12.1 Evidence for Continental Drift

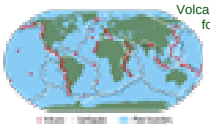
- Early maps of the world caused Wegener to propose the continental drift theory.
  - The continents looked as though they might fit together like puzzle pieces.
    - The continental shelves actually fit together even better.
  - The original supercontinent was named Pangaea by Wegener.
  - Wegener also realized that other evidence also supported his theory.
    - There were matching geologic features and rocks on different continents.
    - There were matching fossils, like *Mesosaurus*, on different continents.
    - There was evidence of different climates, (eg. Such as glaciers) on warm continents.

Like pieces of a jigsaw puzzle, the continents fit together into one, large whole.

See pages 506 - 509

How Can Continents Move?

- Wegener's evidence for continental drift did not explain how entire continents could change locations.
  - New scientific equipment allowed scientists to measure the slow but steady drift of Earth's tectonic plates.
  - It was noted that earthquakes and volcanoes appear in certain patterns along the edges of tectonic plates.
  - Mapping of the ocean floor revealed the Mid-Atlantic Ridge, a long mountain range running down the middle of the Atlantic Ocean.
  - Rocks taken from the Mid-Atlantic Ridge were younger than other ocean rocks.
  - Sediments along the ridge became thicker farther away from the ridge.
  - Paleomagnetism shows that iron-based rocks along the ridges are striped with reversing magnetic fields.



Volcanoes are frequently found on boundaries between tectonic plates.

See pages 510 - 512

Sea Floor Spreading: An Explanation

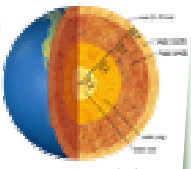
- Hess suggested that magma rose to form new rock at certain places.
  - Magma (melted rock) rises and falls like warm and cold liquids.
  - The convection currents of magma formed a spreading ridge where they broke through Earth's crust.
    - Like a "new crust" conveyer belt
    - Magnetic striping of basalt rock shows long stripes of new rock moving away from ocean ridges and also reveals the direction of Earth's magnetic field at that time.
- Wilson then unified the ideas of Wegener and Hess into the plate tectonic theory.
  - Continental drift occurs because of areas like these ridges that push along tectonic plates floating on Earth's surface.
  - Geologic hot spots are anywhere magma rises to Earth's surface.

See pages 512 - 513

Take the Section 12.1 Quiz

12.2 Features of Plate Tectonics

- Earth is over 1200 km thick and has four distinct layers.
  - These layers are the crust, mantle (upper and lower), outer core, and inner core.
    - Crust – outer solid rock layer (granite on land, basalt in oceans)
    - Mantle – thickest layer, mostly solid except for upper mantle being able to flow like "thick toothpaste"
    - Outer core – composed of liquid iron and nickel
    - Inner core – mostly solid iron, at tremendous temperature and pressure
- Tectonic plates make up the lithosphere, which floats on the asthenosphere.
  - The lithosphere is the crust and upper portion of the upper mantle.
  - The asthenosphere is the molten layer of the upper mantle.
    - Heat to keep the asthenosphere molten comes from radioactive elements.



Earth's layers

See pages 518 - 521

Plate Motion (continued)

- Continents, attached to the tectonic plates, float in the magma of the asthenosphere.
  - As magma is heated in the asthenosphere, convection currents form.
  - Rising magma can reach the surface at ridges (in the oceans) or rifts (on land).
    - The magma cools when it reaches the surface, solidifies, and is pushed aside as new magma pushes from below. This is called ridge push.

- Tectonic plates are all moving at the same time.
  - There are 12 large tectonic plates and many smaller ones.
  - Where continental and oceanic plates meet, subduction occurs.
    - The denser oceanic plate subducts under the lighter continental plate.
      - By "slab pull," the rest of the plate follows.
  - Large earthquakes and volcanoes are found in subduction zones.

See pages 520 - 522

Plate Interactions

- A plate boundary an area where two plates are in contact.
  - The way the plates interact is based on the type of plate and the direction the plates are moving relative to each other.
  - Divergent plate boundaries – areas where plates are spreading apart
  - Convergent Plate boundaries – areas where plates meet
  - Transform plate boundaries – areas where plates move past each other

Tectonic plate boundaries, and their relative movement to each other.

