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Constraints on the anisotropic contributions to velocity discontinuities at about 60 km depth beneath the oceans with Pacific – Atlantic comparisons

Catherine A. Rychert (1), Nicholas Harmon (1), and Michael Kendall (2)

(1) Southampton, National Oceanography Centre, Ocean and Earth Science, Southampton, United Kingdom (c.rychert@soton.ac.uk), (2) University of Bristol

Strong, sharp, negative seismic discontinuities, velocity decreases with depth, are observed beneath the Pacific seafloor at about 60 km depth. It has been suggested that these are caused by an increase in radial anisotropy with depth, which occurs in global surface wave models beneath the oceans. Here we test this hypothesis in two ways. We evaluate whether an increase in surface wave radial anisotropy with depth is robust with synthetic resolution tests. We do this by fitting an example surface wave data set near the East Pacific Rise using a variety of starting models. We also estimate the apparent isotropic seismic velocity discontinuities that could be caused by changes in radial anisotropy in S-to-P and P-to-S receiver functions and SS precursors using synthetic seismograms. We test one model where radial anisotropy is caused by olivine alignment and one model where it is caused by compositional layering. The result of our surface wave inversion suggests strong shallow azimuthal anisotropy beneath 0–10 Ma Pacific seafloor, which would also have a radial anisotropy signature. An increase in radial anisotropy with depth at 60 km depth is not well-resolved in surface wave models, and could be artificially observed. Shallow isotropy underlain by strong radial anisotropy could explain moderate apparent velocity drops (<6%) in SS precursor imaging, but not receiver functions. The effect is diminished if strong anisotropy also exists at 0–60 km depth as suggested by surface waves. Overall, an increase in radial anisotropy with depth may not exist at 60 km beneath the oceans and does not comprehensively explain the scattered wave observations. We compare and contrast the Pacific observations with new in situ measurements from the PI-LAB experiment at the equatorial mid-Atlantic Ridge from surface waves and SKS and discuss implications for the spread-rate dependence of the formation of anisotropy.