



Coupling of Seismic and Electromagnetic Waves in Layered Porous Media

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A lot of studies were made to develop and improve the theory and practical computation techniques of synthesizing theoretical seismograms in layered media. Applications of Chen's technique, which decomposed every vector using a set of basis of orthogonality and completeness in a cylindrical coordinate system before applying the generalized reflection and transmission coefficients method, showed that this method is valid and efficient in dealing with elastic waves in multi-layered media. In porous media, seismic and electromagnetic waves are coupled and the main coupling mechanism is electrokinetic effect. Pride's model gives a set of macroscopic dynamic governing equations controlling the coupled seismic and electromagnetic waves in fluid-saturated porous media. These governing equations have the form of Biot's equations coupled to Maxwell's equations with coupling occurring in the transport relations. In this study, we extended Chen's method of calculating synthesizing theoretical seismograms to the study on the coupled seismic and electromagnetic waves in layered porous media, which are described by Pride's model. We expanded the governing equations corresponding to PSVTM and SHTE models respectively by a set of vector basis of function in a cylindrical coordinate system and derived the explicit formulas of calculating the generalized reflection and transmission coefficients. The reciprocity test and the numerical results of some model tests showed that our technique is valid for the computation of the coupled seismic and electromagnetic waves in multi-layered porous media. We also made sensitivity analysis of some model parameters and discussed the potential application of the current technique. Thus, this work can provide an effective approach of investigating seismoelectromagnetic effects in porous media, which is useful for monitoring the pumping of oil and gas reservoirs and the possible electromagnetic disturbances associated with earthquakes and volcano eruptions.