

# Lecture-1: Geophysics

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## Lecture Schedule

Date	Day	Time	L/R	Broad Topic(s)
<b>Module 1: Earth Structure and Plate Tectonics</b>				
				<b>Internal structure of the Earth</b>
			L1	Plate Tectonics: kinematic Earth, analyzing plate boundaries
			L2	Tectonics on a sphere: Geometry of Plate Tectonics
			L3	Triple Junction of plates: stability and significance
			L4	Absolute plate motion and plate driving forces

**The surface of our planet is ever changing  
&  
So is our understanding of how it works!**



**225 Million Years Ago**



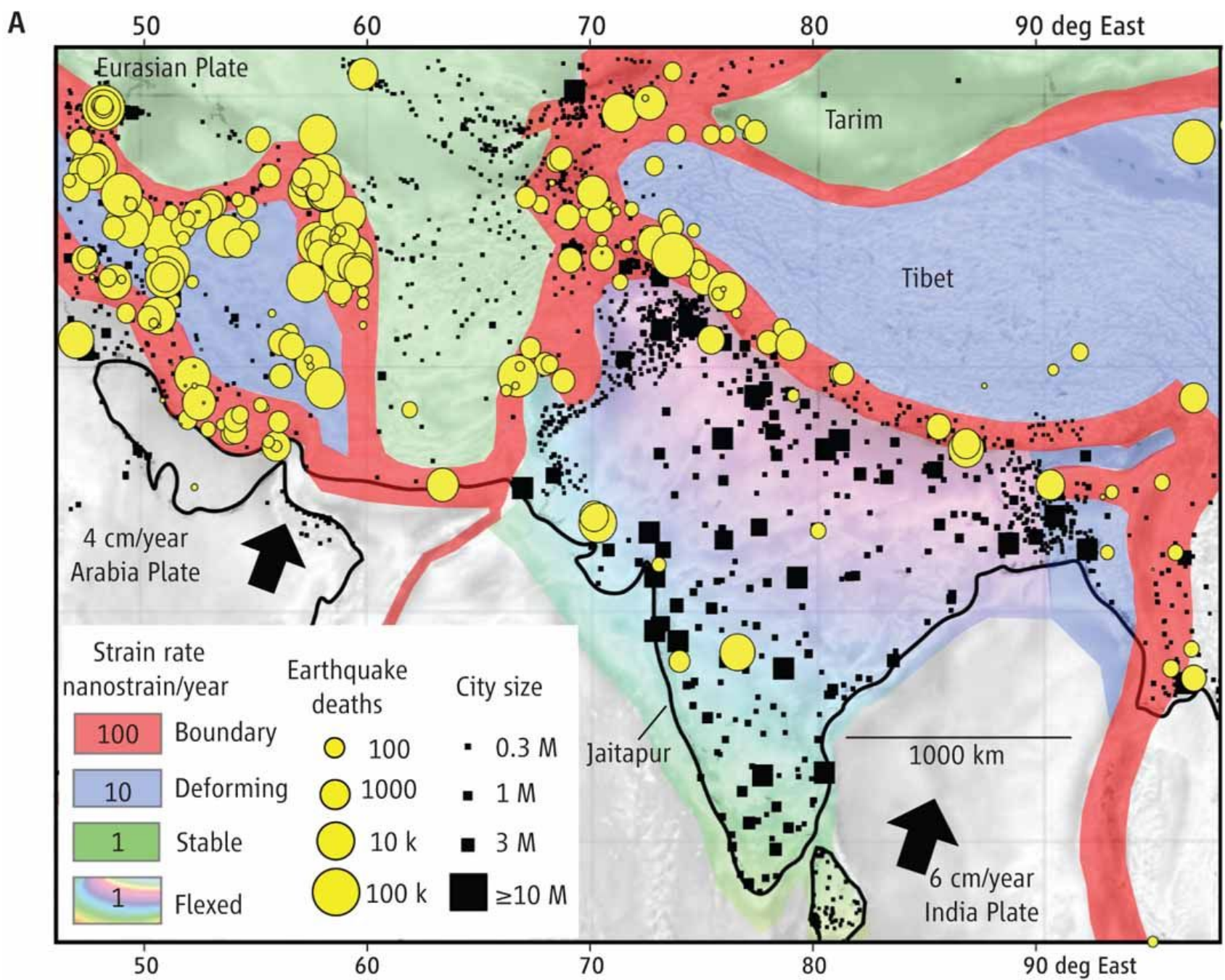
**150 Million Years Ago**



**100 Million Years Ago**



**Earth Today**



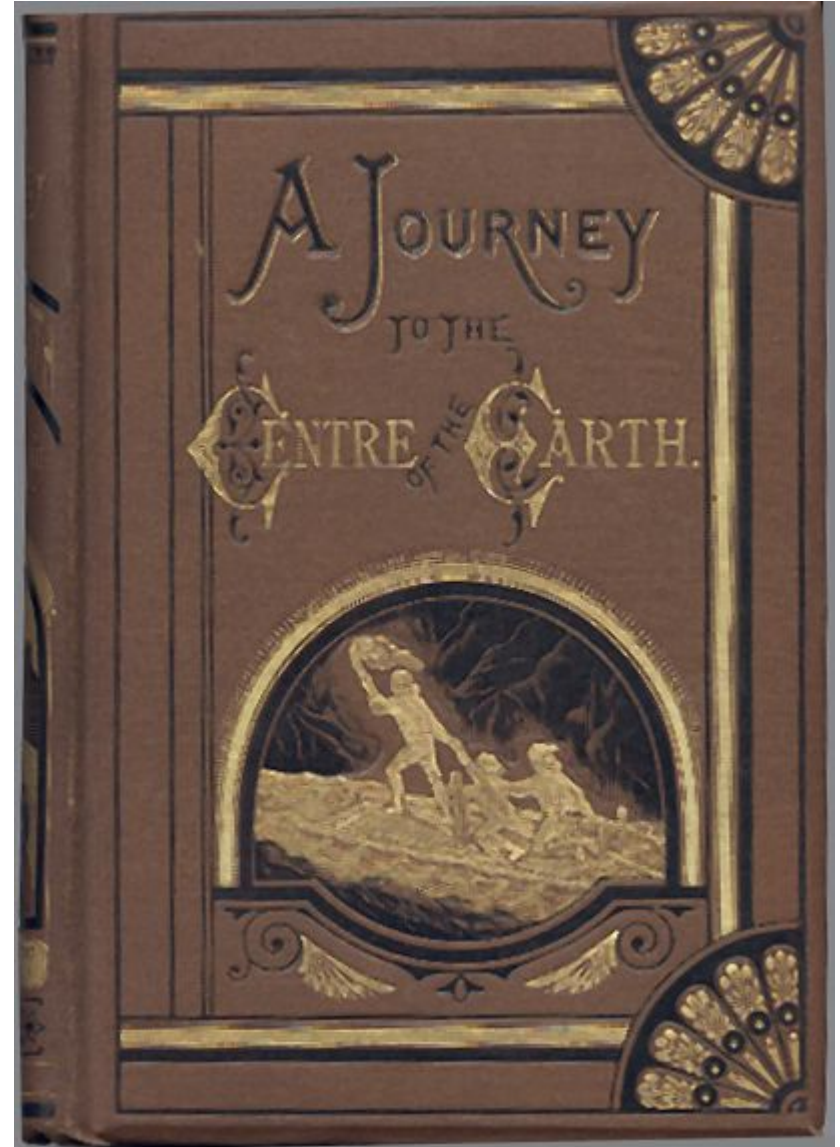


# How does the Earth work?



## Internal Structure of the Earth

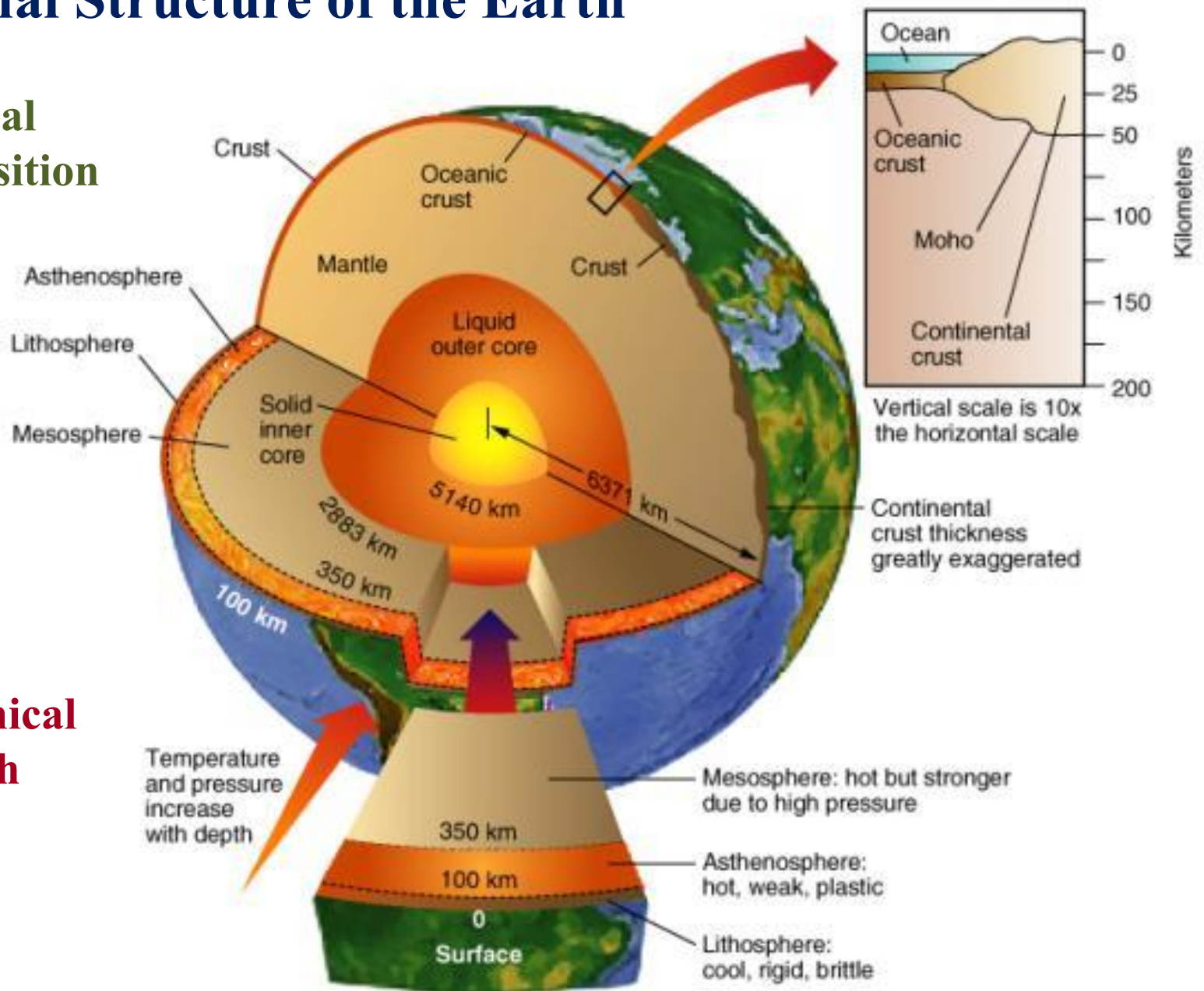
- Gravity Field
- Volcanism
- Seismic Wavefield



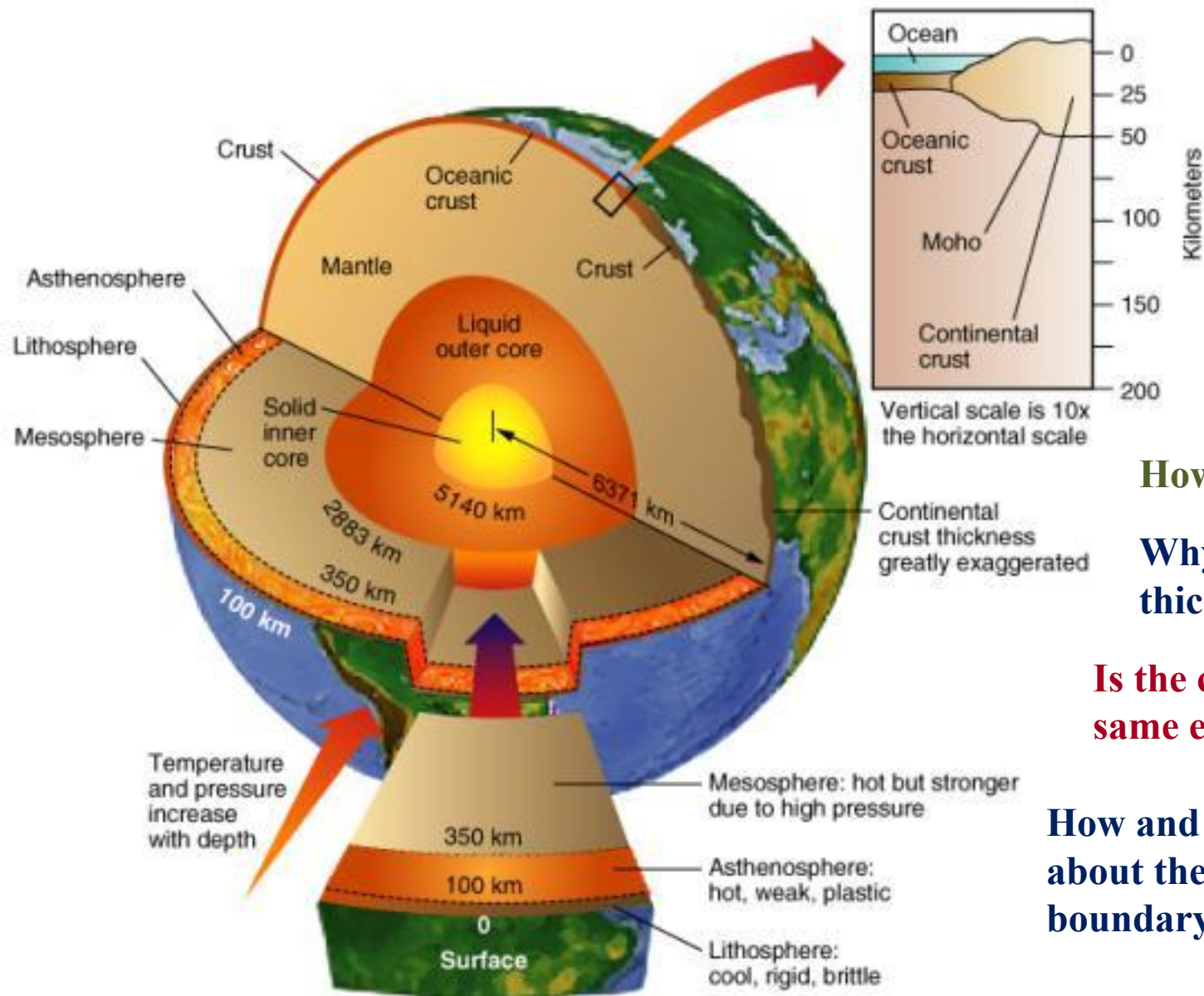
# Internal Structure of the Earth

## Chemical Composition

## Mechanical Strength



# Internal Structure of the Earth



How thick is the crust?

