Constraints on Flow Dynamics within the Oceanic Asthenosphere from an Ocean-bottom Seismograph Array in the Central Pacific
由海底地震儀資料探索海洋軟流圈流動機制

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Convective flow in the mantle and the motions of tectonic plates produce deformation of the Earth's interior, and the rock fabric produced by this deformation can be discerned using anisotropy of seismic wavespeed. This deformation is particularly prevalent close to critical plate boundaries beneath the ocean and the uppermost mantle, including near seafloor-spreading centers as new plates are formed via corner flow, and within a weak asthenosphere that lubricates large-scale plate-driven flow and accommodates smaller-scale convection. Seismic models of oceanic upper mantle are conflicting regarding the relative importance of these deformation processes: seafloor-spreading fabric is very strong just beneath the crust-mantle boundary at relatively local scales, but at global and/or ocean-basin scales, oceanic lithosphere is found to be weakly anisotropic when compared to the asthenosphere. There is little consensus on which of these factors are dominant, in part because observations of detailed lithosphere structure are limited. To address this discrepancy, we conducted the NoMelt experiment on ~70 Ma Pacific lithosphere between the Clarion & Clipperton fracture zones. Rayleigh waves recorded from teleseismic events and ambient-noise with an ocean-bottom seismograph array provide unique localized constraints on seismic anisotropy within the oceanic lithosphere-asthenosphere system. Azimuthal anisotropy is strongest within the high-velocity seismic lid, with fast direction coincident with seafloor spreading. A minimum in the magnitude of azimuthal anisotropy occurs within the middle of the seismic low-velocity zone, and then increases with depth below the weakest portion of the asthenosphere. Fast directions rotate from fossil-spreading direction within the lithosphere, to a more east-west direction at depth. In no depth range does the fast direction correlate with the apparent plate motion. Our results suggest seafloor-spreading induced lithospheric fabric generates the strongest anisotropy, while density- and/or pressure-driven flow produces a secondary peak in anisotropy at the base of the asthenosphere.