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Structure of the Precambrian lithosphere in Fennoscandia - an indication of stability of mantle lithosphere fabrics and existence of an early form of plate tectonics

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We model lithosphere thickness and anisotropic structure in one of the oldest continental regions on the planet - the Fennoscandian Shield. Our models, based on empirically derived relation between static terms of relative P residuals and lithosphere thickness and considering velocity anisotropy (Babuska and Plomerova, 1992), are in good agreement with estimates of the lithosphere thickness based on surface waves, magnetollurics and xenoliths. The lithosphere base is mapped at depth of about 200-220 km beneath the central part of the craton and it shallows significantly at its margins. In general, the large-scale seismic anisotropy reflects a rock texture, created by orientation of crystals of olivine (LPO) in a stress field, acting during formation of the mantle or its later deformations. We show results of our study of anisotropy from teleseismic data recorded during several passive experiments (Varmland'91, TOR-96/97, SVEKALAPKO-98/99) by temporary stations and by permanent observatories in Fennoscandia. Joint inversion of independent data (shear-wave splitting and P-residual spheres) allows us to invert for orientation of elastic tensor, symmetry and thickness of the anisotropic medium (Kozlovskaya et al., 2006). Geographical variations of anisotropic parameters of teleseismic body waves and their distinct dependence on direction of wave propagation through the upper mantle allow us to model several mantle lithosphere domains with different fabrics both in the Proterozoic and in the Archean parts. The domains can be separated by a steep narrow zone, e.g. the Protogine Zone between the Sveconorwegian and Svecofennian lithospheres in the

Proterozoic part of the shield (Plomerova et al., 2001). Similarly steep boundary was found by different methods (Arlit et al., 1999; Plomerova et al., 2002; Cotte et al., 2002; Plomerova and Babuska, 2004) between the Shield and the Phanerozoic Europe. On the other hand, intercalating wedges of the Proterozic and Archean lithospheres of different fabrics are seen by seismic anisotropy in south-central Finland (Plomerova et al., 2006; Vecsey et al , 2006). The model corresponds to recently studied mantle xenolith ages (Peltonen and Brugmann, 2006), surface wave tomography (Bruneton et al., 2004, Pedersen et al., 2006) and location of upper mantle reflectors (Yliniemi et al., 2004). Moreover, several domains were revealed within the Archean mantle lithosphere itself. We interpret the anisotropic domains as fragments of mantle lithosphere retaining an old fossil olivine fabric, which was created before these micro-continents assembled (Babuska and Plomerova, 2006). The mantle lithosphere composed of blocks with differently oriented fabrics supports an idea that lithospheric roots have been formed during an early form of plate tectonics, i.e., by subduction-related processes, i.e., thrust stacking of oceanic (proto-cratonic) lithospheres and accretion of magmatic arcs, since Archean.