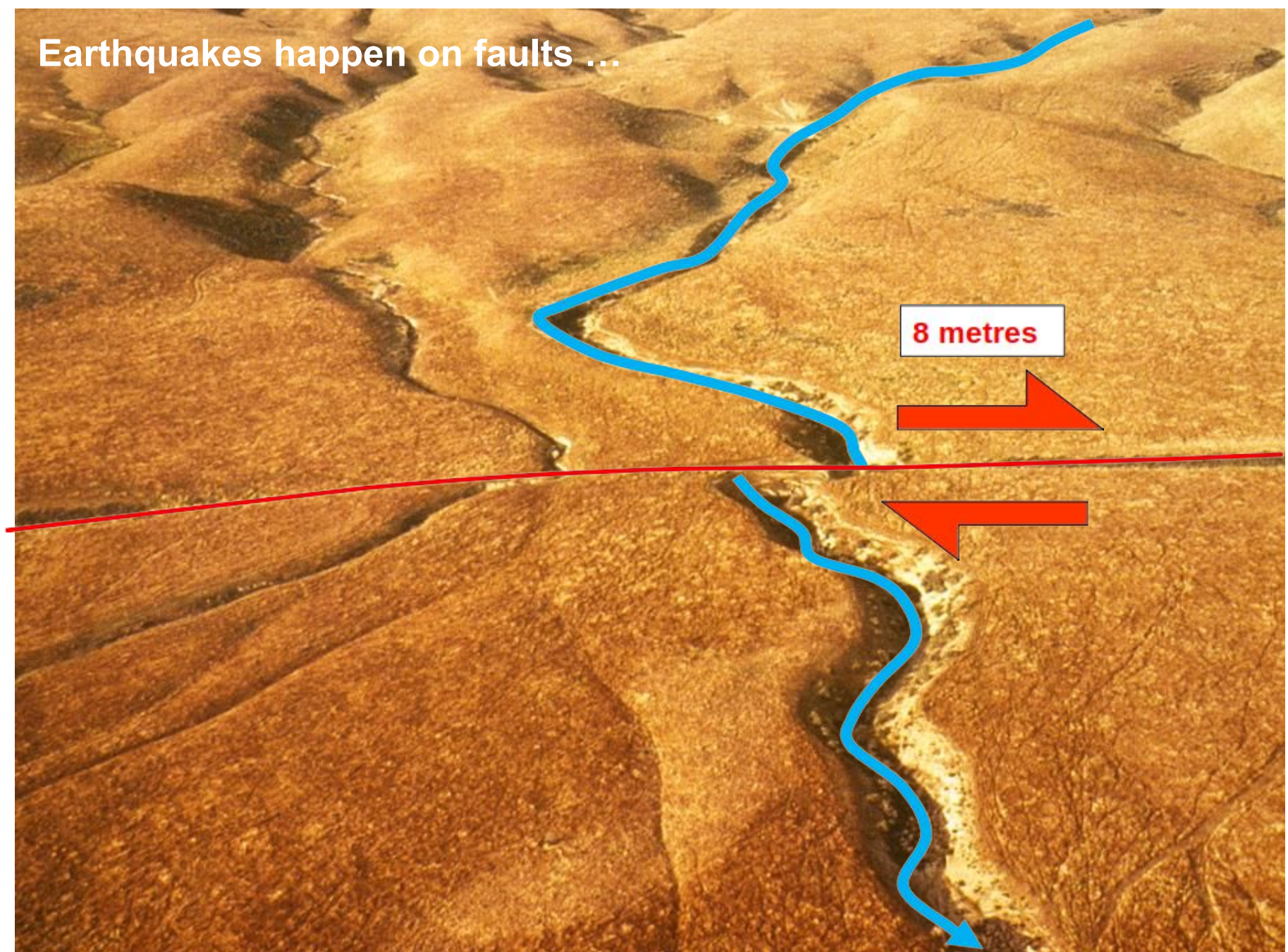
Why is there a thickness variation?

Is the crustal composition same everywhere?

How and what do we know about the Crust-Mantle boundary?



# Earthquakes happen on faults ...



# Seismic (Elastic) Waves within the Earth

## Basic Concepts:

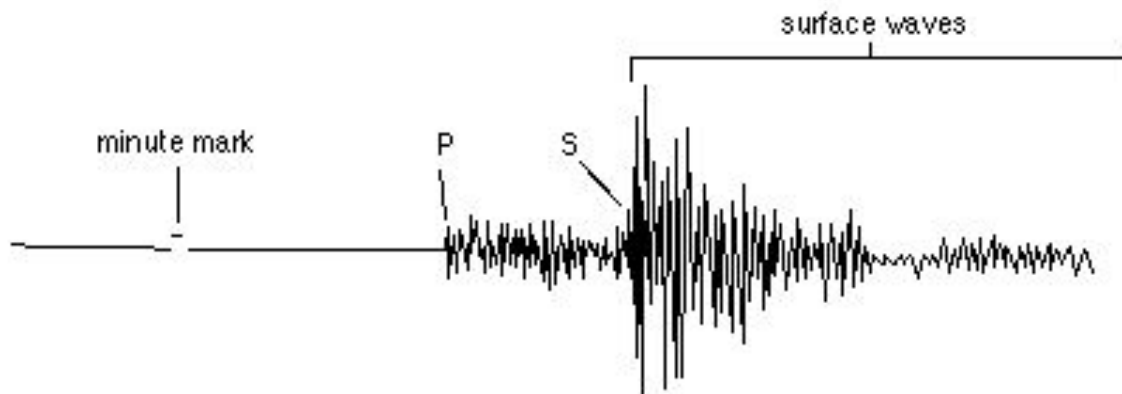
Earthquakes  
(Passive **Source**)

Generates  
**Seismic Waves**

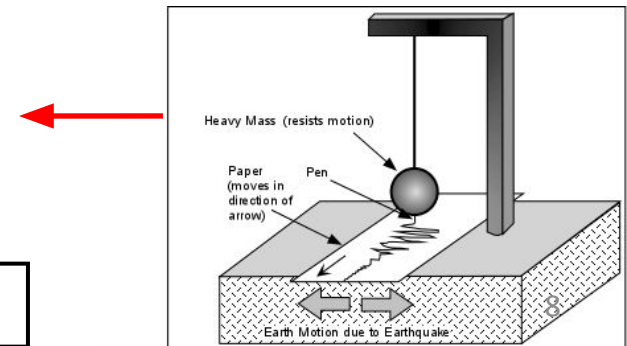
Propagate away  
from source and  
**samples the  
Earth structure**



**Free Surface ground  
motions** caused by  
these propagating  
waves → **recorded at  
surface detectors  
(SEISMOMETERS)**



