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)	Oceanic	Continental
Average thickness	7 km	30-50 km (thickest under mountains)
Seismic P Waves	7 km/s	6 km (higher in lower crust)
Density	3.0 g/cm3	2.7 g/cm3
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)

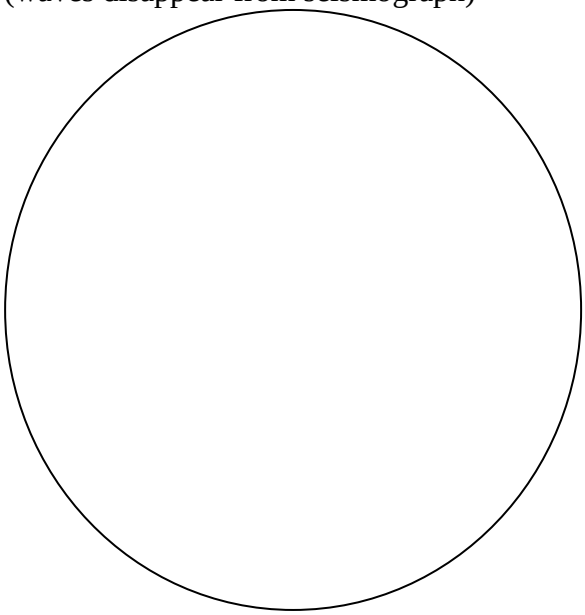
670 km and above - upper mantle

670 km and below - lower mantle

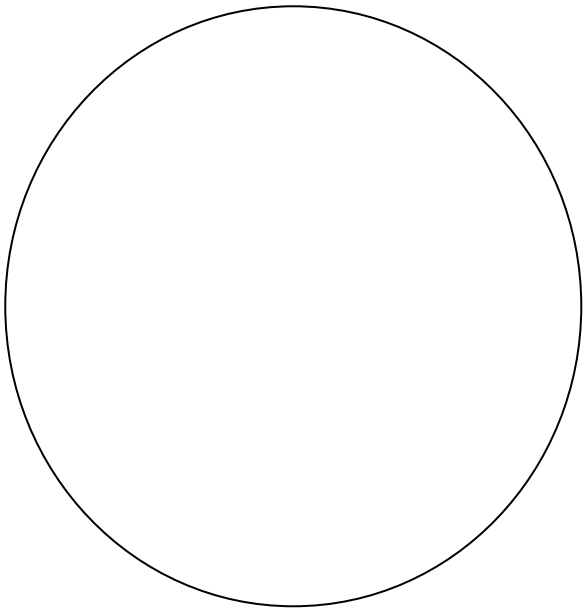
THE CORE

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 saves 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/cm3

Mantle - 3.3 ---> 5.5 g/cm3
- core @ CMB 10 g/cm3 and 12-13 g/cm3 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^2]

* forces increase with an increase in mass of either.
* forces decreases 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)

mass = d x 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°C / km
* T @ center of Earth: 6900°C
the gradient is due to convection in the mantle
(heats the Earth from the inside out)

Magnetic Reversals

Facts:
Used dating techinques 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