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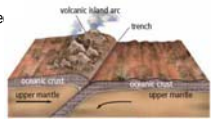
Plate Interactions (continued)

1. Divergent plate boundaries are areas where plates are spreading apart.
   - Ocean ridges and continental rifts are examples.
   - The Mid-Atlantic Ridge is the longest mountain range on Earth.
2. Convergent plate boundaries are areas where plates collide.
   - A. Oceanic-continental plate convergence
     - The oceanic plate subducts under the continental plate, forming a trench.
     - Cone-shaped volcanoes can form from magma seeping to the surface.
       - This is how the volcanic belt of the North America's west coast has formed.
     - Mountain ranges like the Coast Mountain range also form from the collision.
     - Earthquakes can occur when subduction, ridge push, and slab pull stall.



The convergence of an oceanic and a continental plate.

See pages 523 - 525

Plate Interactions (continued)

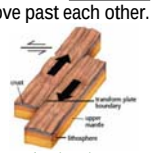
A. Oceanic-oceanic plate convergence
- The cooler, denser plate will subduct under the less dense plate.
- Convergence may produce a volcanic island arc, such as those found in Japan, Indonesia, and Alaska's Aleutian islands.

B. Continental-continental plate convergence
- Since both are continental plates, their densities are similar.
- As they collide, their edges fold and crumple, forming mountain ranges.
  - The Himalayas are the world's youngest (and tallest) mountain range, formed as Asia and Africa plates collided 40 million years ago.
    - They are still growing taller today.

See pages 523 - 525

Plate Interactions (continued)

3. Transform plate boundaries are where plates move past each other.
   - Usually are found near ocean ridges
   - Since rock slides past rock, no mountains or volcanoes form.
   - Earthquakes and faults are very common.



Transform boundary

4. Earthquakes often form from the friction between moving tectonic plates.
   - This accounts for 95 percent of all earthquakes.
   - The Juan de Fuca convergent plate boundary west of Vancouver Island has many earthquakes.
     - Large earthquakes hit this region every 200 to 800 years.

San Andreas fault

See pages 526 - 527

Describing Earthquakes

- Earthquakes are very difficult to predict.
  - Scientists understand why they happen, but it is very difficult to predict their timing, exact location, and strength.
  - Their pressure build-up happens underground, over very long periods of time.
  - What we do understand has helped us to prepare structures to survive them.
  - The focus of the earthquake is where the pressure is finally released.
    - The epicentre is the point on the surface directly above the focus.
  - Earthquakes occur at various depths, depending on the plates involved.
    - Earthquakes at the surface tend to cause more damage.

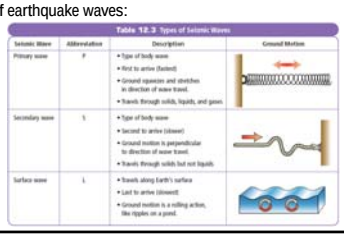
Table 12.2 Depth of Origin of Earthquakes

Classification	Depth of Focus
Shallow focus	0 to 70 km
Intermediate focus	70 to 300 km
Deep focus	greater than 300 km

See page 528

Describing Earthquakes (continued)

- Earthquakes produce seismic waves.
  - Seismology is the study of these waves.
  - These waves reveal the source and strength of an earthquake.
    - They also help us learn about the composition and distances of the Earth's interior.
  - Types of earthquake waves:



See page 529

Describing Earthquakes (continued)

- Seismic waves behave differently in different Earth layers.
  - Knowing this, scientists can learn about earthquakes and Earth's interior.
- Seismometers are used to measure seismic wave energy.
  - Early seismometers just measured whether the ground shook.
  - Some seismometers measure horizontal movement, others vertical movement.
    - A seismogram is produced, showing when an earthquake started, how long it lasted, and the magnitude.
    - 1 increase in magnitude = 10X stronger
      - A magnitude 6 earthquake is 100X more powerful than a 4.
    - Since seismic waves travel at different speeds, a distance-time graph can reveal the focus.

See pages 530 - 531

Volcanoes

- The movement of tectonic plates causes volcano formation.
  1. Composite volcanoes – found along plate boundaries
     - Layers of ash and thick lava form a tall cone.
     - As magma reaches the surface, it cools, hardens, and traps gases below.
     - Pressure builds; eventually, there is an eruption.
  2. Shield volcanoes – these are not found at plate boundaries but instead form over hot spots.
     - Thin magma/lava flows out from a hot spot and forms a low, wide cone.
     - The Hawaiian Islands are an example of a chain of shield volcanoes.
  3. Rift eruptions – occur along long cracks in the lithosphere
     - These are not explosive, but they release massive amounts of lava.

Mount St. Helens is composite volcano.

Take the Section 12.2 Quiz

See pages 532 - 534