Recorded ground motion is **SEISMOGRAM**

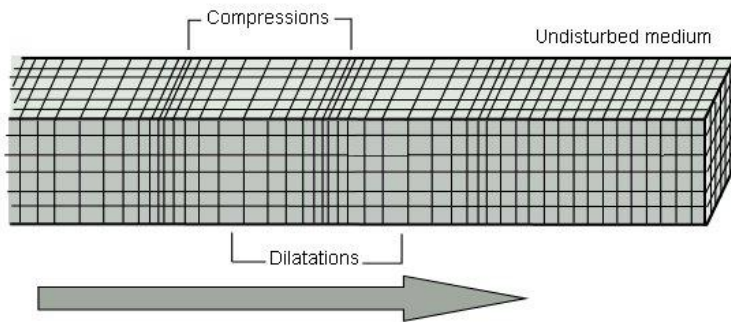




# Seismic (Elastic) Waves within the Earth

## Primary waves - Longitudinal waves

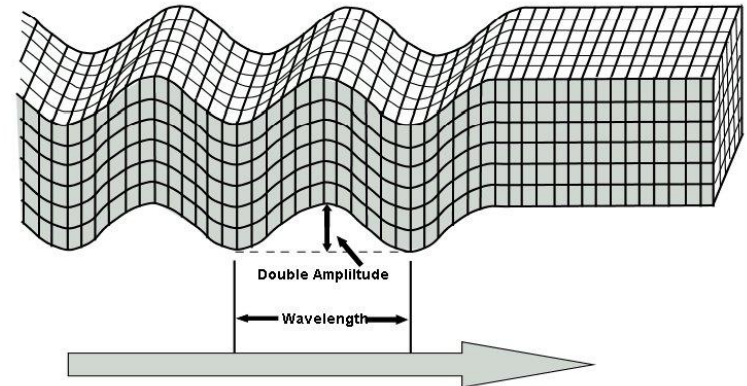
### P Wave



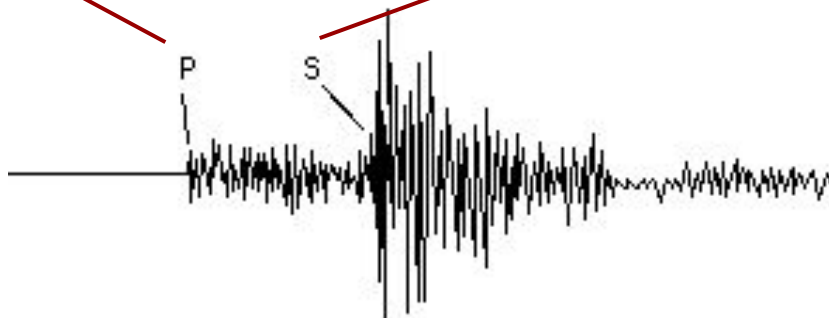
$$V_p = \left[ \frac{(K + 4/3\mu)}{\rho} \right]^{1/2}$$

