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Modification of anisotropy analysis in Moho using converted Ps phase

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Extended Abstract

Summary

Seismic velocity changes and shear wave anisotropy analysis can provide insights into deep structures. In multi-layered structures, cosine moveout pattern of radial component is observed for converted Ps phase. The method to calculate anisotropy parameters in layered structures has been developed by Ruempker et al. (2014).

Some seismic stations do not have enough coverage in some azimuths, and we can split parameters (φ, δt) by fitting the best curve on Ps arrivals using the grid-search method. In this study, using synthetic data, the effect of the azimuth coverage is investigated and the sensibility of the results is also examined.

Introduction

Seismic anisotropy analysis is one of the methods to study the rate of tectonic stresses in deep structures. Variation of seismic wave velocity with direction is considered as seismic anisotropy. Whenever a shear wave reaches the anisotropic media; it splits into two directions, called fast and slow directions. Parameters which describe seismic anisotropy are the direction of polarization of the fast shear wave (denoted by φ) and the splitting time between the fast and slow component of shear waves (denoted by δt). Thus, resolving the seismic anisotropy of the lithosphere-asthenosphere system and its variations is one of the main problems in geodynamic interpretation.

As overburden pressure is increasing in the lower crust and the uppermost mantle, cracks are expected to close (Babuska and Pros, 1984), and crustal fluids, filled the cracks and fractures, generate seismic anisotropy (Ague, 1995). Therefore, the lattice-preferred orientation (LPO) is the main source of seismic anisotropy in nonexistence of cracks and fractures. Main constitutions of the crust are minerals with various degree of anisotropy (Babuska and Cara, 1991) and properties of olivine and orthopyroxene crystals dominate the upper mantle anisotropy (Sadidkhouy et al., 2008).

Seismic anisotropy analysis is one of the methods to study the rate of tectonic stresses in deep structures. Seismic anisotropy is directional variation of seismic wave velocity. In the upper crust, the main reason for seismic wave anisotropy is the existence of fractures, cracks and joints.

Methodology and Approaches

In multi-layered structures, cosine moveout pattern of radial component is observed for converted Ps phase. The method to calculate anisotropy parameters in the layered structures has been developed by Ruempker et al. (2014). Ps-receiver functions in anisotropic media exhibit distinct azimuthal patterns of their radial and transverse components (Levin and Park, 1997; Schulte-Pelkum et al., 2005). If the ray path was perpendicular to fast direction on anisotropy, the effective time arrival of Ps in anisotropic media would be equal to Ps time arrival in the isotropic media. Both, radial and transverse waveform amplitudes exhibit a π-periodicity with respect to the back azimuth φ_f. The converted Ps phase arrivals are calculated by receiver functions method. The energy diagram illustrating the stacked energy of the radial component from the grid-search is used for splitting parameters φ and δt based on fitting the best curve on Ps arrivals.

The systematic analysis of Ps phase for anisotropic media is often limited by the lack of high-quality data over a wide range of back azimuths at individual seismic stations.

Some seismic stations do not have enough coverage in some back azimuths. In this study, using synthetic data, the effect of the azimuth coverage is examined and the sensibility of the results is also investigated.

Results and Conclusions

The limitation of the method presented by Ruempker et al. (2014) for anisotropy analysis with Ps phase is the lack of high quality data recorded with different back azimuths at each station. In this paper, for the first time, the effect of the lack of back azimuth data on the shear wave shear anisotropy calculation method in the lower crust has been investigated. In addition, data from the Kerman Seismic Station (KRBR) have been used to determine the shear wave anisotropy in lower crust.

In case of hexagonal anisotropy with horizontal symmetry axis, harmonic functions have been used to evaluate anisotropy parameters and provide possibility of using alternate receiver functions with π-periodicity.

The results of this study indicate that the anisotropy and its alignment are respectively $\delta t = 0.34 \pm 0.02$ (sec) and $\varphi_f = 65 \pm 4$ (degrees).