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Dipping fossil fabrics of continental mantle lithosphere as tectonic heritage of oceanic paleosubductions

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Subduction and orogenesis require a strong mantle layer (Burov, Tectonophys. 2010) and our findings confirm the leading role of the mantle lithosphere. We have examined seismic anisotropy of Archean, Proterozoic and Phanerozoic provinces of Europe by means of shear-wave splitting and P-wave travel-time deviations of teleseismic waves observed at dense arrays of seismic stations (e.g., Vecsey et al., Tectonophys. 2007). Lateral variations of seismic-velocity anisotropy delimit domains of the mantle lithosphere, each of them having its own consistent fabric. The domains, modeled in 3D by olivine aggregates with dipping lineation a, or foliation (a,c), represent microplates or their fragments that preserved their pre-assembly fossil fabrics. Evaluating seismic anisotropy in 3D, as well as mapping boundaries of the domains helps to decipher processes of the lithosphere formation.

Systematically dipping mantle fabrics and other seismological findings seem to support a model of continental lithosphere built from systems of paleosubductions of plates of ancient oceanic lithosphere (Babuska and Plomerova, AGU Geoph. Monograph 1989), or from stacking of the plates (Helmstaedt and Schulze, Geol. Soc. Spec. Publ. 1989). Seismic anisotropy in the oceanic mantle lithosphere, explained mainly by the olivine A- or D-type fabric (Karato et al., Annu. Rev. Earth Planet. Sci. 2008), was discovered a half century ago (Hess, Nature 1964). Field observations and laboratory experiments indicate the oceanic olivine fabric might be preserved in the subducting lithosphere to a depth of at least 200-300 km. We thus interpret the dipping anisotropic fabrics in domains of the European mantle lithosphere as systems of “frozen” paleosubductions (Babuska and Plomerova, PEPI 2006) and the lithosphere base as a boundary between the fossil anisotropy in the lithospheric mantle and an underlying seismic anisotropy related to present-day flow in the asthenosphere (Plomerova and Babuska, Lithos 2010).