## Secondary waves – Transverse waves

### S Wave



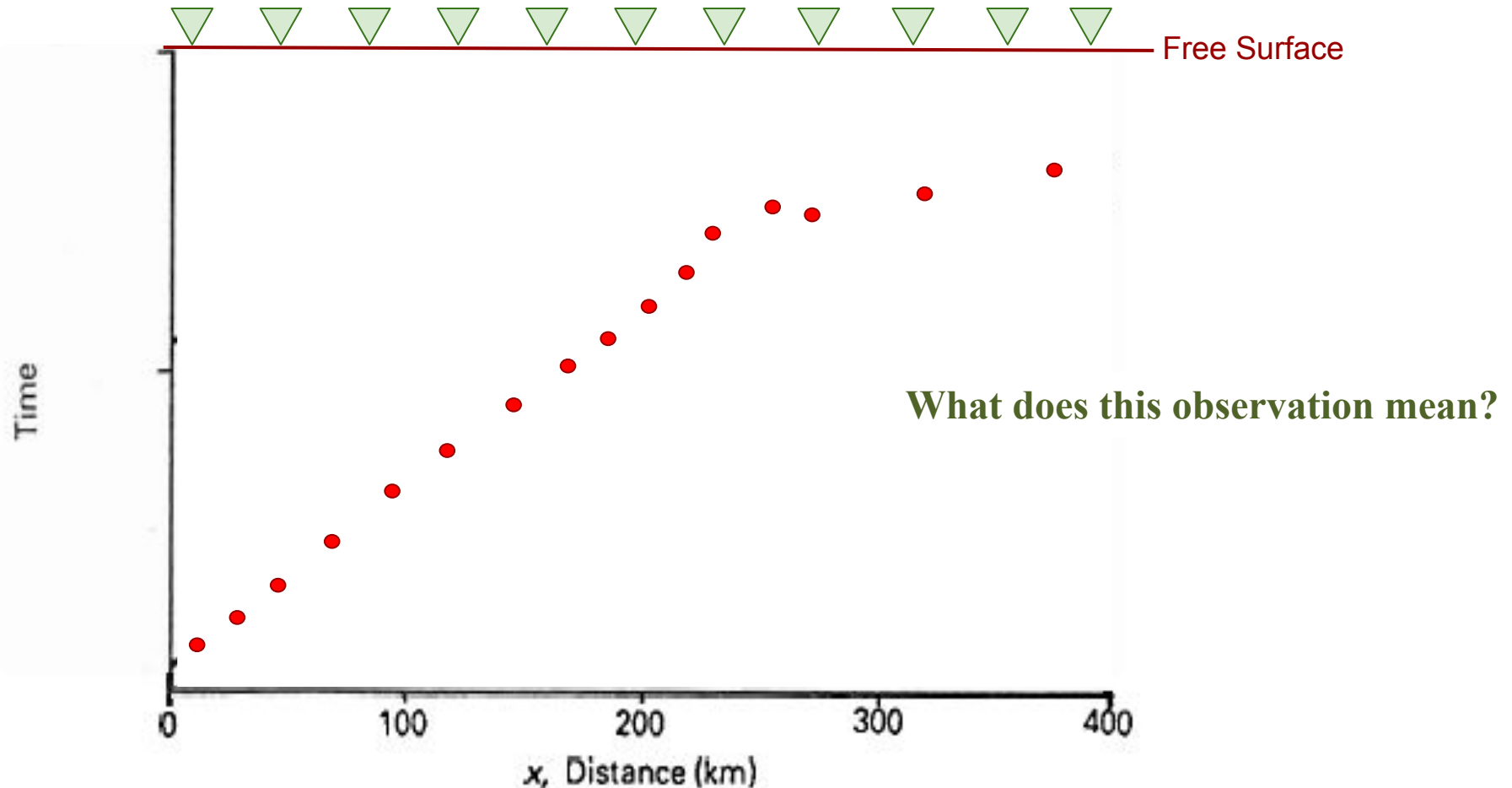
$$V_s = [\mu/\rho]^{1/2}$$



Recorded ground motion is **SEISMOGRAM**

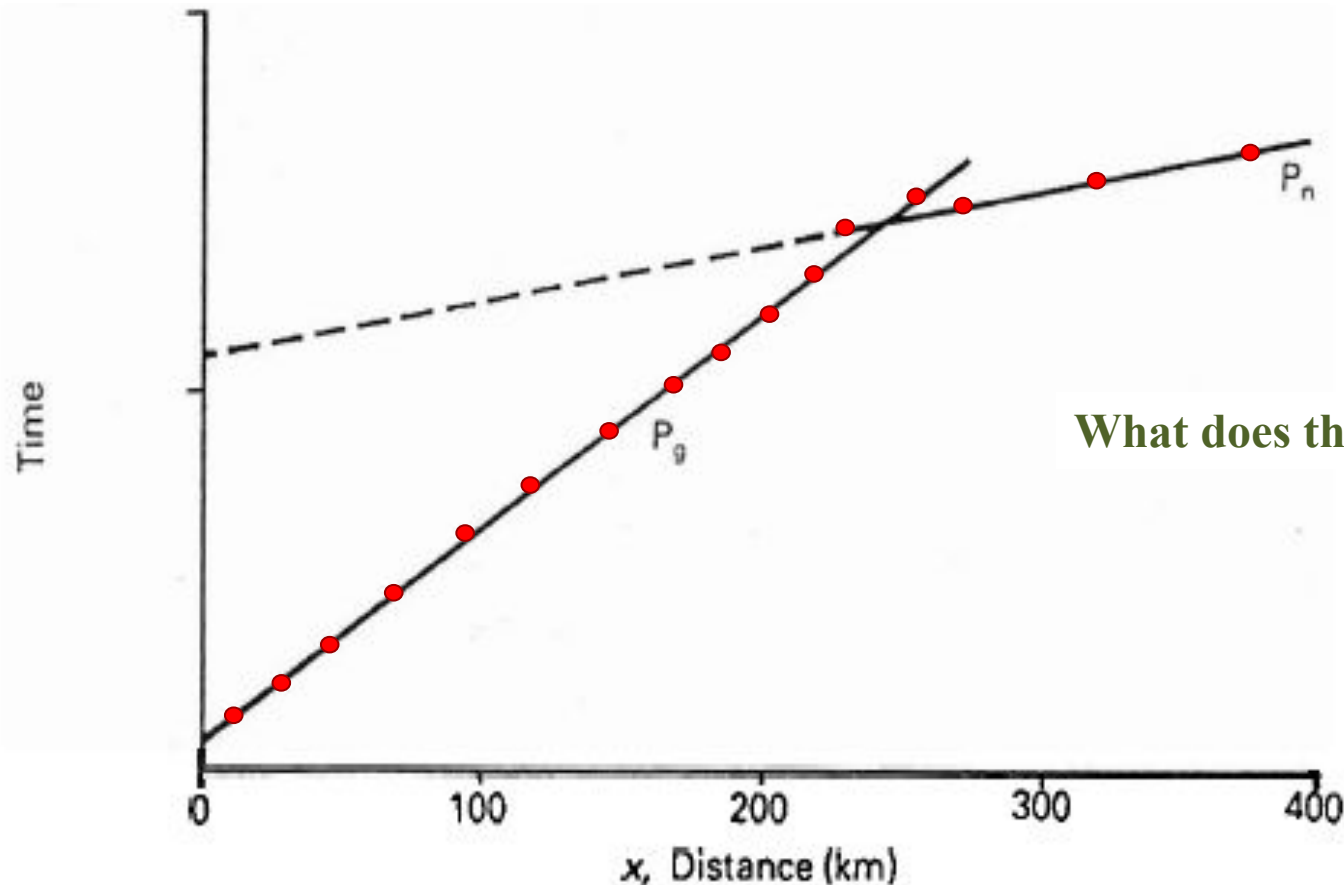
# The Mohorovicic Discontinuity (Moho)

- Mohorovicic (1909) used an earthquake in Yugoslavia as a seismic source
- Observed arrival times of P-wave at a range of distance (seismograph stations)



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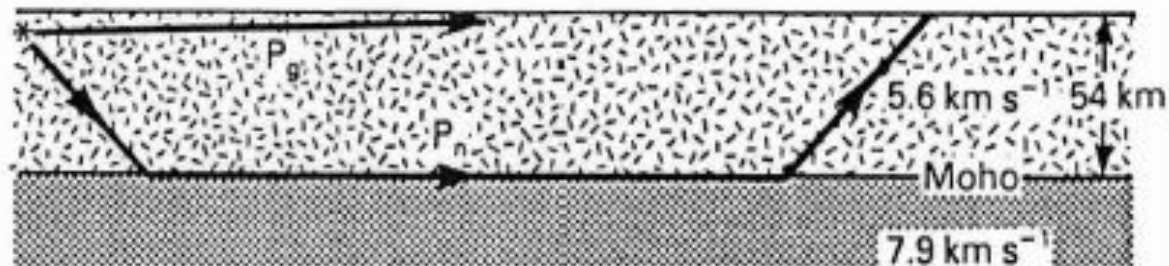
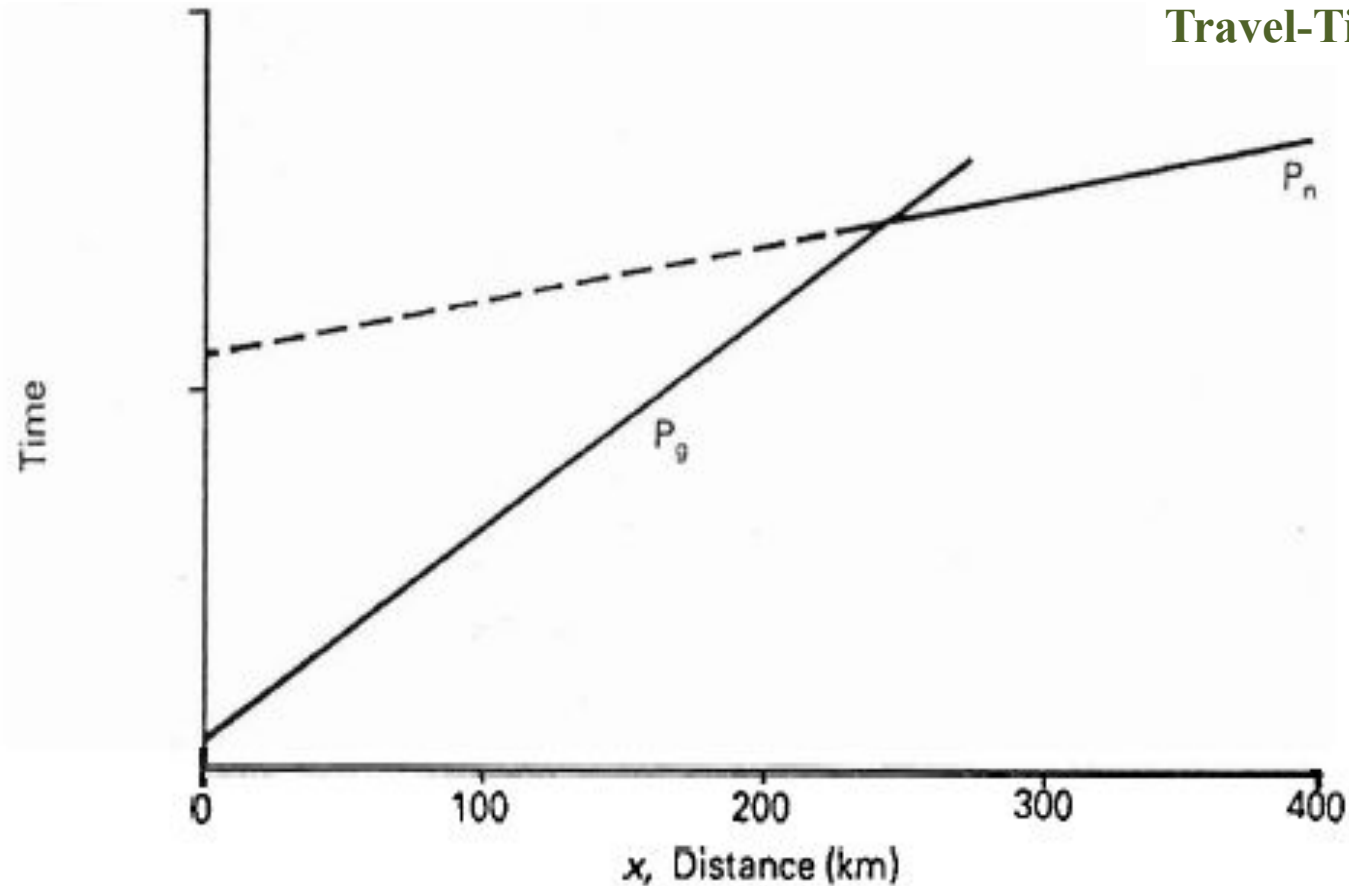


