Surface-wave constraints on upper mantle petrofabric and flow beneath ~40 Ma seafloor in the south Pacific

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Observations of seismic anisotropy in the ocean basins provide key constraints on present-day asthenospheric flow as well as relic fabric recorded in the lithosphere during its formation near the ridge. The international collaboration *PacificArray* seeks to advance understanding of the Pacific lithosphere-asthenosphere system using focused ocean bottom seismometer (OBS) arrays. A particular goal of this initiative is to elucidate the extent and role played by small-scale convection (SSC) in plate and asthenosphere evolution. Here, we present initial results from the Young ORCA (OBS Research into Convecting Asthenosphere) array, consisting of 30 broadband OBS situated on ~40 Ma seafloor in the south Pacific. We measure ambient-noise Rayleigh- and Love-wave phase velocities from 5–25 s and 3–9 s period, respectively. Fundamental mode Rayleigh waves are observed from 14–25 s period. At shorter periods (5–10 s), we isolate the first-overtone Rayleigh wave from the fundamental-mode water-column arrival by removing the coherent pressure signal from the vertical channel. Love-wave mode content is fundamental mode at periods < 7 s but ambiguous at longer periods. We solve for the 1D azimuthal anisotropy of phase velocities and find 2θ Rayleigh-wave anisotropy with fast axis parallel to the fossil-spreading direction (FSD) from 5–25 s with a peak-to-peak strength of up to ~3.5%. Additionally, clear Love-wave anisotropy is observed, consisting of a 2θ component (~2%) perpendicular to the FSD and a 4θ component (~1.5%) rotated 45° from the FSD. Together, these observations indicate a strong horizontal lattice-preferred orientation of olivine in the lithosphere parallel to the FSD, presumably associated with corner flow at the ridge. To extend constraints into the asthenosphere, we will measure Rayleigh-wave phase velocities from teleseismic earthquakes ranging from 20–150 s and invert the full broadband phase-velocity dataset for isotropic velocity, V_{SV}, and azimuthal anisotropy, G. The Love-wave observations will provide constraints on V_{SH}, and thus radial anisotropy, in the upper lithosphere. We will interpret the asthenospheric fabric in the context of SSC and compare our model to previous observations in the Pacific, including the NoMelt array on older (~70 Ma) seafloor.

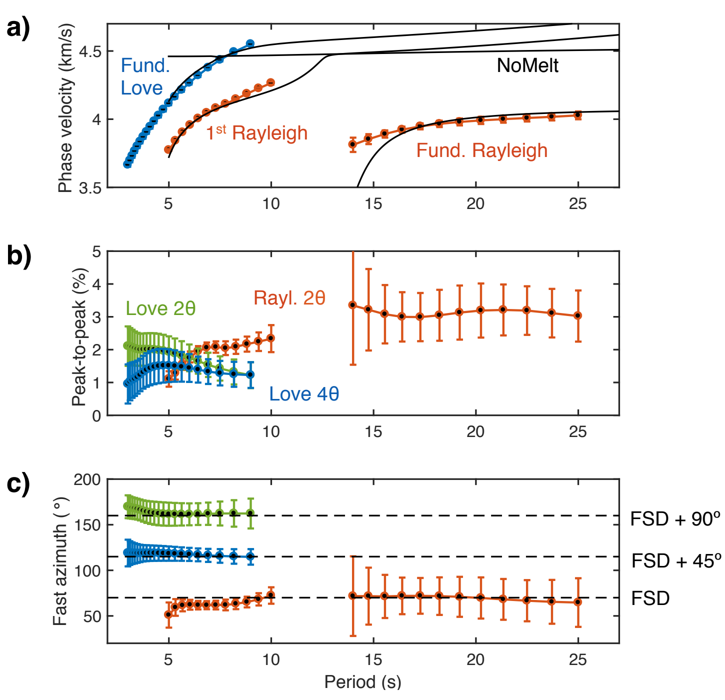

Figure. Summary of ambient-noise phase velocity measurements at Young ORCA. (a) Rayleigh and Love wave isotropic phase velocities with predictions from the ~70 Ma NoMelt model in black. (b) Azimuthal anisotropy strength and (c) fast azimuth, including 2θ dependence for Rayleigh waves and 2θ+4θ dependence for Love waves.