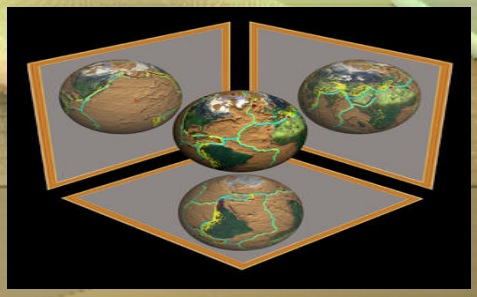
Plate Tectonics

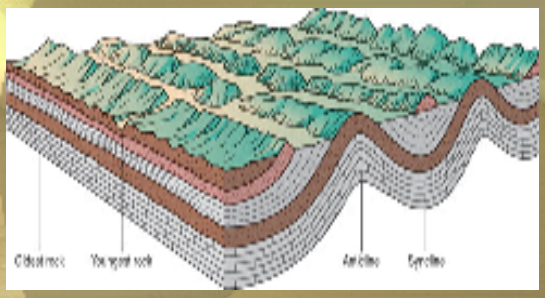


- The Theory of Plate Tectonics explains:
  a. Earthquakes
  b. Volcanoes
  c. Continental drift
  d. Deep ocean trenches
  e. Mountains
  f. Deformed rocks
  g. Mid-ocean ridges

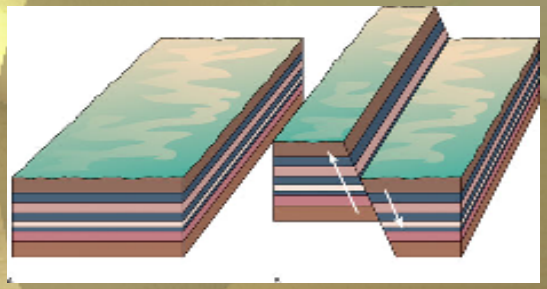
Evidence of Crustal Movement

- Appearance of deformed rock layers
  - Concept of horizontality
    - Rocks form in horizontal layers on Earth's surface
    - Called strata (like layers to a cake)
  - Three categories of deformed rock:
    - Occurs when forces push the strata (layers) are pushed up or down
    1. Anticline: pushed up forming an arch
    2. Syncline: pushed down forming a bowl
    3. Fault: large crack occurs in the rocks – Strata moves up or down along the crack

Deformed Rock Strata



Development of a Fault



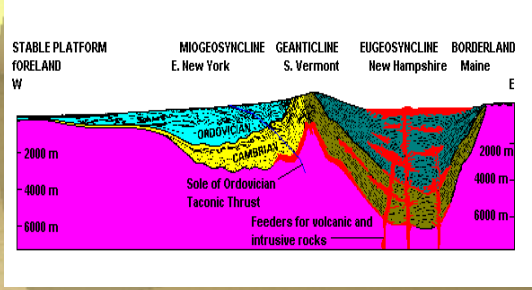
Evidence of Crustal Movement

- Location of fossils in sedimentary rock
  - Reveals that Earth's crust is dynamic (moving)
    Ex: fossils of marine life found on top of mountains
- Benchmark elevation markers placed over the world (specific elevation markers that measure the exact longitude/latitude coordinates and elevation at a specific point on the Earth's surface)
  - Measurements are taken over time
  - Reveal that positions are changing
  - Provide evidence Earth is moving

Evidence of Crustal Movement

- Geosyncline
  - Large shallow ocean basin where sediments accumulate
  - Weight causes continents to rise upward
- Concept of:
  - Lighter continents floating on the mantle
  - Dense ocean basins sinking into the mantle
  - Isostasy—Earth's crust in state of equilibrium

Geosyncline = "crustal warps"

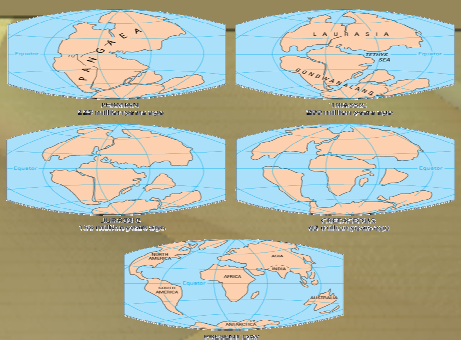


Continental Drift

- Studied fossils from Africa and South America
  - Many of the same species
  - Ancient land bridges connected the continents