**What does this observation mean?**



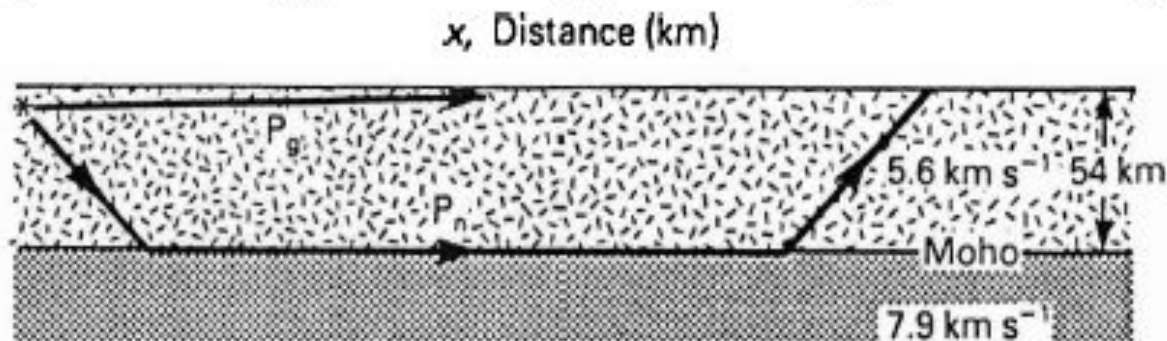
# The Mohorovicic Discontinuity (Moho)

## Travel-Time Curve



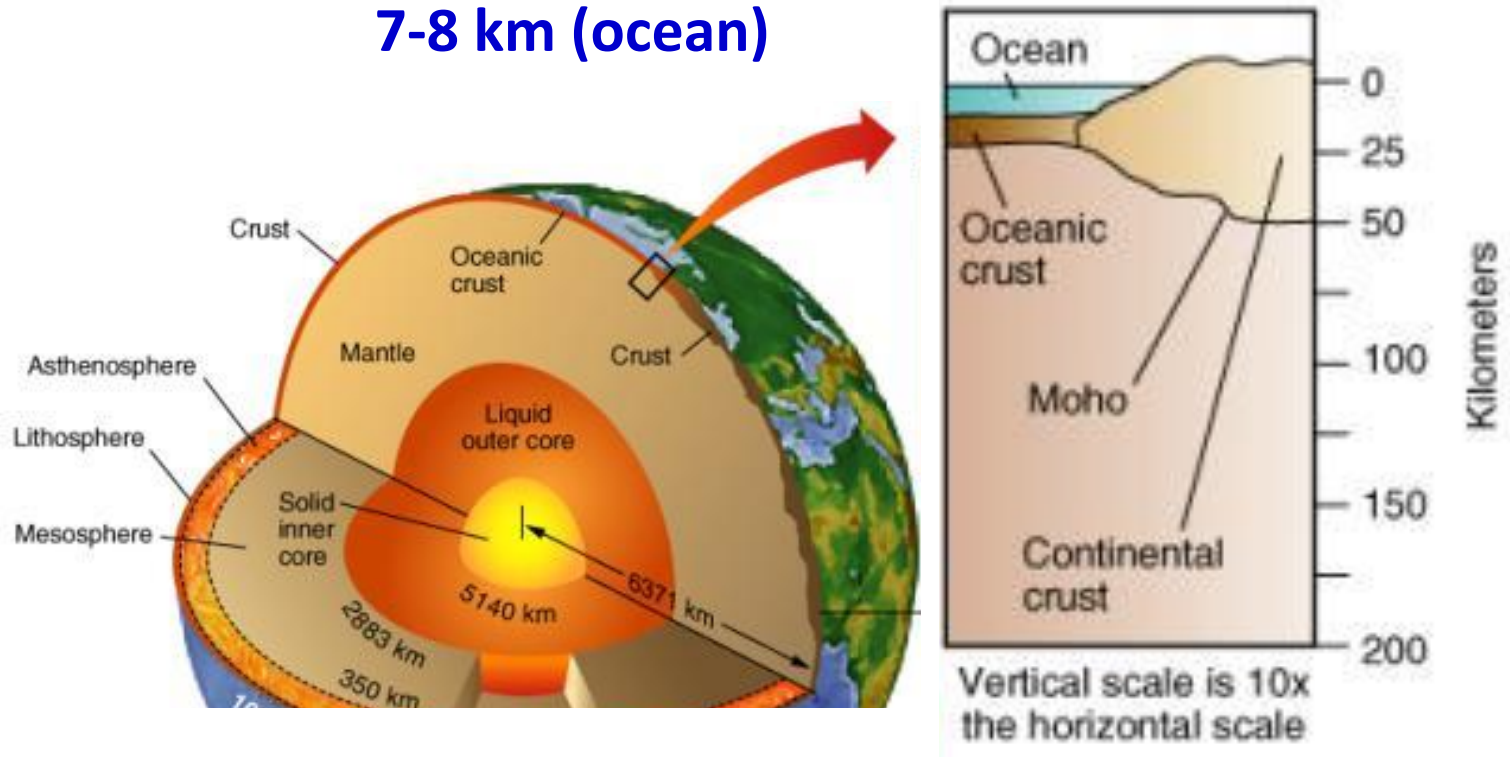
# The Mohorovicic Discontinuity (Moho)

- Inferred a discontinuity in **V<sub>p</sub>**: increased from  $\sim 6 \text{ km s}^{-1}$  to  $\sim 8 \text{ km s}^{-1}$ .
- This was termed the **Mohorovicic Discontinuity (MOHO)**.
- Found to be present almost everywhere in the Earth.
- Rocks above the Moho belong, by definition, to the **crust**: below the Moho, extending to the outer core, lies the **mantle**.



# Continental and Oceanic Crust

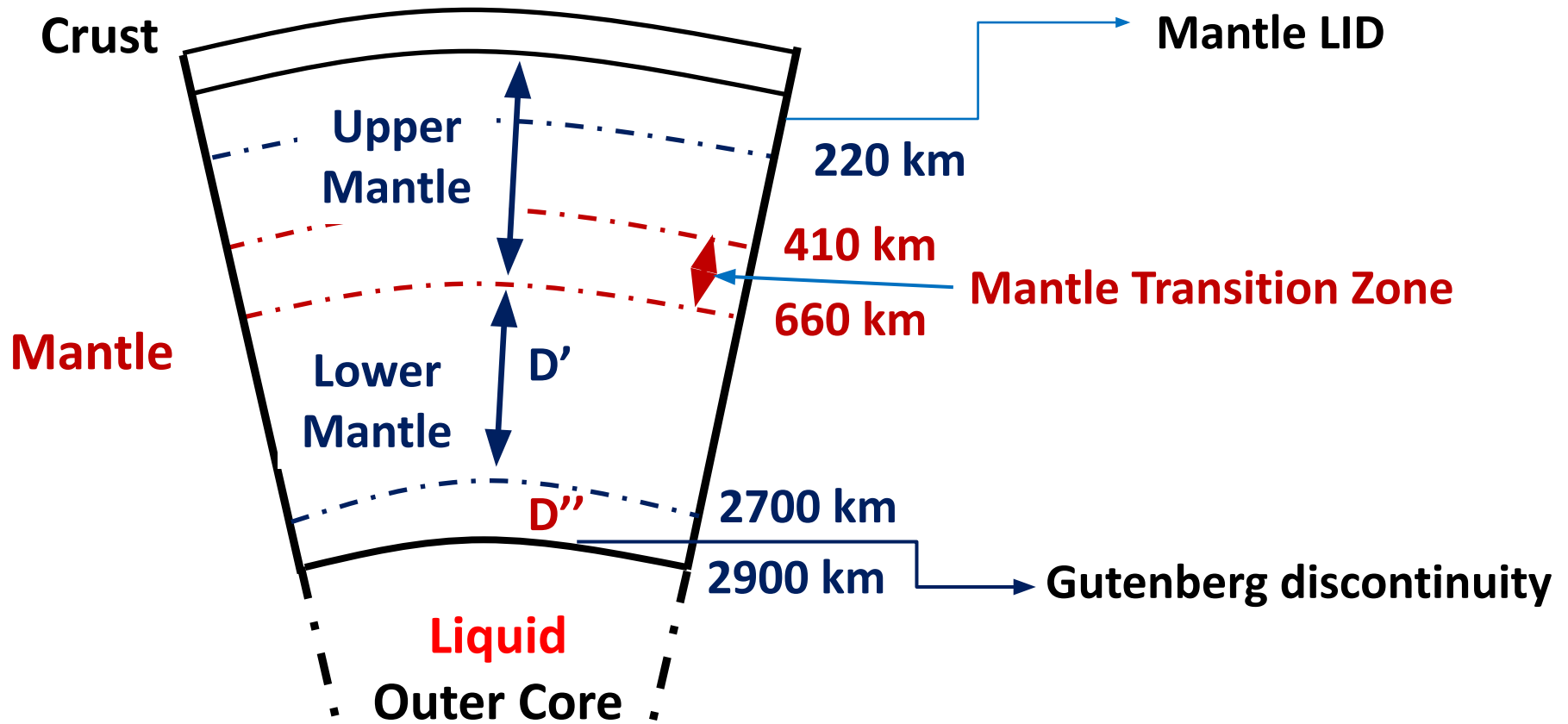
Average thickness: 35 km (continent)  
7-8 km (ocean)



