Geophysical Research Abstracts,
Vol. 11, EGU2009-4536, 2009
EGU General Assembly 2009

‘Similarity method’ to evaluate splitting from shear phases

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To retrieve reliable 3D anisotropic models of the upper mantle, we need to analyze waves with as much complete as possible azimuth and incidence-angle coverage. Usually, we have enough data for methods dealing with P-traveltime deviations, but a distribution of earthquake foci providing core-mantle refracted shear waves (SKS) is limited. The waves suitable for splitting analysis have several other limitations:

• Only strong shear waves with a high signal/noise ratio can be analysed reliably, therefore, events with magnitudes higher then six and preferably deep ones, are used.
• Core shear phases SK(K)S, which are well discriminated from direct S waves, are generated at epicentral distances larger than 90 degrees.
• Employment of only SK(K)S waves implies narrow incidence angle interval of incoming waves.
•Contrary to the SK(K)S phases, direct shear waves can exhibit elliptical polarisation before entering anisotropic structures, but on the other hand they illuminate broadly the volume studied. Processing of direct shear-waves is more complicated and, therefore, they are used only exceptionally (Savage, 1999)

We present results of shear-wave splitting measurements on a set of wave-forms recorded at an array. The presented method incorporates also direct shear waves into the splitting analysis and thus increases amount of evaluated anisotropic parameters from the high quality signals and improves angular coverage of the volume by additional rays. Consequently, 3D models of retrieved anisotropic structures can be considered more representative.

The method assumes that undisturbed waveforms arrive at the bottom of the volume beneath the array with similar (or identical) shape and polarization, though a general one. The task is to find this similarity from wave-forms recorded at individual stations of the array and disturbed by the structure beneath the array. We test different conditions of waveform similarity, namely in its shape, polarization, spectral character, etc. Corresponding weighting of the similarity misfit functions is provided by the use of multiobjective optimization (Kozlovskaya et al., 2007). We compare results from the similarity method with results of splitting measurements of the SK(K)S anisotropy beneath the Bohemian Massif (waveforms recorded during passive seismic experiment BOHEMA II).