Title: Anisotropic tomography of the European upper mantle

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Abstract: Large-scale seismic anisotropy of the continental mantle lithosphere derived from joint inversion/interpretation of directional variations of P-wave travel-time residuals and SKS-wave splitting calls for orientation of the symmetry axes to be treated generally in 3D. Nevertheless, most of the tomography studies neglect the anisotropy of the body waves completely or they are limited to either azimuthal or radial anisotropy. Therefore, we have developed a code called AniTomo for coupled anisotropic-isotropic travel-time tomography of the upper mantle. The novel code allows inversion of relative travel-time residuals of teleseismic P waves simultaneously for 3D distribution of P-wave isotropic-velocity perturbations and anisotropy of the upper mantle. We assume weak anisotropy of hexagonal symmetry with either the ‘high-velocity’ *a* axis or the ‘low-velocity’ *b* axis. The symmetry axis is allowed to be oriented freely in any direction. Model parameters are perturbations of isotropic component of the anisotropic velocity, strength of anisotropy, and azimuth and inclination of the symmetry axis. We have tested the new code thoroughly, involving both simple methodological tests to find out basic characteristics of the method and tests mimicking real tomographic inversions as to the target structures and the station-event distribution. Regarding the well-known trade-off between P-wave anisotropy and isotropic heterogeneities, the inversion with code AniTomo can successfully distinguish the isotropic and the anisotropic components of the velocity, depending, of course, on data quality. For the first application of the novel code, we opted for data from international passive seismic experiment LAPNET (2007 – 2009) deployed in a tectonically stable region of northern Fennoscandia. The resulting tomographic model shows that the strongest anisotropy and the largest isotropic-velocity perturbations concentrate at the mantle-lithospheric depths while in the deeper parts their amplitudes decrease significantly. The anisotropy derived in the mantle-lithospheric part of the model enables us to delimit regions of laterally and vertically consistent anisotropy. These regions are compatible with the domains inferred from the joint interpretation of directional variations of P-wave travel-time residuals and SKS-wave splitting parameters. We associate the domain-like anisotropy with fossil fabrics of blocks of the Archean mantle lithosphere, preserved probably from the time of the lithosphere origin.

Keywords: Seismic tomography, Velocity anisotropy, Body waves, Upper-mantle structure, 3D fabrics of mantle-lithosphere domains, Fennoscandia