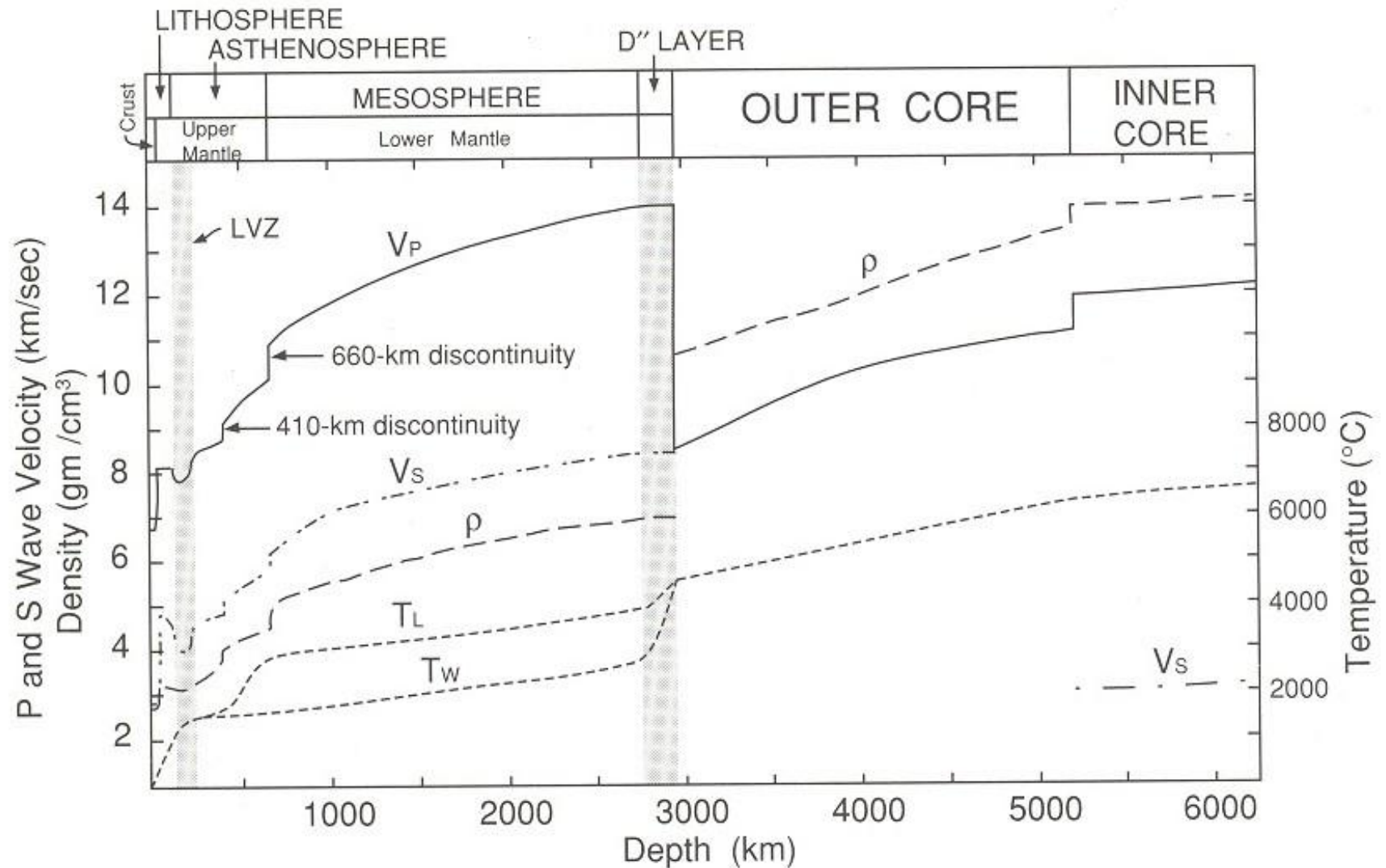
- Must have originated by different processes and
- **Also have different compositions!** (*more on this later..*)



