The Earth

R ~ 6400 km

Structure of the Earth

Crust  2.8 gm/cc
   continental  50 km
   oceanic      5 km
   Granite/Basalt Rocks (solid)

Mantle  4.5 gm/cc
   upper       800 km
   lower      2000 km
   Oxygen, Silicon, Magnesium, & Iron (plastic-like)

Core  12.9 gm/cc
   outer liquid 2100 km
   inner solid  1400 km
   Iron and Nickel

Deepest Mine (S.A.) 3.4 km, deepest hole (Texas) 7.7 km

How do we know the structure within the Earth?

Seismic Waves (vibrations)
   Earthquakes - sudden movement of the earth
   Explosions

Seismograph records
   Earth vibrations
   amplitude, time
   type
      transverse
      longitudinal

Different layers, velocities
   ⇒ refraction
   liquids do not transmit
      transverse waves

4 types of seismic waves
   Body Waves - through Earth
      P (primary)
         longitudinal, fast
      S (secondary)
transverse, slow
Surface Waves
\[ L \text{ (Love) - sideways} \]
\[ R \text{ (Raleigh) - elliptical} \]

ratio Body/Surface amplitude
distinguishes earthquakes from nuclear explosions

CRUST
density 2.8 gm/cc

common elements by weight

Rock - heterogeneous
(non-uniform) aggregate of minerals
Mineral - naturally occurring homogeneous inorganic compound
definite crystal structure characteristic properties color, density, hardness

Types of Rocks

IGNEOUS
most common youngest at surface granite, basalt formed from molten matter oldest inside
SEDIMENTARY
deposits of weathered eroded rocks, compressed gypsum, clay, quartz

METAMORPHIC
changed, recrystallized by heat and pressure in crust without melting

MANTLE 4.5 gm/cc
sharp boundary at crust dense silicate materials rich in Mg Fe multiple layers mostly solid close to melting

Outer CORE
liquid - no S waves molten Fe + Ni Co S Si

Dynamo Effect
heat flow + rotation ⇒ magnetic field

Inner CORE 12.9 gm/cc
solid, near melting, P 3.5 million atmospheres, T ~ 5000°C

VOLCANOS
>500 in last 400 yr show dynamic (changing) nature of Earth’s surface

Krakatoa in Indonesia volcanic island dormant 200 years exploded in 1883 heard in Australia > 5000 km away
17 km³ rock/pumice into air destroyed 2/3 of island tidal wave drowned 36,000 people

Volcanic Activity most widespread after mountain formation
**Magma** - hot material below surface, plastic

**Lava** - rises, becomes liquid, flows or explodes out

Old View - static Earth
continents and oceans fixed

Modern View - dynamic,
Plate Tectonics

**Fossils**
remains of organisms
in geological past
preserved in sedimentary rocks
recognizable layers
radioactive dating
provide time record
life on Earth

**Phanerozoic Eon**

**Cambrian Period**
570 MYA Million Years Ago
fossils visible to naked eye

**Precambrian Eon**
3800 MYA microscopic fossils

Age of Earth $4.6 \times 10^9$ yr