, accelerometers, electric dipoles and capacitance probes in order to monitor the seismic and seismoelectric fields during water saturation. Apparent velocities and frequency spectra are derived from seismic and electric measurements during experiments in varying saturation conditions. Amplitudes of the seismic and seismoelectric waves and their ratios (i.e. transfer functions) are discussed using a spectral analysis performed by Continuous Wavelet Transform (CWT). The experiment results reveal that the amplitude ratios of seismic to co-seismic electric signals remain rather constant as a function of the water saturation. This result show good agreement with theoretically predicted transfer functions including effective fluid properties and some recent electrokinetic models. This experiment also show the evidence of the dynamic effect in seismoelectric coupling.

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