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Shear-wave splitting beneath thick lithospheric keels: a case study of the East European Craton

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The method of shear wave splitting provides a unique possibility to identify seismic anisotropy and to measure the orientations of fast and slow wave propagation directions. Seismic anisotropy results from the lattice-preferred orientations of anisotropic minerals. Though the depth of the anisotropic layer is less well-constrained there is evidence that most of the splitting occurs in the asthenosphere and/or lithosphere. Lithospheric anisotropy is often referred to as "frozen" anisotropy as it renders past tectonic events. On the other hand, asthenospheric anisotropy results from the deformation associated with plate motion. That deformation aligns the minerals, in particular olivine, in the direction of relative motion.

One of the major questions in geodynamics is, if this relative motions is caused by the motion of the tectonic plate (driven by slab pull and ridge push) or accommodates the convective motion of the upper mantle (basal drag). Obstacles to the mantle flow provide a possibility to distinguish between either of the possible mechanism. The East European Craton may represent such an obstacle as it can be identified in tomographic studies down to depths of more than 300 km. Previous investigations in its surroundings in central Europe indicate fast directions aligning along the cratons' margins. This may indicate asthenospheric flow around the thick lithospheric keel. Though plate motion is slow (˜20mm/yr) the direction of European plate motion correlates well with the seismic fast directions. We investigate shear wave splitting of 18 broadband stations located on the East European Craton. Some of these stations operate for more than a decade and thus provide an ideal dataset for a wide range of backazimuths. We can distinguish two prominent regions. Fast directions align parallel to the margins in the south and west, which may indicate active mantle flow around the craton. The northern and central part of the craton show north to north-eastern fast directions. This might indicate frozen anisotropy form earlier tectonic events.