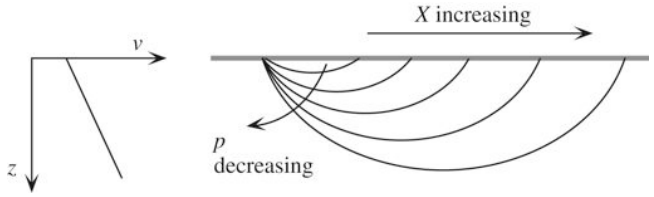
EAS 8803 - Obs. Seismology
Lec#13: Travel Time Calculation

- Dr. Zhigang Peng, Spring 2011



Review of Snell's Law

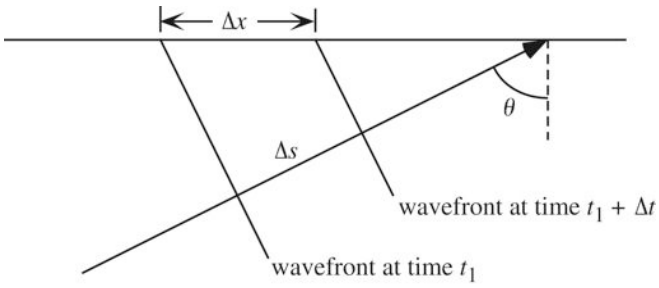


Figure 1. A plane wave incident on a horizontal surface. The ray angle from vertical is termed the incidence angle θ.

Review of Snell's Law

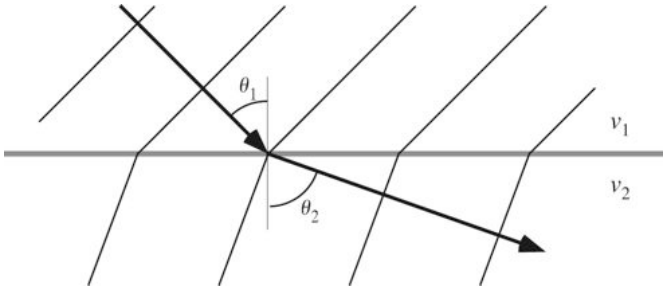


Figure 2. A plane wave crossing a horizontal interface between two homogeneous half spaces. The higher velocity in the bottom layer causes the wavefronts to be spaced further apart.

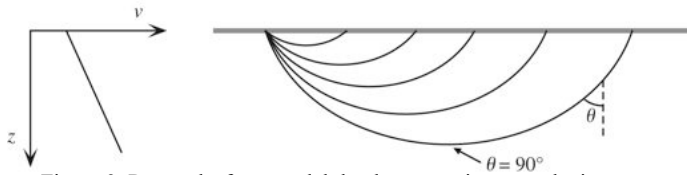


Figure 3. Ray paths for a model that has a continuous velocity increase with depth will curve back toward the surface. The ray turning point is defined as the lowermost point on the ray path, where the ray direction is horizontal and the incidence angle is 90 deg.

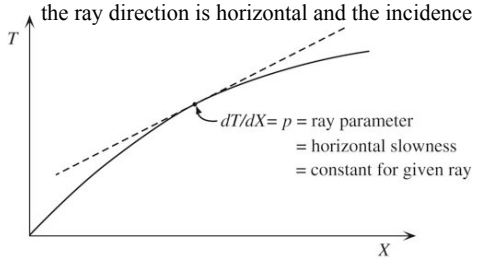
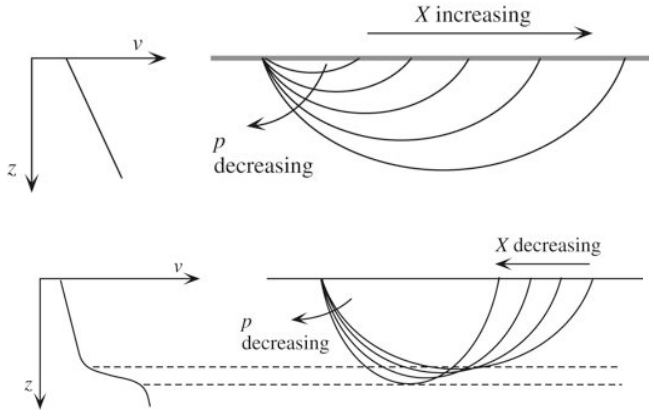


Figure 4. A travel time curve for a model with continuous velocity increase with depth.

Travel time curves and delay times



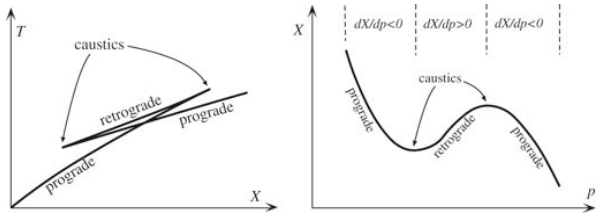


Figure 5. A triplication in the travel time curve and the corresponding $X(p)$ curve resulting from a steep velocity increase.

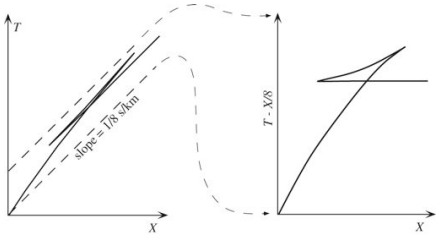


Figure 6. A reduction velocity can be used to expand the time scale to show more detail in the travel time curve.

