SEISMIC ANISOTROPY AND GLOBAL GEODYNAMICS

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Abstract

Clear evidence has accumulated during the last 40 years, demonstrating that seismic anisotropy is not a second order effect but that it is present at all scales, though not in all depth ranges of the Earth. Conversely, in spite of its inherent theoretical complexity, seismologists must realize that they must include anisotropy in their modelling in order to avoid wrong interpretations. Different physical processes or geometrical configurations can give rise to observable seismic anisotropy, crystal intrinsic anisotropy, fine layering, cracks or fluid inclusions, and several conditions must be fulfilled to detect it at large scale.

The large variety of seismic datasets which provides insight into the location at depth of large scale anisotropy, will be reviewed, with the emphasis on the upper mantle. The scientific potential of seismic anisotropy is enormous since it makes it possible to address a large variety of geological and geophysical issues such as the depth extent of continental root, the coupling between lithospheric plate and underlying asthenosphere, the interaction between plume upwellings and upper mantle, the mapping of deformation and geodynamics processes in play in the deep mantle. In the upper mantle, seismic anisotropy is reflecting plate tectonics, but some new observations of seismic anisotropy enable us to go beyond. Some examples of anisotropic tomographies in different regions of the world and in different tectonic contexts will illustrate how anisotropy enables to gain more insight into geodynamic problems.

In addition to the well-documented seismic anisotropy in lithosphere- asthenosphere and D”-layer, there are now new evidences of seismic anisotropy in the transition zone. These observations strongly suggest that the extended transition zone (410-1,000km) is another boundary layer which might limit the passage of matter between the upper and the lower mantle, not only for subducting slabs but for upwellings as well. A thorough comparison between global distribution of anisotropy and mantle convection modelling is necessary in order to go beyond preliminary results demonstrating a correct agreement between flow pattern and seismic anisotropy below oceanic plates.