SIMULTANOEUS ESTIMATES OF IN-SITU POROSITY AND PERMEABILTY IN THE NEAR-SURFACE SOIL FROM SEISMIC DISPERSION AT THE LOW FREQUENCIES

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The extraction of any meaningful subsoil information from the velocity dispersion and attenuation information contained in the low-frequency (10-100 Hz) field seismic data is generally conceived as an over-ambitious task. However, we have detected that even at these low frequencies the poroelastic behavior of different seismic wave attributes and wavetypes can differ in such a way that their integration offers unique estimates of multiple soil properties at an undisturbed condition. We propose a new concept utilizing the underlying physical mechanism of frequency-dependent seismic wave propagation in the water-saturated near-surface soil.
We shall discuss the possible integration of frequency-dependent velocity and attenuation of low-frequency compressional and shear waves derived from the seismic transmission data in various soil types e.g., sand, clay, peat and gravel. The choice of the poroelastic model is data-driven. The integration leads to unique and stable estimates of in-situ porosity and permeability, simultaneously. This has obvious advantages compared with empirical approaches like those using Kozeny-Carman relation or multidisciplinary integration performed at the interpretation stage or joint inversion based on only field observation/statistics. The uniqueness and stability of the estimates derive from the fact that we selectively use only those frequency-dependent wave attributes and the differences in their underlying physics that can exploit the convexity inherent in the integrated property domain. Results will be illustrated using data from realistic synthetic tests and multiple field experiments.