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Joint inversion of shear-wave splitting parameters and longitudinal-wave residuals with the use of multi-objective optimization and its application to the seismic anisotropy investigations in the Fennoscandian Shield

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We propose a new method of joint inversion of anisotropic shear-wave splitting parameters and longitudinal- wave residuals with the use of multiobjective optimisation (Kozlovskaya, 2001). The method is tested with synthetic data and applied to the several sets of real data including the body waves registered during the SVEKALAPKO deep seismic tomography experiment in the Fennoscandian Shield. In general, an orientation of anisotropic structures in the upper mantle can be retrieved independently from P-wave residuals as well as from shear-wave splitting parameters. However, modelling the upper mantle anisotropy independently, and moreover, evaluating the splitting only in 2D (horizontal component of anisotropy), leads often to contradictory models. This apparent contradiction can be easily removed, if a broader set of models of anisotropy is assumed (e.g. hexagonal symmetry with slow symmetry axis and with various degree of anisotropy) and a general 3-D orientation of symmetry axes is allowed (Babuska et al., 1993). Under such assumption a joint inversion of splitting parameters of teleseismic shear waves and P-wave residual spheres makes it possible to retrieve 3D self-consistent anisotropic models of the mantle lithosphere (Sileny and Plomerova, 1996). The inversion is non-linear and its resolution and efficiency can be analyzed in a more convenient way, if it is formulated as a multi-objective optimization problem. The inversion confirmed the existence of several mantle lithosphere domains with different orientation of anisotropic structure below the SVEKALAPKO

seismic array. In particular, strong anisotropy and uniform orientation of anisotropic material in the upper mantle was revealed beneath the Archean domain. On the other hand, the anisotropic pattern corresponding to the Proterozoic domain is more heterogeneous with weaker anisotropy in the central part. This may result from the collision (underthrusting) of the Proterozoic and Archean units, each of them having different orientation of mantle material.