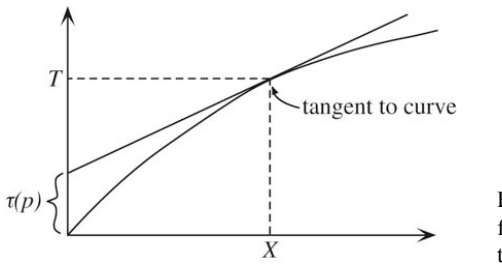


Figure 7. The delay time, $\tau(p) = T - pX$, is given by the intercept of the tangent to the travel time curve.

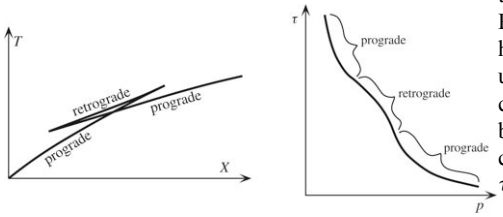


Figure 8. The $\tau(p)$ function "unravels" triplication in travel time curves. Prograde branches have concave upward $\tau(p)$ curves; retrograde branches have concave downward $\tau(p)$ curves.

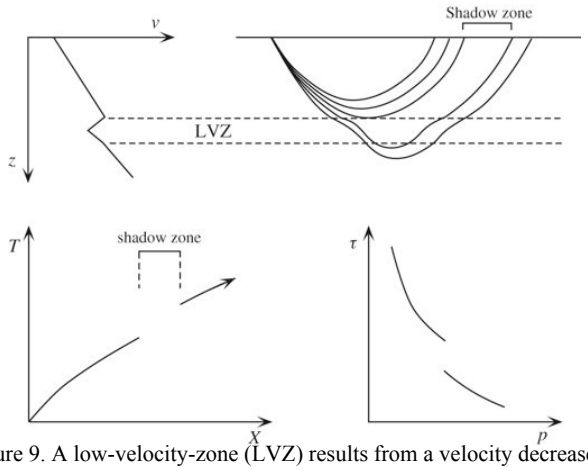


Figure 9. A low-velocity-zone (LVZ) results from a velocity decrease with depth.

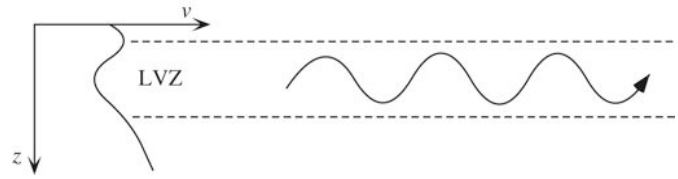
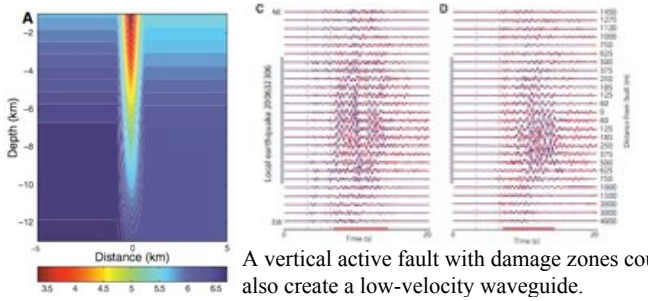
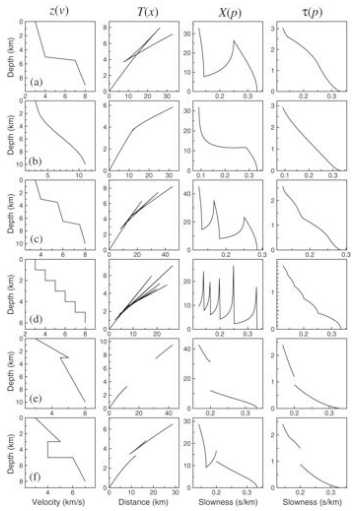


Figure 10. A low-velocity-zone (LVZ) can trap waves, creating a wave guide.



A vertical active fault with damage zones could also create a low-velocity waveguide.



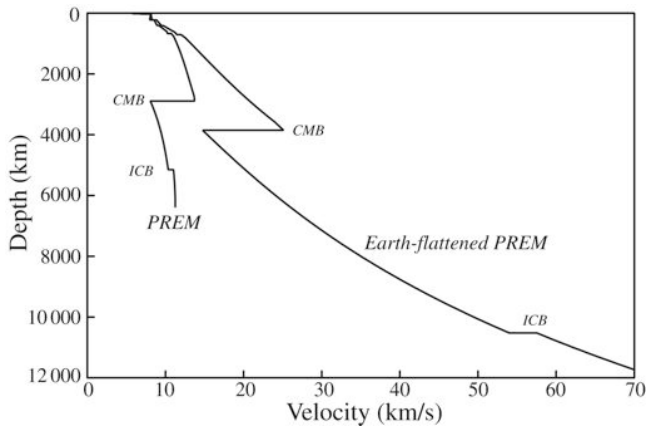


Figure 14. The Earth-flattering transformation applied to the PREM P-velocity model.