Growth and evolution of continental lithosphere by cycles of oceanic subductions – Evidence from seismic anisotropy supported by petrologic and geochemical findings

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Formation and evolution of the continental lithosphere, one of the ILP research themes, still belongs to fundamental questions often debated within different geoscience disciplines. We emphasize the role of mantle lithosphere that forms the biggest volume of continents, but is often overlooked, particularly in geologic interpretations of tectonic processes. Investigation of seismic anisotropy from propagation of teleseismic P and S waves in three dimensions (3D) provides a unique constraint on tectonic fabrics and character of past and present-day deformations. We collect independent findings from seismology, petrology and geochemistry to support our 3D anisotropic model of mantle lithosphere with tilted symmetry axes, derived from data of passive seismic experiments organised in tectonically different domains of Archean, Proterozoic and Phanerozoic provinces of Europe. We delimit the extent of lithosphere domains and their boundaries according to changes in orientation of the large-scale anisotropy, associated with a systematic preferred orientation of olivine, originally formed by mantle convection in the oceanic mantle lithosphere and “frozen” deep in continents.

We explain the oriented dipping fabrics in the continental mantle lithosphere by successive subductions of ancient oceanic plates and their accretions enlarging a primordial continent core, consequent supercontinent break-ups and assemblages of wandering micro-plates to create the patchwork structure of the present-day continents. Supporting arguments for such model arise from petrologic and geochemical studies indicating that continental peridotites formed in oceanic environments and became “continental” after significant thickening or underthrusting. Combining seismological, petrologic and geochemical findings can help to bridge the gap between the different viewpoints and evoke further discussions on growth mechanisms and evolution of the continental lithosphere. Data gathered during new large-scale passive seismic experiments, like AlpArray, AdriaArray, PACASE and related projects, including CoLiBrl - Continental Lithosphere: a Broadscale Investigation, will provide new exciting materials for studies of formation and evolution of the continental lithosphere.