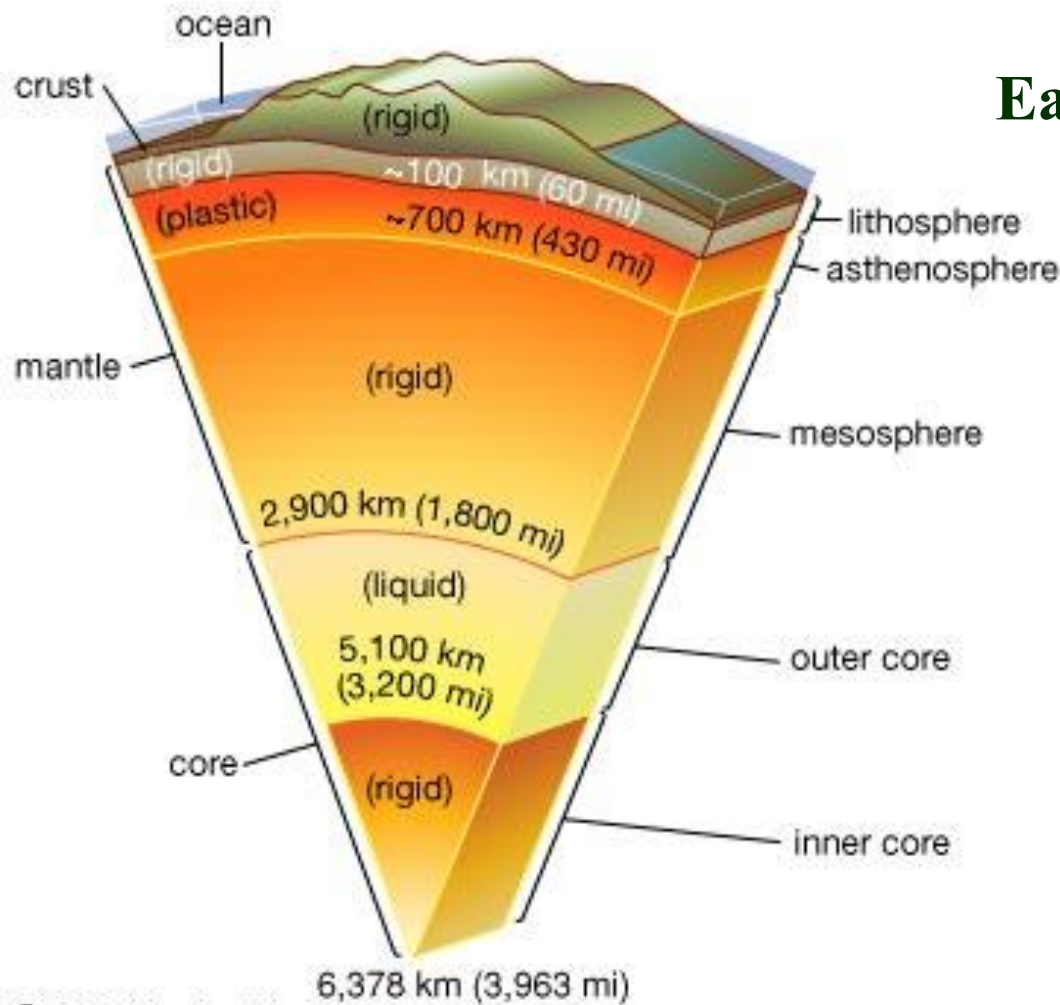
# Mantle Discontinuities



# Distribution of seismic velocities and density within the Earth



# Layering based on Physical Properties



## Earth as a Heat Engine

### Lithosphere:

- Mechanically Strong Boundary Layer
- Conductive Heat Loss

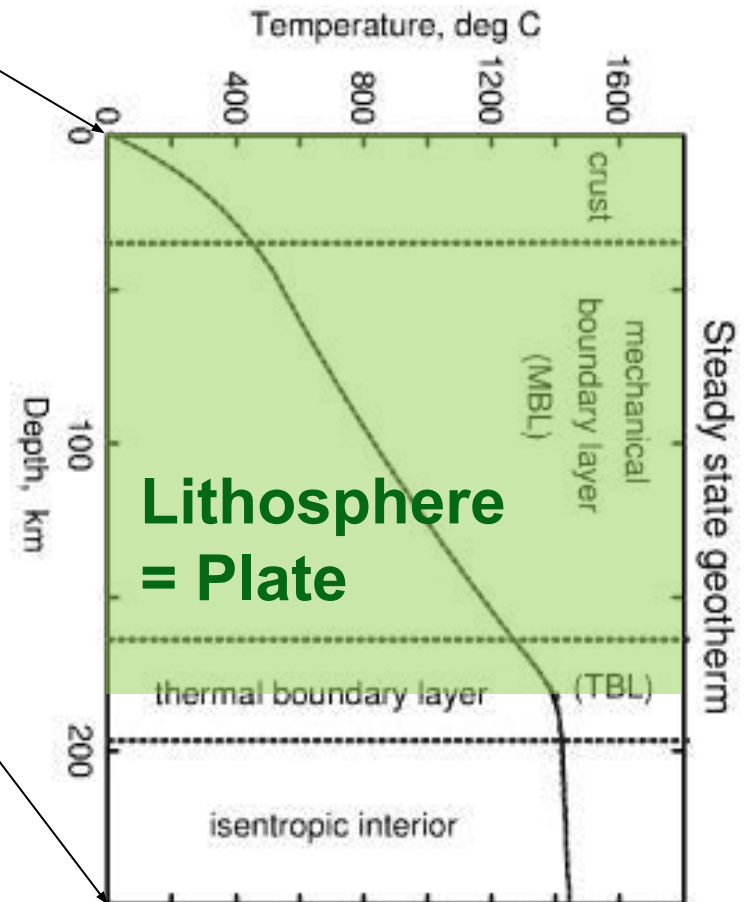
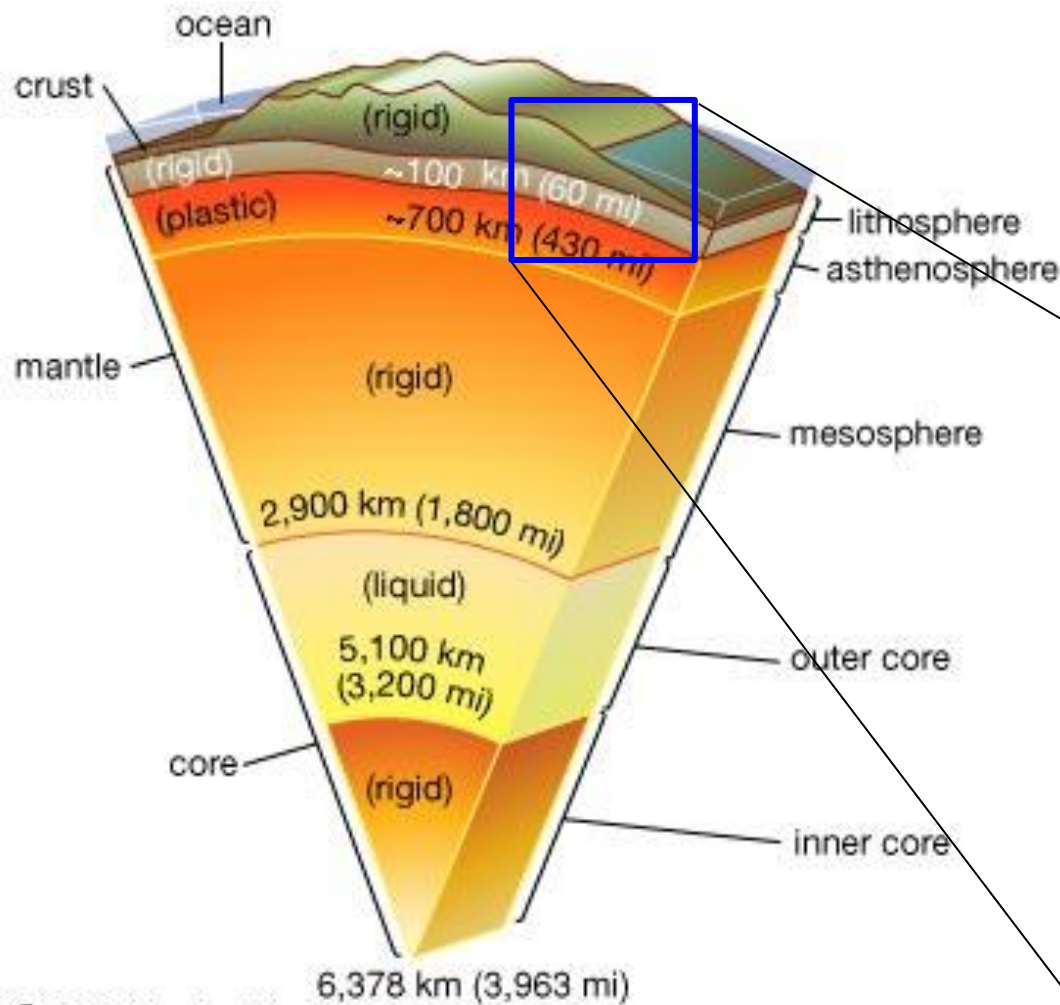
### Asthenosphere:

- Mechanically weak underlying layer
- Convective Heat Loss

**How is the Lithosphere-Asthenosphere Boundary (LAB) defined?**



# Lithosphere-Asthenosphere Boundary (LAB)



# Lithosphere-Asthenosphere Boundary (LAB)

