A comprehensive portrait of the central Pacific lithosphere-asthenosphere system from NoMelt seafloor geophysical observations

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With a thin homogeneous crust and simple tectonic history, ocean basins provide an exceptional environment for imaging processes associated with mantle convection. Oceanic lithosphere retains fingerprints of melting, melt extraction, and deformation during spreading, while the asthenosphere provides a present-day view of the deforming mantle. Ocean-bottom seismographs and Magnetotelluric (MT) sensors provide unique new tools for imaging the oceanic lithosphere-asthenosphere system. The NoMelt experiment combines active- and passive-source seismic and passive-source MT imaging to provide a comprehensive portrait of the physical state and deformation processes associated with ~70 Ma Pacific lithosphere and asthenosphere. Seismic velocity, attenuation, and conductivity profiles through the upper 300 km suggest a cool, dry lithosphere, underlain by a moderately low-velocity, high-attenuation, and conductive asthenosphere that appears hydrated but does not contain significant partial melt. Seismic-velocity variations relative to this background structure are highly anisotropic. We find the strongest anisotropy located in the lithosphere with a direction consistent with fossilized seafloor-spreading fabric, a minimum in the strength of shear anisotropy within the center of the low-velocity zone, and a secondary peak in anisotropy deeper in the asthenosphere associated with pressure- or buoyancy-driven flow. The lithosphere-to-asthenosphere transition is located by several different data sets at ~80 km depth, suggesting a rheological change locked in by the dehydration boundary at a young age. Using the combined anisotropy constraints, we estimate an *in situ* elasticity tensor that is remarkably similar to field samples of abyssal peridotites, suggesting nearly complete alignment of the sample fabric at seismic length scales.

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