

## INTERIOR OF THE EARTH

Deep parts of the Earth are studied indirectly through Geophysics.

Geophysics includes the study of seismic waves and the Earth's magnetic field, gravity and heat.

### Evidence From Seismic Waves

Seismic Reflection - the return of some of the energy of seismic waves to the Earth's surface other the waves bounce off a rock boundary.

\*Density sensitive: waves move faster in more dense materials

Seismic Refraction - the bending of seismic waves as they pass from one material to another.

(similar to the way that lights bends) eyeglasses, water

Reflection

Refraction

### The Earth's Internal Structure

Compositional and Geophysical Views of the Earth

## Earth's Structure

### 1) Crust (compositional)

Average thickness	Oceanic 7 km	Continental 30-50 km (thickest under mountains)
Seismic P Waves	7 km/s	6 km (higher in lower crust)
Density	3.0 g/cm <sup>3</sup>	2.7 g/cm <sup>3</sup>
Probable Composition	Basalt underlain by Gabbro	Granite and other Plutonic igneous rocks, met or sediment. cover

Moho - separates crust from the mantle

We also have samples of both types of crust.

### 2) Mantle

#### a. Lithosphere - crust and upper mantle (**geophysical term**)

- Lithos - strong, hard, brittle
- averages 70 km beneath oceans, may be 125-150 km beneath continents
- seismic waves v generally increases with depth
- low velocity zone ---> marks boundary of Asthenosphere

#### b. Asthenosphere - low velocity zone (**geophysical term**)

- rocks are close to melting point - which is controlled by T and P
- may be partially molten - crystal and liquid slush
- makes them weaker - can be deformed in a ductile manner

#### c. Lower Mantle (**compositional**) also called Mesosphere (**geophysical**)

- 400 km - concentric layers at these depths
- 670 km - deepest quakes

\* These layers are probably "pressure collapse" layers  
@ 670 km olivine ---> perovskite

We also have samples of mantle rocks in the form of Ophiolites.

How do ophiolites form?

*This means mantle could have similar chemical composition throughout, but not the same mineral composition.*

Graphite ---> Diamond

(called polymorphs)

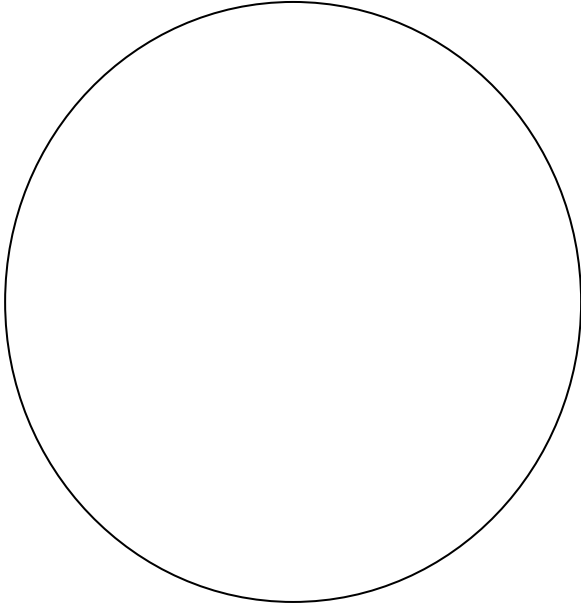
670 km and above - upper mantle

670 km and below - lower mantle

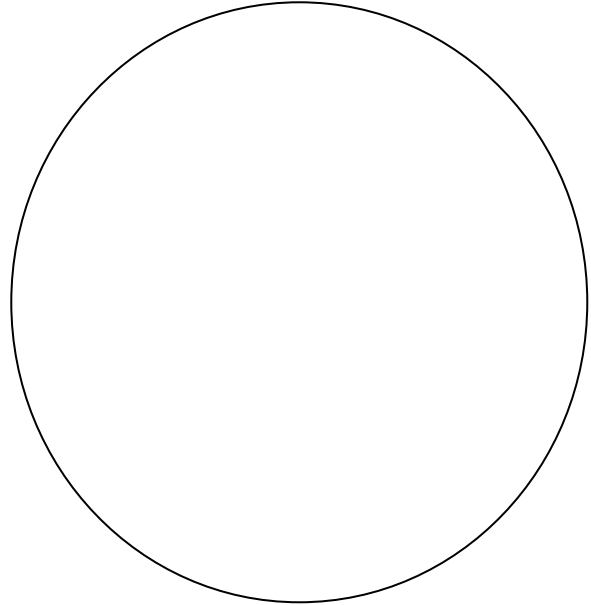
## THE CORE

Found the boundary by the shadow zones of earthquake waves.

**S WAVES**  
(waves disappear from seismograph)



**P WAVES**



shadow zones

The way in which the P waves are refracted within the Earth's core suggest that the core has 2 parts, the Outer core and the Inner core.

The Earth's Composition: From astronomical, sample and seismic evidence

- mostly iron along with minor O, Si, S, and Ni

- overall density of the Earth - 5.5 g/cm<sup>3</sup>

Mantle - 3.3 ---> 5.5 g/cm<sup>3</sup>

- core @ CMB 10 g/cm<sup>3</sup> and 12-13 g/cm<sup>3</sup> at center of Earth

Iron idea comes from meteorites.

## CMB

- marked by a great change in density and temperature

- transition is up to 200 km thick and is uneven

- upper mantle and outer core are undergoing convection

(low density rises, high density sinks)

- maybe even crustal plates from subduction

## ISOSTASY

- Balance or equilibrium of adjacent blocks of brittle crust  
“floating” on the upper mantle (asthenosphere)
- Blocks of wood floating on water rise or sink until they displace an amount of water equal to their own weight.

Isostatic Adjustment - blocks reach their equilibrium

---> Similarly, the weight of crustal blocks is equal to the weight of the displaced mantle

- \* Increases in weight on a continent will cause the crust to sink.
- \* Decreases in weight will cause the crust to rise.

Crustal Rebound - rise of the crust after removal of ice sheets.

## GRAVITY MEASUREMENTS

Force of g between A & B = constant [mass a x mass b / distance<sup>2</sup>]

- \* forces increase with an increase in mass of either.
- \* forces decrease with distance apart.

Gravity Meter - measures the gravitational attraction between the Earth and a mass within the instrument.

\*Used to explore local variations in rock density (or anything else that is down there)

$$\text{mass} = d \times v$$

- >Dense rock pulls stronger
- >Less dense pulls less

Positive  
Gravity Anomaly

Negative  
Gravity Anomaly

Other Positives : Uplifted Region (by tectonics)

Other Negatives : Held Down Region (by tectonics)

## The Earth's Magnetic Field

Magnetic Field - region of magnetic force.

Generated in the core, produced by convection in the outer core and electric currents.

- \* Has two poles

Geothermal Gradient

- \*  $25^{\circ}\text{C} / \text{km}$

- \* T @ center of Earth:  $6900^{\circ}\text{C}$

the gradient is due to convection in the mantle  
(heats the Earth from the inside out)

## Magnetic Reversals

### Facts:

Used dating techniques to get absolute dates.

Rock Used = Basalt (mafic - iron rich)

## Magnetic Anomaly

Positive - Develops over rock with more iron (mafic, sima or ocean crust): basalt, gabbro, or ultramafic

Negative - Develops over rock with low magnetism (felsic).

Magnetometer - used to measure magnetism