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Laterally Varying Deep Seismic Anisotropy Around the Black Forest Observatory, Germany

Joachim Ritter, Michael Grund, and Yasmin Sanz Alonso
Karlsruhe Institute of Technology (KIT), Geophysical Institute, Karlsruhe, Germany (joachim.ritter@kit.edu)

The Black Forest Observatory is built into a deep mine in Southwest Germany. There high precision measurements can be conducted at a very low noise level due to its specific siting and careful handling. Now high-quality seismological broadband waveforms are available for more than 25 years of observations. We use this unique dataset to study seismic shear wave birefringence of the core phases SKS, PKS and SKKS, because it is the best such dataset available in Europe. Due to the long recording period waveforms from 1166 events were analysed. After a rigorous data selection, 318 phases could be used. As results the splitting parameters phi (fast shear wave polarisation direction), dt (time delay between the fast and slow propagating shear waves) and null splits are determined based on single event measurements (53 split results and 227 null splits) and the simultaneous inversion of multiple waveforms (27 split results and 14 null splits).

The backazimuthal distribution of the splitting parameters clearly suggests that a laterally uniform anisotropic structure at depth cannot explain the observations. Instead at least two laterally varying structural pattern are required: towards NW, in the South German Triangle, a two-layer model can best explain the backazimuthal distribution of the splitting parameters. The other observational quadrants are dominated by null splits, especially in the SW quadrant. In this direction the steeply propagating core phases cross the deep structure (if there is any) of the southernmost Upper Rhine Graben and/or the Kaiserstuhl volcanic complex. However, the actual cause of the null splits or the lateral variation is still a matter of debate.