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Lithospheric and asthenospheric structure below oceans and continents from anisotropic tomography

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The nature and the depth of the Lithosphere- Asthenosphere boundary (LAB) in oceans and continents are still controversial. Much progress on these issues were done during the last ten years. Anisotropy provides fundamental information on oceanic plates and continents and anisotropic studies revealed the layering of both oceans and continents.

An oceanic plate cannot be considered as a single layer and its structure displays a stratification with the existence of a mid-lithospheric discontinuity between 60-80km almost independent of the age of the sea floor, which is not completely understood. At larger depths, the S-wave velocities enable to map the thermal boundary of LAB which looks in good agreement with classical plate models, better than the half-space cooling model. The issue of coupling between lithosphere and asthenosphere can be addressed by considering the depth variation of azimuthal anisotropy.

For continents, we consider the specific case of India, which is quite unique in many respects. The Indian moved at an exceptional high rate (18-20cm/year) after the birth of La Réunion hotspot, ≈65Ma ago and the Deccan volcanic province before the collision with the Asian continent. Other older plumes Marion, Kerguelen located in the Indian ocean are also associated with very fast plate motion. We present a high-resolution 3D anisotropic model of the Indian plate region down to 300 km depth, obtained by inverting a new massive database of surface-wave observations. Our estimates of the depth to the Lithosphere-Asthenosphere Boundary (LAB) derived from seismic velocity Vsv variations at depth reveal large variations (120-250 km) beneath the different cratonic blocks. A low velocity layer associated with the Mid-lithospheric discontinuity is present when the root of the lithosphere is deep.
This extensive anisotropic tomographic investigation of the Indian continent displays an almost north-south keel, 600km long and 300km wide, down to 250km depth. The keel is characterized by fast velocities, smaller than average radial and azimuthal anisotropies. The distribution of azimuthal anisotropy defines the flow lines around the keel, and, at the LAB, coincides with the APM direction of the Indian plate. Such a keel could probably perturb the plume-induced flow in the asthenosphere. The influence of such a keel on the interaction of India with several mantle plumes (Marion, Crozet, Kerguelen, La Réunion), is presently under investigation.