

MEETINGS

What Is the Lithosphere-Asthenosphere Boundary?

EarthScope Institute on the Lithosphere-Asthenosphere Boundary; Portland, Oregon, 19–21 September 2011

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The lithosphere-asthenosphere boundary (LAB) marks a pronounced transition in the mechanical behavior of the upper mantle, separating the strong lithosphere from the weak asthenosphere beneath it. Although this boundary is fundamental to scientists' understanding of plate tectonics, identifying which factors (e.g., temperature, melt, volatiles, mineralogy) are responsible for the rheological contrast at the LAB remains a challenge. Recent geophysical and geochemical observations of the uppermost mantle have motivated a new discussion of this fundamental boundary.

An EarthScope Institute on the Lithosphere-Asthenosphere Boundary was convened in Oregon. The meeting organizers included Terry Plank, Greg Hirth, and the authors of this report. The 3-day workshop brought together 102 participants representing a wide range of disciplines in the Earth sciences. The meeting was structured around three primary themes: physical and chemical properties that

define the LAB; interactions between the lithosphere and asthenosphere; and the LAB beneath North America, where data from EarthScope provide unprecedented detail. See <http://www.earthscope.org/workshops/lab11> for PDFs of the presentations.

Scientific highlights from the meeting included new detections of scattered seismic energy from upper mantle interfaces beneath Southern California, the Colorado plateau, Afar, and the Pacific Ocean, adding to previous observations of a widespread discontinuity at 60- to 120-kilometer depth beneath both continents and oceans. The origin of this increasingly observed interface was hotly debated, and there were discussions as to whether it actually represents the LAB. In some regions the discontinuity coincides with other geophysical evidence for the base of the mechanical lithosphere (e.g., a decrease in shear wave velocity as constrained by surface waves). In other regions it does not and has been identified as a midlithospheric discontinuity. The group discussed giving these seismic discontinuities a single name; however, it was recognized that

the boundaries appear to have distinct physical origins, for which a single name would be misleading. The general consensus was that layering inferred from geochemical, petrological, mineralogical, and seismological observations does not necessarily coincide with the rheological LAB and that the LAB label should be used with care. Other possible origins for subcontinental scattering layers were pitched at the institute, including grain boundary sliding and a water-carbon dioxide (H₂O-CO₂) mantle solidus.

Presentations at the workshop also demonstrated how the rheological LAB exerts a controlling influence on cratonic stability and plate-driving forces and on regional-scale processes such as small-scale convection, shear-driven upwelling, and postloading and postseismic deformation of the lithosphere. Through these mechanisms the LAB influences melting, mineral hydration, and geochemical and thermal interactions in the mantle. The resulting patterns of surface volcanism and geochemical heterogeneity can be detected in the western United States using recent EarthScope data and interpreted through numerical modeling.

Participants departed the workshop recognizing that an improved understanding of the LAB will require integration of a wide variety of observations and modeling approaches.

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