Theory called Continental Drift (1960s)

- Explained how continents were connected and drifted apart
- Rock types were also similar



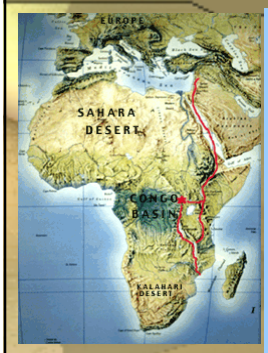
Continental Drift

- Glaciers left scars in rocks
  - Similar from one continent to the other
  - Direction of glacial movement lined up
    - If continents were rejoined
- Theory was originally rejected for 2 reasons:
  - Wegner (early 1900s) was a meteorologist, not a geologist – believed continents "slide" over ocean floor
  - Failed to provide the mechanism for drift

Continental Drift

- Geologists have collected enough data and evidence to prove continental drift.
- Found that at one time all the continents were joined together to form one super-continent called Pangea.

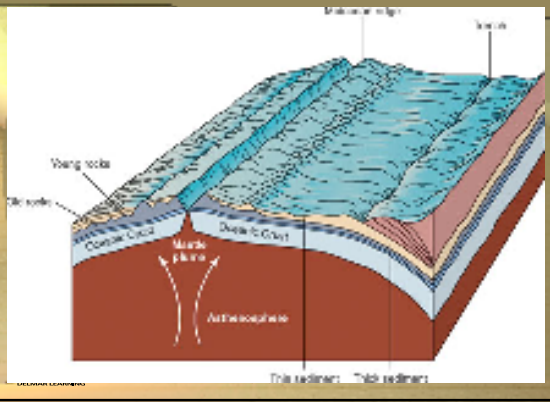
PANGEA



Seafloor Spreading

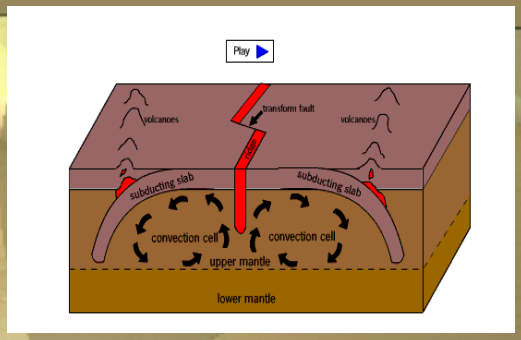
- Underwater mapping revealed mountain ranges
- Called the mid-ocean ridges
- Theories of how crust formed at center
  - Was moving outward
  - Called seafloor spreading
  - Evidence — alternating bands of magnetic crystals
  - Magnetic north and south - change periodically

Mid-ocean Ridge



Seafloor Spreading

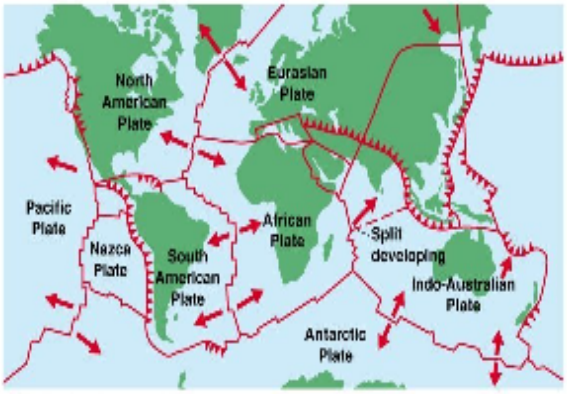
- Scientists dated rock from mid-ocean ridges
  Older - farther from the ridge center
- Cooler as moved away from ridge center
- Indicated large convection cells
- Proved Wegner's theory of continental drift !



