Abstract

Approximation of weakly anisotropic media allows to simplify solutions of modeling and inversion in anisotropic media. Perturbation methods are commonly used tools for describing wave propagation in weakly anisotropic media. An anisotropic medium is replaced by an isotropic background medium where wave propagation can be treated easily and, then, the correction for the effects of anisotropy are computed by perturbation techniques.

To minimize errors which are inherent in any perturbation method the background isotropic medium should be chosen to be as close as possible to the true anisotropic medium. To obtain the isotropic background media, formulae for a sectorially best-fitting isotropic medium are derived and their application is illustrated by examples of media with transversely isotropic and orthorombic symmetries.

For modeling in weakly anisotropic media a quasi-isotropic (QI) approach is considered. Seismograms obtained by the QI approach are compared with seismograms resulting from the standard anisotropic ray method and finite-difference numerical forward modeling. The comparison shows that the QI approach is sufficiently accurate in media with 1–5% anisotropy.

I develop a 3D finite-difference (FD) perturbation method for the robust and efficient qP-wave traveltime computation in anisotropic media which is important in many modeling and inversion applications. I suggest to apply this method using isotropic and ellipsoidally anisotropic background media. The ellipsoidally anisotropic background media allow to improve the accuracy of the traveltime computations.

The approximation of weakly anisotropic media allows to obtain linear relations between perturbations of the elastic parameters of the weakly anisotropic medium with respect to an isotropic background medium and corresponding traveltime perturbations. The relations are inherently linear for qP-wave traveltimes, and can be linearized for qS-wave traveltimes using the qS-wave polarization vectors. The qS-wave polarization vectors are available from a seismic experiment as well as traveltimes. On the basis of these linear relations the same linear tomographic inversion scheme for qP- as well as for qS-wave data is developed. The joint inversion of qP- and qS-waves allows to determine the full elastic tensor of the weakly anisotropic medium. The inversion procedure was tested using synthetic noise-free and noisy data obtained for homogeneous and layered models.