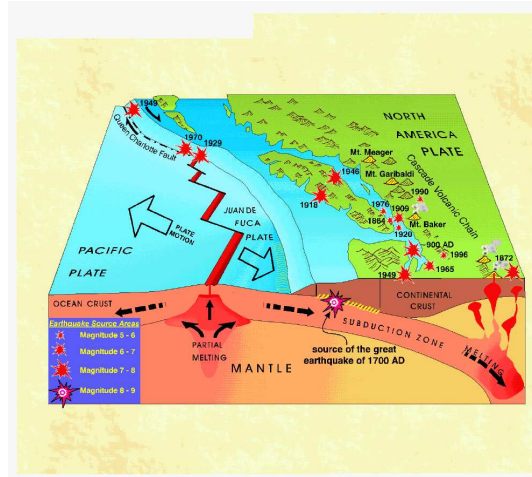


Thermal Conductivity Within the Juan de Fuca Subducting Plate



The Juan de Fuca plate subducts beneath western North America along the Oregon and Washington and northern California coastline. Subducting plates are a major cooling source for the Earth's interior. The degree of cooling has implications for other forms of mantle convection that may be required to cool the whole Earth. Constraints on the depth to which plates sink is key to these arguments. We know from earthquake locations along the Benioff zones that slabs sink to at least 650 km depth. More recent seismic tomography images show that plates may sink even deeper in some regions of the earth (Grand et al., 2001)

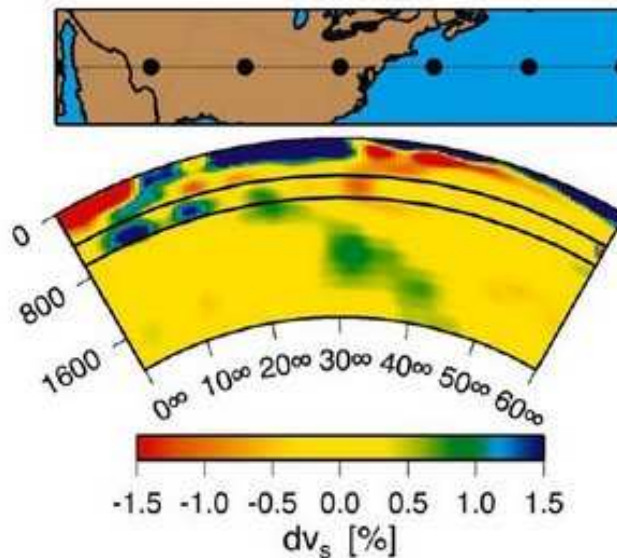
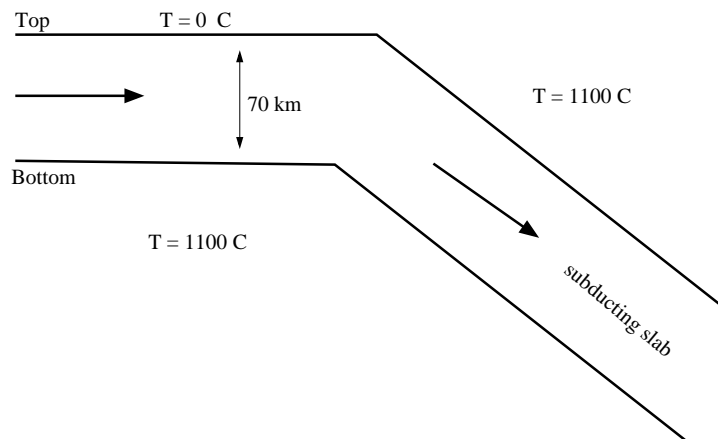


Fig. 3. Combined cross section through the tomographic S-velocity models NA00 [11,12] (above 660 km) and the model of Grand [1] (Grand, personal communication, 2001; below 660 km). Bold lines mark the 660 km and the 400 km discontinuity. Velocity anomalies are relative to PREM-C [46] in the upper mantle, to PREM [36] in the lower mantle. The color scale is saturated for stronger anomalies than + or -1.5% as occur in the uppermost mantle.

1. Let's examine how a lithospheric plate heats up conductively as it sinks into the mantle. Some investigators have shown that above $800\text{ }^{\circ}\text{C}$ lithospheric rocks are too warm to allow rupture of earthquakes. (The exact mechanism of deep focus earthquakes is currently a topic of active debate and could involve phase transitions). Assume that the lithospheric plate moving along the Earth's surface is in thermal equilibrium with the atmospheric temperature ($T = 0\text{ }^{\circ}\text{C}$) and the mantle temperature ($T = 1100\text{ }^{\circ}\text{C}$) below, and displays a conductive profile when it enters into the mantle (time = 0). During subduction, the mantle temperature above and below the subducting slab is always $1100\text{ }^{\circ}\text{C}$ (these are your boundary conditions). Use numerical modeling and fourier synthesis to determine the time it takes to heat up the lithospheric plate to a temperature above which earthquakes can no longer occur.



2. Use your result in problem #1 to find the deepest depth to which the subducting Juan de Fuca plate can sink and still allow earthquakes to rupture. (You may need information about the subduction angle and convergence rate of the Cascadia convergent margin provided on the last page of this lab).