Geophysical Research Abstracts
Vol. 16, EGU2014-14812, 2014
EGU General Assembly 2014

Strain localisation: Shear zones in the lithospheric mantle

Andrea Tommasi, Alain Vauchez, David Mainprice, and Sylvie Demouchy
Geosciences Montpellier, Univ. Montpellier & CNRS, Montpellier, France (deia@gm.univ-montp2.fr)

A variety of evidence, from direct observations of deformed peridotites in orogenic massifs, ophiolites, and mantle xenoliths to seismic reflectors and seismic anisotropy beneath major fault zones, consistently supports prolongation of major faults into the lithospheric mantle as ductile shear zones. However, the geometry of these mantle faults and the mechanisms accommodating this deformation remain poorly understood. Coupling between deformation in frictional faults in the uppermost crust and localized shearing in the ductile crust and mantle is required to explain post-seismic deformation, but mantle viscosities deduced from geodetic data and extrapolated from laboratory experiments are only reconciled if temperatures in the shallow lithospheric mantle are high (>800 °C at the Moho) or if, as suggested by recent experiments (Demouchy et al, PEPI 2013), the strength of the mantle lithosphere is significantly lower than what was predicted based on extrapolation of high-temperature experimental data. There is also a discrepancy between the scale at which deformation processes are studied (a few kilometers, at most, due to the limited size of continuous mantle exposures at the Earth's surface) and the scale inferred for strain localization in the mantle from geophysical observations (tens of kilometers), combining structural and seismic properties data for naturally deformed peridotites and seismological observations allows discussing strain localization and development of shear zones in the lithospheric mantle. Seismic anisotropy, especially shear wave splitting, provides strong evidence for coherent deformation over domains several tens of km wide in the lithospheric mantle beneath major transcurrent faults, but it cannot detect narrow strain localization zones or shallowly dipping faults. Shallow-dipping seismic reflectors imaged by seismic profiles in the lithospheric mantle are interpreted as the continuation of normal or, less frequently, inverse faults in the mantle. Subhorizontal reflectors deep in the mantle lithosphere are also reported by receiver function studies. However, the nature of these reflectors (compositional or anisotropy gradients) is poorly understood, as illustrated by forward models of the seismic properties of mantle shear zones. In this presentation, we will associate observations, experimental data, and petrophysical models to better constrain the deformation processes allowing for development of localized deformation in the lithospheric mantle and the extent of the resulting shear zones.