Determining Green’s Functions for Coupled Elastic Waves and Electromagnetic Fields in a Homogeneous Porous Medium

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Abstract:
The theory of coupled elastic waves and electromagnetic fields in porous media exists for two decades. Several modeling codes have been developed and some field work has been carried out with mixed success. Modeling the so-called electroseismic and seismo-electromagnetic wavefields is tricky because of the strong elastic fields generated by mechanical sources and strong electromagnetic fields generated by electromagnetic sources, while the coupled fields have relatively small amplitudes. A second difficulty is the fact that the elastic field is essentially a wavefield, while the electromagnetic field is a diffusive field. The slow P-wave is usually also a diffusive field depending on the frequency bandwidth of the data. On the other hand, for porous soils and rocks, laboratory measurements have been carried out to experimentally validate the current theoretical model and to some extent this has been successful. To be able to understand measured data it is crucially important that we have good control on the accuracy of modeled data. Today we don’t have this control, which makes it hard to judge the quality of the modeled data and trust the experimental validation of the theory. It is therefore important that exact solutions are found to validate modeling codes in simple configurations. These modeling codes can then numerically validate the theory by matching the results obtained in laboratory or field experiments. The simplest configuration is the homogeneous space and we show exact solutions for the governing equations for point sources and point receivers. These Green’s functions are obtained for any type of point source and any type of receiver. We reduce the coupled equations to two scalar equations for the electric field and the particle velocity vectors. Solutions for longitudinal and transverse waves are obtained separately and these are combined to obtain the Green’s functions for the electric field and the particle velocity, from which the solutions for all other fields are found. We show numerical examples of the fields that can be measured in the field.