DESCRIPTION AND MODELLING OF 3D WAVEFIELDS IN LAYERED ELASTIC MEDIA WITH CURVED REFLECTORS

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Seismic waves travelling in the subsurface can be described by two physically different processes: propagation inside layers with smoothly varying properties and reflection and transmission at internal reflectors, which are formed by parameter discontinuities. We describe and model 3D wavefields scattered in layered elastic media according to this principle. Our approach is analytical and merges a surface integral representation and a generalized wavenumber-domain decomposition. We explicitly represent the scattered wavefield as the superposition of events multiply reflected and transmitted in accordance with the wavecodes, which allows modeling of selected events independently. Each event is formed by the sequential action of the classical surface integral propagators inside heterogeneous layers and convolution reflection and transmission operators at curved interfaces. We use a seismic-frequency approximation of the propagators in the form of a tip-wave superposition method (TWSM). Also, for a seismic frequency range, we reduce the reflection and transmission operators to effective reflection and transmission coefficients. Effective coefficients generalize plane-wave coefficients widely used in the conventional seismic modeling for curved reflectors, non-planar wavefronts and finite frequencies. Through numerical modeling examples, we illustrate that the approach is capable of reproducing complex wave phenomena, such as caustics, edge diffractions and head waves. We also show how the methodology can be applied in various exploration tasks, in particular for modeling of the Green's function in geologically complex elastic media and for the 4D modeling of seismic reflection data.

References

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