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The influence of near-vertical SK(K)S ray path incidence on the backazimuthal variation of shear-wave splitting parameters: A case study of the Central Alps

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Seismic anisotropy in the upper mantle is generally assumed to be caused by lattice-preferred orientation (LPO) of olivine and orthopyroxene. This phenomenon is of great interest to geodynamics, since it may constrain remotely the geometry of deformation that is causing the LPO. A rather useful (although not the only) way of studying seismic anisotropy is shear-wave splitting (SWS), which refers to the birefringence of shear-waves that generally occurs in anisotropic media. To describe this effect on teleseismic shear-waves one often recurs to two parameters, the splitting delay (δt) and the fast polarization orientation (φ, azimuth). While many studies have focused on interpreting mean φ , it has remained largely unnoticed that also the orientation of the flow plane can perhaps be constrained. This is of interest, since it may permit distinguishing between a lithospheric or asthenospheric origin of anisotropy. That would allow entirely new constraints on geodynamic processes occurring in the subsurface. It may indeed be possible to differentiate between alignment geometries of olivine, e.g., of an upward-aligned olivine b- or c-axis in a single-layer anisotropy case. The difference shows up in the amplitude and polarity of backazimuthal variations of SWS parameters. Both LPOs could be related to different geodynamic models; simple asthenospheric flow (SAF, b-up olivine) and vertical coherent deformation (VCD, c-up olivine) within lithosphere. Resolving the polarity of the oscillation around the mean φ may thus give an indication on the origin of anisotropy and the presence of geodynamic activities, e.g. in subduction zones. We examine these approaches using SWS measurements from the Central Alps, which unveil a homogeneous, trench-parallel pattern of φ, satisfying our single-layer anisotropy assumption. Moreover, we discuss whether the source of anisotropy can be explained by the lithospheric slab (VCD, c-up olivine) or the mantle flow in the sub-slab mantle (SAF, b-up olivine).