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# Shear-wave splitting of SK(K)S-phases beneath the Upper Rhine Graben area: Indications for laterally and vertically varying seismic anisotropy

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The observed backazimuthal variations in the shear-wave splitting of core-refracted shear waves (SK(K)S-phases) at the Black Forest Observatory (BFO, SW Germany) indicate small-scale lateral and (partly) vertical variations of the elastic anisotropy in the upper mantle. However, most of the existing seismic anisotropy studies and models in the Upper Rhine Graben (URG) area are based on short-term recordings and thus suffer from a limited backazimuthal coverage and averaging over a wide or the whole backazimuth range. Hence, to find and delimit basic anisotropy regimes, also with respect to the connection to geological and tectonic processes, we carried out further SK(K)S splitting measurements at permanent (BFO, WLS, STU, ECH) and semi-permanent (TMO44, TMO07) broadband seismological recording stations.

To achieve a sufficient backazimuthal coverage and to be able to resolve and account appropriately for complex anisotropy, we analysed long-term recordings (partly > 20 yrs.). This was done manually using the MATLAB-program SplitLab (single-event analysis) together with the plugin StackSplit (multi-event analysis). The two splitting parameters, the fast polarization direction $\Phi$ given relative to north and the delay time $\delta t$ accumulated between the two quasi shear waves, were determined by applying both the rotation-correlation method and the minimum-energy method for comparison. Structural anisotropy models with one layer with horizontal or tilted symmetry axis and with two layers with horizontal symmetry axes (assuming transvers isotropy with the fast axis being parallel to the symmetry axis) were tested to explain the shear-wave splitting observations, including lateral variations around a recording site.

The determined anisotropy is placed in the upper mantle due to the duration of the delay times (> 0.3 s) and missing discrepancies between SKS- and SKKS-phases (so not hints for significant lowermost mantle contributions). The spatial distribution and the lateral and backazimuthal variations of the measured (apparent) splitting parameters confirm that the anisotropy in the mantle beneath the URG area varies on small-scale laterally and partly vertically: On the east side of the URG, from the Moldanubian Zone (BFO, STU, ECH) to the Saxothuringian Zone (TMO44, TMO07) a tendency from two layers with horizontal symmetry axes to one layer is suggested. In the Moldanubian Zone, between the east side (STU, BFO) and the west side (ECH) of the URG, a change of the fast polarisation directions of the anisotropy models with two layers with horizontal

symmetry axes is observed. Inconsistent measured apparent splitting parameters and the observation of numerous null measurements, especially below the URG may be at least partly related to scattering of the seismic wavefield or a modification of the mantle material.