Geophysical Research Abstracts
Vol. 17, EGU2015-2706-1, 2015
EGU General Assembly 2015

Origin of Seismic Anisotropy in Oceanic Plates and Mantle

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Seismic anisotropy is strongest in Earth's thermo-mechanical boundary layers where anisotropy should be straightforward to relate to mantle flow. However, both frozen-in and active mantle convection scenarios have been invoked, and no simple, global relationships exist. We show that lattice preferred orientation (LPO) inferred from mantle flow computations, in fact, produces a plausible global background model for asthenospheric azimuthal anisotropy underneath oceanic lithosphere. The same is not true for absolute plate motion (APM) models, unless reference frames are adjusted. A $\sim$200 km thick layer where the flow model LPO matches observations from tomography lies just below the $\sim$1200C isotherm of a half-space cooling model, indicating strong temperature-dependence of the processes that control the development of azimuthal anisotropy. We infer that the depth extent of shear, and hence the thickness of a relatively strong oceanic lithosphere, can be mapped this way. Radial anisotropy does not appear to conform to this background model, and ocean-basin specific deviations from the half-space cooling pattern are found in all of the surface wave models we considered. We discuss an expanded, comprehensive analysis of anisotropy and how results pertain to boundary layer dynamics.