Probing Lowermost Mantle Dynamics with Observations of Seismic Anisotropy

By Jonathan Wolf

Convection in Earth's mantle has a major influence on Earth's evolution. Present and past convection-induced deformation manifests itself in seismic anisotropy, which is particularly strong in the mantle's upper and lower layers. While the general patterns of seismic anisotropy have been mapped for the upper mantle, our picture of seismic anisotropy in the lowermost mantle is incomplete. This is in part due to the fact that it is difficult to isolate the deep mantle anisotropy contribution for a given seismogram because of the unknown influence of the upper mantle. We have established AxiSEM3D as a tool to compute global wave propagation routinely and efficiently in arbitrarily anisotropic media. This work has enabled us test and improve traditional methods for characterizing deep mantle anisotropy, and to develop new techniques to measure lowermost mantle anisotropy. We have applied these techniques to several specific problems related to anisotropy and flow in the deep mantle. For example, we have mapped slab-driven flow in the lowermost mantle beneath the northeastern Pacific; we have identified seismic anisotropy that is co-located with an ultra-low velocity zone (ULVZ) at the edge of the Pacific large low velocity province (LLVP); and we have found evidence for slab-driven transport of ULVZ material along the core-mantle boundary beneath the Himalayas. These studies are shedding light on the relationships among structures such as LLVPs, ULVZs, mantle plumes, and paleo subducted slabs, and their respective roles in the mantle's convective system.