d5 Detailed upper-mantle structure < Low Velocity Zone >

> It is like one of those dull headlines that journalism students are warned about, such as "Crime Rates Remain Low in Toronto." —Steven Weinberg, *Facing Up*.[1]

Upper-mantle structure is known from its effect on refracted seismic waves traveling through it from natural (earthquake) and artificial (detonation) sources. In the 1960s, seismic studies, with improved time-precision and response-calibration of a global network of seismometers, established the presence within the upper mantle of a seismic-wave low velocity zone (LVZ). Significant lateral variations were found of the thickness of the seismic-wave high-velocity lithosphere above the LVZ.

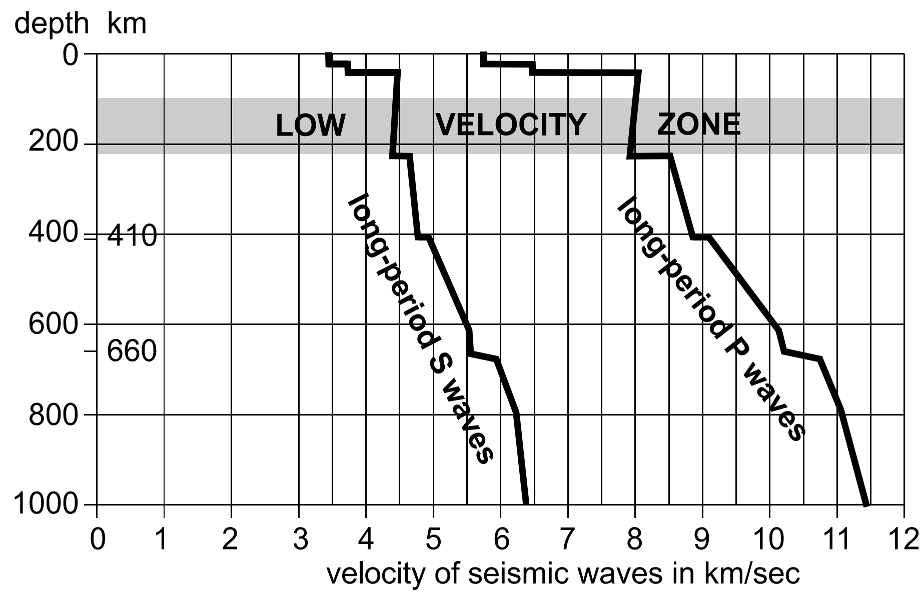
Refracted seismic waves are sensitive to velocity gradients as well as to velocity jumps at discontinuities. For one dimensional (1D) resolution, a structure needs to be continuous over an observational range of 1000 km for a few hundred kilometers depth, and 3000 km, and beyond, for depths to 660 km.

High-resolution short period seismic waves (although influenced by lateral variations in structure) consistently reveal the presence of the two major discontinuities near 410 and 660 km which mark the upper-mantle transition zone. The same have been confirmed by long-period seismic body waves (using algorithms developed during the 1970s to compensated for the inherently poor vertical resolution of these) (***Figure d5.1***).

Seismic-wave reflectivity of the 660-km discontinuity indicates it is a change through 4 km or less. The 410-km discontinuity is less sharp.[2] ❑

Figure d5.1 [3]
Upper-mantle preliminary reference Earth model (PREM) for Earth's interior below a continental region.

Notice the decreases of P and S velocities down through the Low Velocity Zone.



Footnote d6.1 Water and volcanism.

Arc volcanism is the eruption of andesite magma that originates in the partial melting of locally "wet" upper-mantle peridotite (that contains approximately 0.1 wt% water). The water is carried down by subducting hydrated lithosphere that dehydrates (releases the water) due to increasing pressure as depths of 10-20 km are exceeded. Indeed, the mantle above 410 km has little capacity for dissolved water—as can be inferred from "dry" midocean-ridge basalts (MORB) fed by melts that contain 0.01 wt% water. By contrast the mantle between the 410 km and 660 km discontinuities has high water solubility and is moderately wet with around 0.05 wt% water as can be inferred from hotspot ocean-island basalts (OIB) fed by melts presumed to be from peridotite derived from that zone.