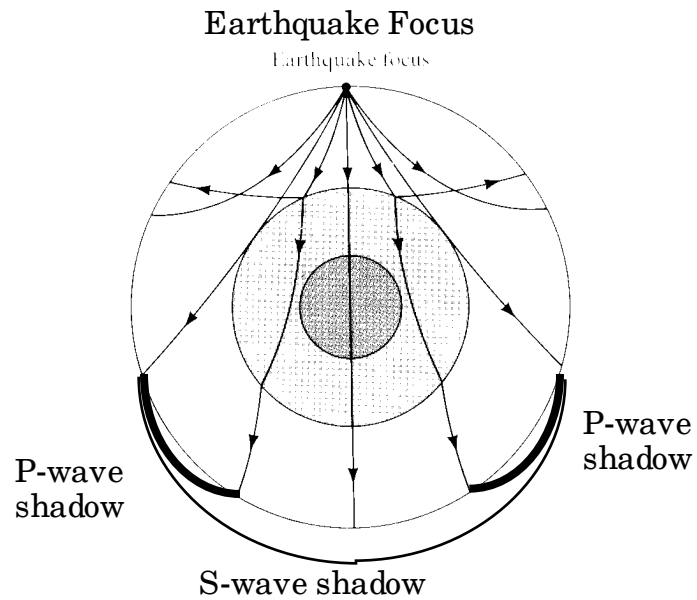


STRUCTURE OF EARTH



P waves = Primary waves = Pressure waves

S waves = Secondary waves = Shear waves (Don't penetrate liquids)

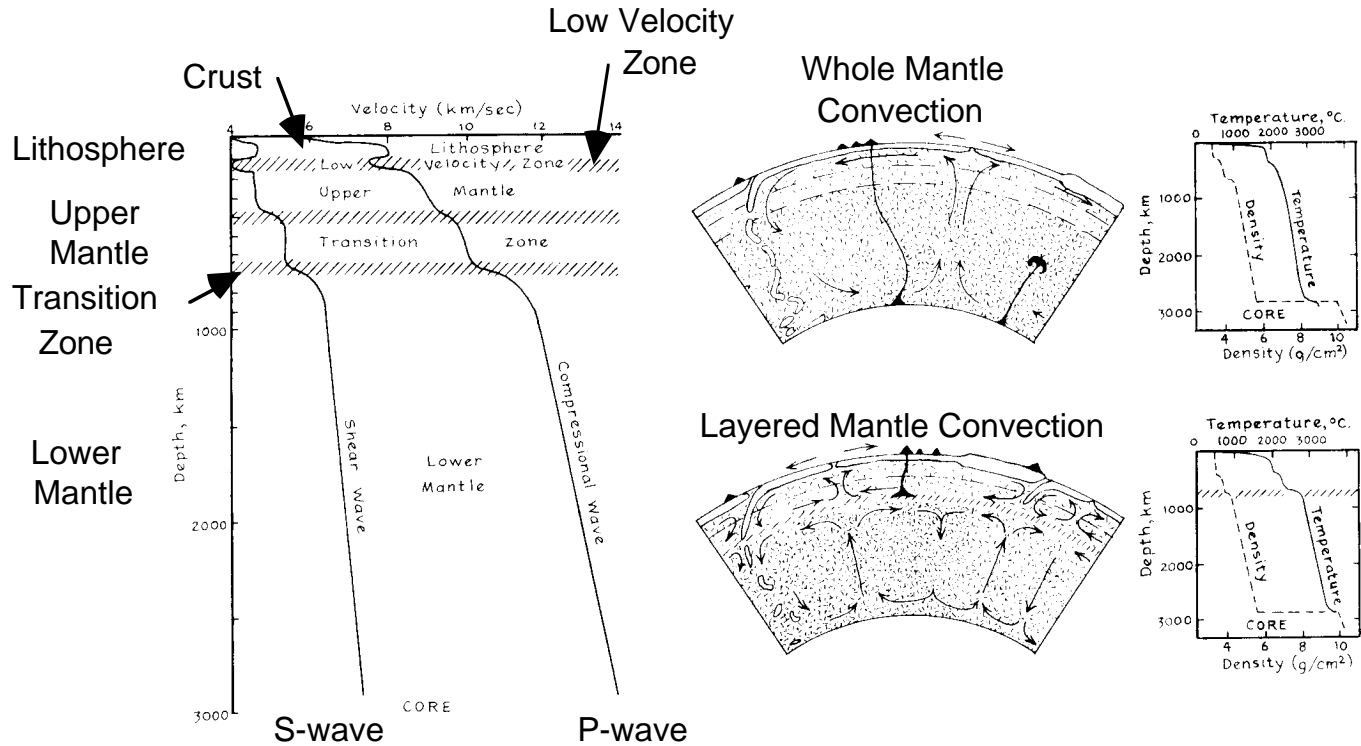
CRUST < 50-70 km thick

MANTLE = 2900 km thick

OUTER CORE (Liquid) = 3200 km thick

INNER CORE (Solid) = 1300 km radius.

STRUCTURE OF EARTH



CRUST :

Conrad discontinuity = upper / lower crust boundary
 Mohorovicic discontinuity = base of Continental Crust
 (35-50 km continents; 6-8 km oceans)

MANTLE:

Lithosphere =	Rigid Mantle	< 100 km depth
Asthenosphere =	Plastic Mantle	> 150 km depth
Low Velocity Zone =	Partially Melted,	100-150 km depth

Upper Mantle	< 410 km
Transition Zone =	400-600 km --> Velocity increases rapidly
Lower Mantle =	600 - 2900 km
Outer Core (Liquid)	2900-5100 km
Inner Core (Solid)	5100-6400 km
Center =	6400 km

UPPER MANTLE AND MAGMA GENERATION

A. Composition of Earth

Density of the **Bulk Earth** (Uncompressed) = **5.45 gm/cm³**

Densities of Common Rocks:

Granite = **2.55 gm/cm³**

Peridotite, Eclogite = **3.2 to 3.4 gm/cm³**

Basalt = **2.85 gm/cm³**

Density of the **CORE** (estimated) = **7.2 gm/cm³**

Fe-metal = 8.0 gm/cm³, Ni-metal = 8.5 gm/cm³

EARTH *must* contain a mix of *Rock* and *Metal* .

