Large-scale fabric of mantle lithosphere of Precambrian cratons as derived from seismic anisotropy

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The radial and azimuthal anisotropy of surface waves constrain the lithosphere thickness of Precambrian cratons to a maximum of about 200-220 km. While the anisotropy within the lithosphere is well developed, below it the seismic anisotropy is very small. Both the surface waves and body waves indicate dipping anisotropic structures in the mantle lithosphere which may represent remnants of accreted pieces of ancient oceanic lithosphere and paleosubductions inferred also from dipping seismic reflections extending into the mantle. An interpretation of the observed surface-wave anisotropy results in a model of olivine petrofabrics with (a,c) foliation plane, characterized by the highest P velocities and polarization of the fast split shear waves. The foliation planes dip steeply beneath the cratons, compared to modest dips beneath Phanerorozoic regions. The steep orientations of the foliation planes mean that a major part of the subcrustal lithosphere of cratons was not formed by the conductive cooling mechanism which should result in subhorizontal orientations of the olivine a-axes and the (a,c) foliation planes. Lateral distribution of the radial anisotropy indicates that the Precambrian mantle lithosphere extends beneath many Phanerozoic orogenic belts. Anisotropy of body-wave velocities, studied by a joint analysis of shear-wave splitting parameters and patterns of teleseismic P-residual spheres, provides a good resolution for identification of boundaries of lithospheric blocks with different fabric orientations, e.g. in the Baltic Shield. The age-dependent large-scale fabrics of the mantle lithosphere indicate different modes of growth of the continental lithosphere during Archean-Early Proterozoic, compared with the Phanerozoic.