Geophysical Research Abstracts
Vol. 15, EGU2013-3105, 2013
EGU General Assembly 2013

Pre-plate tectonics and structure of the Archean mantle lithosphere imaged by seismic anisotropy – inferences from the LAPNET array in northern Fennoscandia

Jaroslava Plomerova, Ludek Vecsey, Vladislav Babuska, and Lapnet Working Group
Institue of Geophysics, Academy of Sciences, Prague, Czech Republic (jpl@ig.cas.cz)

Various studies of seismic anisotropy clearly demonstrate the Archean mantle lithosphere consists of domains with different fabrics reflecting fossil anisotropic structures. We detect anisotropic signal both in the P-wave travel-time deviations and shear-wave splitting recorded by the LAPNET array (2007-2009) in the Archean craton of Fennoscandia (Plomerova et al., 2011). The anisotropic parameters change across the array and stations with similar characteristics form groups. The geographical variations of seismic-wave anisotropy delimit individual sharply bounded domains of the mantle lithosphere, each of them having a consistent fabric. The domains can be modelled in 3D by peridotite aggregates with dipping lineation a, or foliation (a,c). Also radial anisotropy of the Archean lithosphere derived from surface waves indicates inclined structure of all the cratonic regions of the continents, though with less detailed lateral resolution in comparison with body-wave anisotropy. These findings allow us to interpret the domains as micro-plate fragments retaining fossil fabrics in the mantle lithosphere, reflecting thus an olivine LPO created before the micro-plates assembled.

Successive subductions of oceanic lithosphere is a mechanism which can work in modern-style plate tectonics as we know it now, being considered as widespread since 2.7 Ga. Though the modern plate tectonics is the most distinct tectonic style acting up to now, we have to consider a mechanism creating oriented structures (fabrics) in a pre-plate-tectonic style. The early lithosphere formed in dynamic conditions far from simple cooling which would result in sub-horizontal layered structure of the lithosphere. Earlier tectonic modes in a hotter and more dynamic Earth might be similar in some respects to those of the modern-plate tectonics. Basaltic “rockbergs” on convecting magma ocean in the Hadean Earth are supposed to turn to either proto-plate tectonics with platelets and supercratonal, or, to unstable stagnant lithospheric lid models in the Archean ($\sim$4.0 Ga), both evolving into the modern-style plate tectonics (Ernst 2007). The stage of platelets or supercratonal lasted during the deep mantle and plume-driven circulations, when plate motions were controlled by asthenospheric convection dragging buoyant lithosphere along and down. Differential motions between pairs of Precambrian cratons indicated in paleomagnetic records suggest supercontinental amalgamation and dispersal involving Archean cratons. Current thick and cold Archean cratons are thus formed by a collage of fragments of old lithosphere, each of them retaining its fabric. Studies of fossil anisotropy preserved in the mantle lithosphere contribute both to mapping the lithosphere-asthenosphere boundary and deciphering boundaries of individual blocks building the continental lithosphere (Plomerova and Babuska, Lithos 2010).