Tectonic Plates

- Idea is that Earth's surface is composed of large moving plates
  - Theory called Plate Tectonics
  - Plates move relative to one another
  - Plates float on semi-liquid upper mantle
  - Edges of plates called plate boundaries
    - Area where volcanoes are located
    - Area where earthquakes occur

- Movement of plates and tectonic stress
  - Cause earthquakes
- 14 major plates identified
  - All float on the underlying asthenosphere
  - Move relative to one another
  - From 0.5 to 4.0 inches/year



(a)

Plate Boundaries

- Where two tectonic plates meet
- Three main types of plate boundaries:
  - Divergent
  - Convergent
  - Transform Fault Plate Boundary

1 - Divergent - 2 plates moving away from each other
- Associated with mid-ocean ridges
  - EX: Mid-Atlantic Ridge
- Form rift valleys
  - EX: African Rift Valley -- eastern side of Africa

Mid-ocean Ridge Divergent Plate Boundary

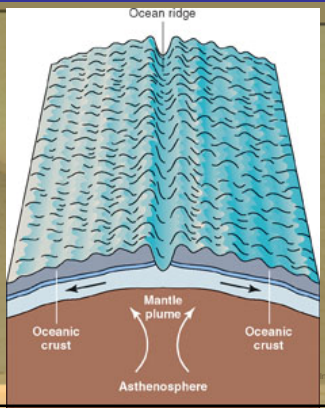


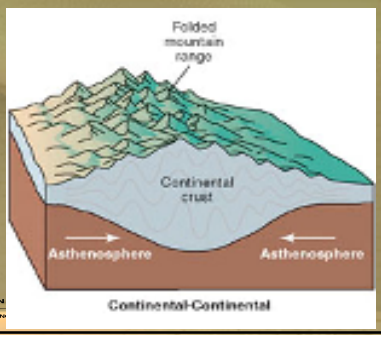
Plate Boundaries

2 - Convergent - where 2 boundaries collide

- Continental - forms mountains
- Oceanic — forms trenches
- Oceanic-Continental -forms a subduction
  - Crust of oceanic plate **descends and melts**
  - Volcanic arc system
    - Series of volcanoes near a subduction zone

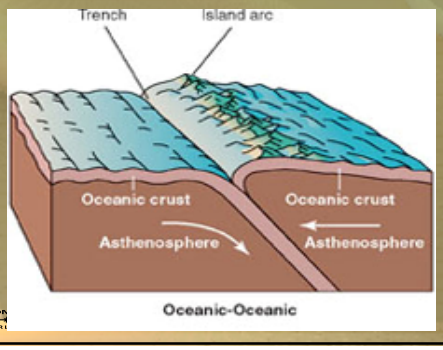
Continental-Continental Convergent Plate Boundaries

(Non-Volcanic: Himalayas – Alps – Appalachian Mountains)



Oceanic-Oceanic Convergent Plate Boundaries

(Violent volcanic islands: Japan, Aleutians, Philippines)



Oceanic-Continental Convergent Plate Boundaries

(Ex: Mt. Vesuvius, Mt. Fujiyama, Andes, Cascades)

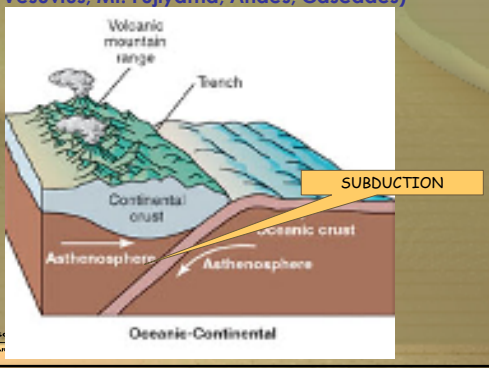


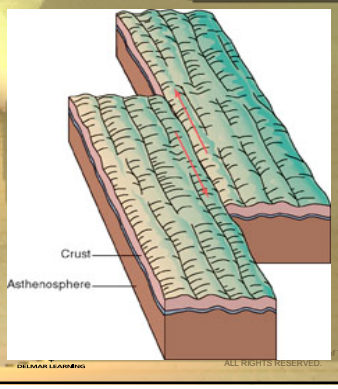
Plate Boundaries

3 - Transform Fault Plate Boundary

- When two plates slide along one another
- Also known as a lateral fault
- Build up great tension due to friction

- Ex: San Andreas fault

Transform Fault Plate Boundary



Mantle Convection

- Driving force causing tectonic plates to move

- Hot spot
  - Where magma rises and breaks through crust
    - Mid-ocean ridges located over hot spots
    - Some volcanic island chains as well
      - Oceanic: Hawaiian Island chain
      - Continental: Yellowstone
  - Tracer for plate movement (rate, direction)

- Convection cycle
  - Once cooled, mantle sinks, starts over