EarthScope IDOR: Controlled-source seismic evidence for a Moho-penetrating steep accretionary margin, Idaho-Oregon

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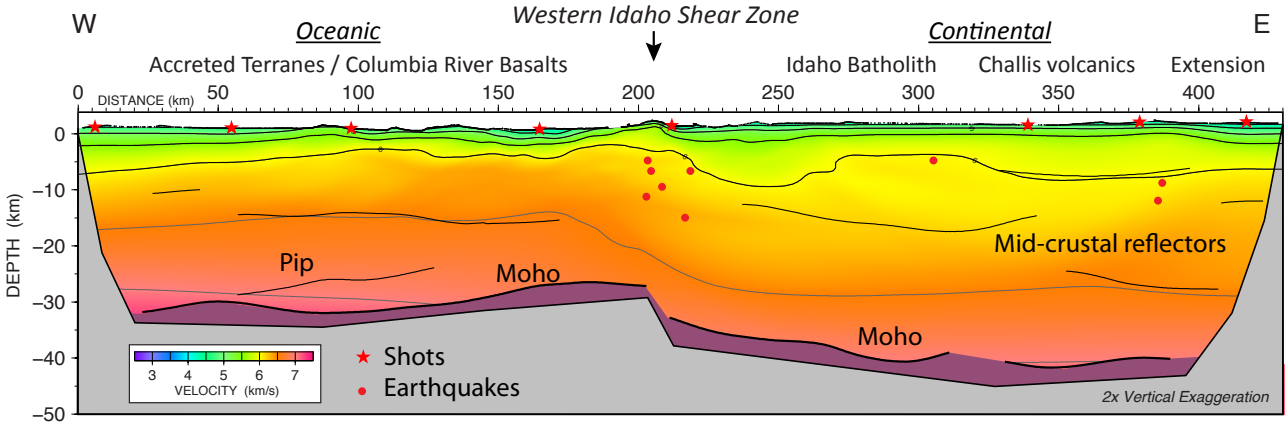
The EarthScope IDOR project is investigating the formation and modification of a steep tectonic boundary in the U.S. Cordillera of Idaho and Oregon. The western Idaho shear zone (WISZ) juxtaposes accreted island-arc terranes against Precambrian North American craton across an unusually narrow, steep boundary adjacent to the Idaho batholith. The tectonic structure of this region has been significantly modified since accretion by large-scale transpression, the emplacement of the Idaho batholith, Challis volcanism, the Columbia River Basalts, and Basin and Range-style extension.

The IDOR controlled-source seismic survey was a 430-km refraction and wide-angle reflection line designed to image the crustal structure and velocity across these contrasting geologic features. Acquisition consisted of 2555 vertical-component seismometer stations that recorded 8 explosive shots, background seismicity, and ambient noise. Data acquisition involved a 53-person field crew composed largely of undergraduate and graduate student volunteers from 22 colleges and universities. Velocity structure across the IDOR line is well constrained by travel time inversion of direct arrivals, wide-angle reflections, and refractions from the crust and Moho. Local earthquakes recorded during the controlled-source deployment are being incorporated into the modeling process to provide additional data between shot point locations.

Results from this analysis of the IDOR controlled-source seismic data reveal significant changes in velocity and crustal structure between the accreted terranes west of the WISZ and the Idaho batholith and Precambrian craton to the east. The seismic data require a lithospheric-scale, near-vertical boundary at the WISZ. The crust west of the WISZ is characterized by faster velocities and a shallower Moho depth, consistent with oceanic-arc crust. Numerous wide-angle reflections are observed, including an arrival from the lower crust that has higher amplitude than the reflection from the Moho. This lower-crustal reflector has an underlying velocity of ~7 km/s, and the layer is interpreted to be underplating associated with the feeder dike system for the Columbia River Basalts. In contrast, the crust east of the WISZ has a much slower velocity and the Moho is 5-10km deeper, consistent with felsic-to-intermediate continental crust. Reflections from this region have lower amplitude and are less continuous than those in the western region. Complex structure underlies the Basin and Range extensional region at the eastern end of the line.



Seismic velocity model of the crust across the western Idaho shear zone based on the EarthScope IDOR controlled-source seismic data.

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