Seismic anisotropy of oceanic lithosphere from OBS noise correlations

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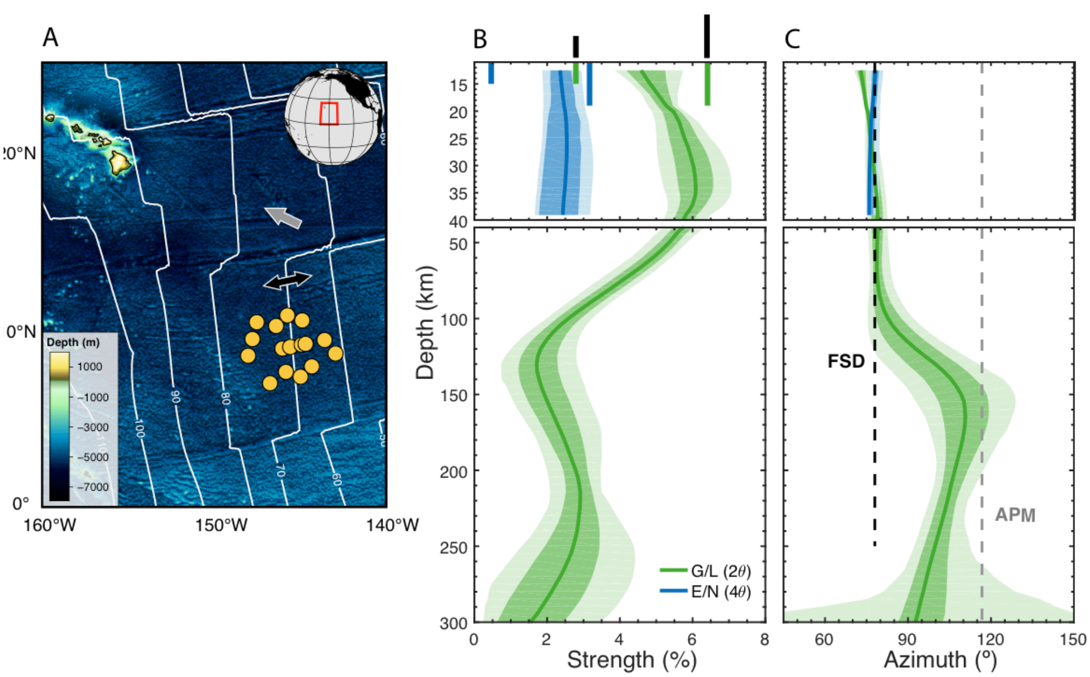
Seismic anisotropy of the oceanic mantle is a key observable for understanding deformation conditions during plate formation at mid ocean ridges (MOR) as well as during subsequent plate cooling. Recent broadband ocean bottom seismometer (OBS) deployments enable high-resolution imaging of the oceanic upper mantle using array-based techniques. Coherent ambient seismic noise within the primary (12-20 s) and secondary (3-10 s) microseism bands in the oceans yield surface-wave constraints with dense azimuthal coverage, suitable for constraining seismic anisotropy. We use noise-derived Rayleigh- and Love-wave phase velocities sensitive to the lithospheric anisotropy beneath the NoMelt array (~70 Ma Pacific). We observe 2θ azimuthal variations for first-overtone Rayleigh waves as well as a 2θ and 4θ dependence for fundamental mode Love waves from 5-7.5 s, each with a fast direction consistent with fossil spreading. These are perhaps the first in situ observations of Love 2θ and 4θ azimuthal anisotropy, which allows us to solve for the complete anisotropic earth structure down to 40 km depth. We solve for G (2θ) and E (4θ) as well as radial anisotropy (ξ) and find that radial anisotropy is required in the lithospheric mantle with $V_{SH} > V_{SV}$ by ~2%. Our models of G, E, and ξ are in agreement with peridotite rock samples from the literature and suggest an increase in fabric strength with depth in the mantle, consistent with flow patterns observed in numerical calculations of passive upwelling at fast-spreading MORs. We seek to compare these observations to those from older (~170 Ma) slow-spreading lithosphere beneath the ENAM array.



NoMelt azimuthal anisotropy inversion. A) The ~70 Ma NoMelt study region with OBS depicted by yellow circles, absolute plate motion (APM) direction by a gray arrow, and fossil spreading direction (FSD) by a black double-sided arrow. Azimuthal anisotropy B) strength and C) direction are shown for G (2θ) and E (4θ) in green and blue, respectively, and their 68% and 95% confidence bounds are shaded. The vertical thick bars of differing length show G and E strengths of peridotite rock samples from two different studies.