Inversion of P-wave traveltimes from a VSP experiment in a homogeneous anisotropic medium

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Determination of seismic anisotropy of rock environment plays an important role both in structural and exploration seismology. Knowledge of the orientation and strength of anisotropy has important geological implications as, e.g., estimation of the orientation of structural elements (layering, dikes, fissures) or of the orientation of the tectonic stress. The goal of this contribution is to test, first in a homogeneous model, the P-wave traveltime inversion based on weak-anisotropy approximation. In this approximation, traveltimes depend, approximately, on 15 P-wave weak-anisotropy (WA) parameters representing an alternative to the standard parameterization by a stiffness tensor. A typical VSP (vertical seismic profiling) configuration is considered, which guarantees relatively high angular illumination of a medium. As observed data, exact P-wave traveltimes generated in homogeneous orthorhombic media of arbitrary orientation, noise free or with added Gaussian noise are used. Results of the inversion are estimates of 15 P-wave WA parameters with corresponding resolution and covariance matrices. Properties of resolution matrices indicate quality of the measurement configuration. Properties of covariance matrices allow us to estimate the accuracy, with which individual WA parameters are determined. Results of a number of synthetic tests for varying source-receiver configurations, two velocity approximations, varying noise types/levels, etc. are presented.