Geophysical Research Abstracts
Vol. 16, EGU2014-3465, 2014
EGU General Assembly 2014

Seismic observations of large-scale deformation at the bottom of fast-moving plates

Eric Debayle and Yanick Ricard

Laboratoire de Géologie de Lyon : Terre, Planètes et Environnement, CNRS, ENS and Université de Lyon 1, France (Eric.Debayle@ens-lyon.fr)

We present a new tomographic model of azimuthal anisotropy in the upper mantle and discuss in details the geodynamical causes of this anisotropy. Our model improves upon DKP2005 seismic model (Debayle et al., 2005) through a larger dataset (expanded by a factor ~ 4) and a new approach which allows us to better extract fundamental and higher mode information. Our results confirm that on average, azimuthal anisotropy is only significant in the uppermost 200-250 km of the upper mantle where it decreases regularly with depth. We do not see a significant difference in the amplitude of anisotropy beneath fast oceanic plates, slow oceanic plates or continents.

The anisotropy projected onto the direction of present plate motion shows a very specific relation with the plate velocity; it peaks in the asthenosphere around 150 km depth, it is very weak for plate velocities smaller than 3 cm yr^{-1}, increases significantly between 3 and 5 cm yr^{-1}, and saturates for plate velocities larger than 5 cm yr^{-1}. Plate-scale present-day deformation is remarkably well and uniformly recorded beneath the fastest moving plates (India, Coco, Nazca, Australia, Philippine Sea and Pacific plates). Beneath slower plates, plate-motion parallel anisotropy is only observed locally, which suggests that the mantle flow below these plates is not controlled by the lithospheric motion (a minimum plate velocity of around 4 cm yr^{-1} is necessary for a plate to organize the flow in its underlying asthenosphere). The correlation of oceanic anisotropy with the actual plate motion in the shallow lithosphere is very weak. A better correlation is obtained with the fossil accretion velocity recorded by the gradient of local seafloor age. The transition between frozen-in and active anisotropy occurs across the typical $\sqrt{\mathrm{age}}$ isotherm that defines the bottom of the thermal lithosphere around 1100 °C. Under fast continents (mostly under Australia and India), the present day velocity orients also the anisotropy in a depth range around 150-200 km depth which is not deeper than what is observed under oceans.