Stony meteorites Remains of broken planets Planetary Interior

Rock=Stony Meteorites “Chondrites” = Olivine, Pyroxene, Metal (Fe-Ni)

Metal = Fe-Ni Meteorites

Core density = 7.2 gm/cm³ -- Too Light for Pure Fe-Ni

Light elements = O₂ (FeO) or S (FeS)

B. How do we know constitution of upper mantle ??

1. Seismic constraints: **Mantle P wave velocity = 8.0 km/sec**

>> Corresponds to **Density** of about **3.2 g/cm³**

>> Peridotite, Eclogite only common rocks w/density 3.2 g/cm³

2. Stony meteorites same mineralogy as Peridotites:

Olivine (65%), Opx (22%), Cpx (10%)

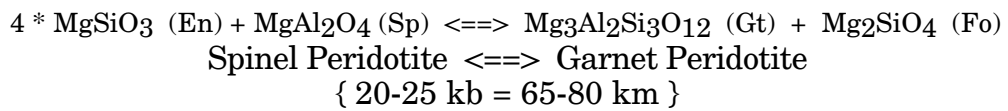
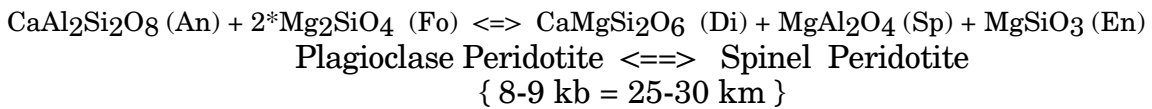
C. Where do we see Peridotite ??

Xenoliths in basalts, kimberlites >> Magmas of Deep origin

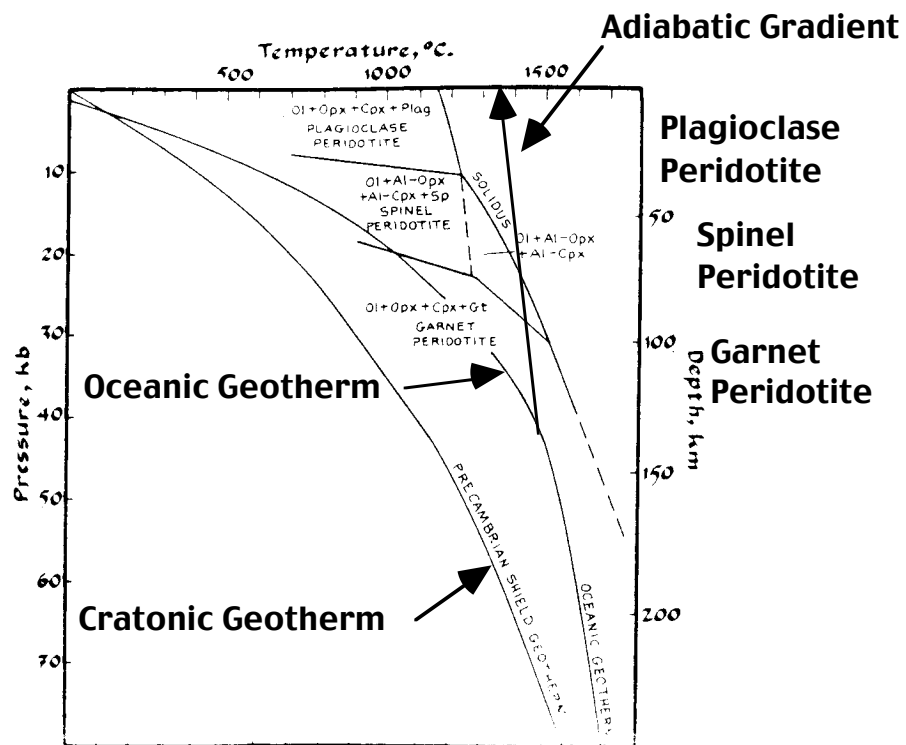
Alpine Peridotites >> Tectonic slices of upper mantle in mountain belts.

D. Peridotite Facies in the Mantle

Some Solid State Reactions:



No Plagioclase Peridotite Under Continental Crust -- Too Deep



PHASE RELATIONS

MELTING IN THE MANTLE

- One way that mantle peridotites may melt is by plastic flow of large regions toward the surface (i.e., lower pressures).
- These regions form “blobs” called “DIAPIRS”.
- Diapirs rise with nearly constant heat content --> follow ADIABAT.
- Diapirs rise above the regional Geothermal Gradient and perturb the local geotherm.
- Because the Adiabatic gradient ($1^{\circ}\text{C}/\text{kbar}$) is much steeper than the slope of the Solidus ($10^{\circ}\text{C}/\text{kbar}$), the Diapir will eventually intersect the solidus and begin to melt.

WHAT CAUSES DEEPER MANTLE TO RISE UPWARD ??

- Radioactive heat production in deep mantle (U, Th, K): Heating “expands” mantle --> less dense --> rises.
- Movement of dense, depleted mantle and/or ocean crust (eclogite) into deep mantle: Deeper mantle must rise to compensate.