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Coupled anisotropic and isotropic tomography of the upper mantle beneath northern Fennoscandia - Application of a novel code AniTomo

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Seismological investigations of the continental mantle lithosphere, particularly its anisotropic structure, advance our understanding of plate tectonics and formation of continents. Orientation of the anisotropic fabrics reflects stress fields during the lithosphere origin and its later deformations. To contribute to studies of the large-scale upper-mantle anisotropy, we have developed code AniTomo for regional anisotropic tomography. AniTomo allows a simultaneous inversion of relative travel time residuals of teleseismic P waves for 3D distribution of isotropic-velocity perturbations and anisotropy in the upper mantle. Weak hexagonal anisotropy with symmetry axis oriented generally in 3D is assumed. The code was successfully tested on a large series of synthetic datasets and synthetic structures.

In this contribution we present results of the first application of novel code AniTomo to real data, i.e. relative travel-time residuals of teleseismic P waves recorded during passive seismic experiment LAPNET in the northern Fennoscandia between 2007 and 2009. The region of Fennoscandia is a suitable choice for the first application of the new code. This Precambrian region is tectonically stable and has a thick anisotropic mantle lithosphere (Plomerova and Babuska, Lithos 2010) without significant thermal heterogeneities.

In the resulting anisotropic model of the upper mantle beneath the northern Fennoscandia, the strongest anisotropy and the largest velocity perturbations concentrate in the mantle lithosphere. We delimit regions of laterally and vertically consistent anisotropy in the mantle-lithospheric part of the model. In general, the identified anisotropic regions correspond to domains detected by joint interpretation of lateral variations of the P- and SKS-wave anisotropic parameters (Plomerova et al., Solid Earth 2011). Particularly, the mantle lithosphere in the western part of the volume studied exhibits a distinct and uniform fabric that is sharply separated from the surrounding regions. The eastern boundary of this region gradually shifts westward with increasing depth in the tomographic model. We connect the retrieved domain-like anisotropic structure of the mantle lithosphere in the northern Fennoscandia with preserved fossil fabrics of the Archean micro-plates, accreted during the Precambrian orogenic processes.