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The analysis of seismic anisotropy in the area of the German Regional Seismic Network (GRSN)

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Based on SKS analysis several studies have shown evidence that the crust and/or the upper mantle are seismically anisotropic beneath the area of the German Regional Seismic Network (GRSN). Until now the relative shares of the crust and mantle to the bulk anisotropy have not been determined. The aim of our study is to estimate the crustal and mantle shares of seismic anisotropy by analyzing the polarization of P-to-S converted waves (receiver functions) generated at the Moho and at the upper mantle discontinuities. Studies of anisotropy can be applied to evaluate the structure of media at scales much shorter than a wave length. Seismic anisotropy finds its expression in a directional dependence of seismic velocities and in the travel time delay between orthogonally polarized S-waves (S-wave splitting). Anisotropic geological structure affects the azimuth dependence of split S-wave amplitudes in a specific way. The azimuth patterns of splitting periodicity, $360°$, $180°$, or other (2, 4 lobed) are defined by the orientation of axis symmetry (vertical, horizontal, tilted) of mineral crystals or porosities/cracks aligned in the subsurface. In addition, a steeply tilted symmetry axis leads to a sign reversal of amplitude and/or to a decrease the periodic amplitude pattern itself.

Since about 16 years the GRSN provides continuous seismological data records for most of its stations for $mb > 5.5$ and epicentral distances of $0° - 100°$. Based on an analysis of back azimuth and incidence rotated ray component (L) we determined an average signal/noise ratio from 4.5 to 22 for these data. Because of the long observation time the azimuth coverage of incidence angles is sufficient for the major part of station $(18/25)$. So, the data basis for an analysis seismic anisotropy is well established.

The P-to-SV converted wave fields generated at the Moho show a frequency variation with azimuth (broading of amplitude peaks) and an azimuth periodicity in amplitude strength. These are indications of both a thickness variation of a transition zone and existence of anisotropy. On the SH-component converted energy is observed, too. Its amplitude and polarity periodicity is $360°$ for most of the GRSN stations. Some stations show less than $360°$ or unclear periodicity.

For the analysis of P-to-S converted waves we selected 2455 events of magnitude $mb > 5.5$. To process the receiver functions (rf) of this data volume we set up an automatic process including the computation of various quality criteria. The processing steps included in the procedure are: (1) rf calculation based on real and theoretical polarization angles, (2) rf selection based of signal-to-noise ratio, (3) rf weighting based on the quality of polarization. The rate of data reduction during this process is approximately between 50 and 70 percent.