INSERT CH 1 STUFF HERE

Continental drift: Wegener's hypothesis, dared to challenge the long-held assumption that the continents and ocean basins had fixed geographic positions; suggested that a single *supercontinent* consisting of all of Earth's landmasses once existed--*Pangaea*

Give the four lines of evidence that support the theory of continental drift:

1. **The Continental Jigsaw Puzzle**
    a. The remarkable similarity between the coastlines on opposite sides of the Atlantic Ocean
    b. In the early 1960s, Sir Edward Bullard and two associates constructed a map that pieced together the edges of the continental shelves of South America and Africa at a depth of about 900 meters (3000 feet). The remarkable fit that was obtained was more precise than even these researches had expected
2. **Fossils Match Across the Seas**
    a. Identical fossil organisms had been discovered in rocks from both South America and Africa that his pursuit
    b. Most paleontologists were in agreement that some type of land connection was needed to explain the existence of similar Mesozoic age life-forms on widely separated landmasses
        i. Classic example: *Mesosaurus*
        ii. *Glossopteris; "seed fern"*
3. **Rock Types and Geologic Features**
    a. Wegener found evidence of highly deformed igneous rocks in Brazil that closely resembled similar rocks in Africa
4. **Ancient Climates**
    a. Wegener learned that evidence for a glacial period that dated to the late Paleozoic had been discovered in southern Africa
        i. How could extensive ice sheets form near the equator?
        ii. Wegener suggested that a more plausible explanation for the late Paleozoic glaciation was provided by the supercontinent of Pangaea

Describe how some rocks, when formed, end up preserving the direction of the Earth's magnetic field.

- Earth's magnetic field is less obvious than the pull of gravity because humans cannot feel it, but compasses confirm its presence
- **Some naturally occurring minerals are magnetic and are influenced by Earth's magnetic field**
- *Magnetite* is abundant in lava flows of basaltic composition
- Some sediments and sedimentary rocks contain enough iron-bearing mineral grains to acquire a measureable amount of magnetization
    - **As the lava cools, these iron-rich grains become magnetized and align themselves in the direction of the existing magnetic lines of force; once the minerals solidify, the magnetism they possess usually remains "frozen" in this position**
        - Rocks that formed thousands of years ago and contain a "record" of the direction of the magnetic poles at the time of their formation are said to possess *paleomagnetism*, or *fossil magnetism*.

Describe how magnetic stripes on the seafloor are formed. How are they related to seafloor spreading and reversals in the earth's magnetic field?

- Vine and Matthews suggested that the stripes of high-intensity magnetism occur where normally magnetized oceanic rocks enhanced the existing magnetic field. Conversely, the low-intensity stripes

are regions where the crust is polarized in the reverse direction, which weakens the existing magnetic field.

- V & M reasoned **that as magma solidifies along narrow rifts at the crest of an oceanic ridge, it is magnetized with the polarity of the existing magnetic field**. *Because of seafloor spreading, this strip of magnetized crust would gradually increase in width.*
  - When Earth's magnetic field reverses polarity, any newly formed seafloor having the opposite polarity would form in the middle of the old strip.
    - Gradually, the two halves of the strip would be carried in opposite directions, away from the ridge crest.
      - **Subsequent reversals would build a pattern of normal and reverse magnetic stripes.**

How does the age of oceanic lithosphere vary within an ocean basin? Where would you expect to find the youngest oceanic lithosphere versus the oldest lithosphere?

- **The seafloor-spreading hypothesis: the youngest oceanic crust would be found at the ridge crest, the site of seafloor production, and the oldest oceanic crust would be located adjacent to the continents**
  - Applying this to lithosphere→**the age of the seafloor increases with distance from a mid-ocean ridge→ the thickness of sediment atop this seafloor is also proportional to distance from the ridge: older lithosphere has had more time to accumulate sediment→OVERALL, OCEANIC LITHOSPHERE IS QUITE YOUNG; oceanic lithosphere forms in the wake of diverging continents and is destroyed at subduction zones as continents converge**
    - Youngest along the mid-ocean ridge? So fucking confused
- The Deep Sea Drilling Project also reinforced the idea that the ocean basins are geologically young because no seafloor with an age in excess of 180 million years ago was found

What are mantle plumes and hotspots? Where do mantle plumes originate? Describe the formation of the Hawaiian Islands in relation to a stationary hotspot.

- *Mantle plumes:* a mass of hotter-than-typical mantle material that ascends toward the surface, where it may lead to igneous activity. These plumes of solid yet mobile material may originate as deep as the core-mantle boundary.
- *Hotspots:* (the surface manifestation of hot, rocky plume ascending through the mantle, and, as the confining pressure drops, triggers partial melting) An area of volcanism, high heat flow, and crustal uplifting that is a few hundred kilometers across
  - **A closer look at the 5 largest Hawaiian islands reveals a similar pattern of ages, from the volcanically active island of Hawaii to the inactive volcanoes that make up the oldest island, Kauai** (which, 5 million years ago, was positioned over the hot spot as the only modern Hawaiian island in existence)

Describe transform fault boundaries. What is the relation of transform faults to mid-ocean ridges? Give an example of a transform fault boundary on land.

- *Transform fault boundaries*: part of prominent linear breaks in the seafloor known as *fracture zones;* along these boundaries plates slide horizontally past one another without the production or destruction of lithosphere
  - Most transform faults are found on the ocean floor, where they offset segments of the oceanic ridge system, producing a step-like plate margin
    - **The Mid-Atlantic Ridge** (mid-ocean ridges), with its zigzag pattern, **roughly reflects the shape of the rifting zone, which resulted in the break up of Pangaea.**
  - Most transform fault boundaries are located within the ocean basins; however, **a few cut through continental crust:**

- ***The earthquake-prone San Andreas fault of California***
- ***New Zealand's Alpine fault***

Describe the stages in formation of an ocean basin (Fig. 2.22). At what stage is each of the following features: East African Rift; Red Sea; Atlantic Ocean

- A. Hot Upwelling Mantle Material Impinges on the Base of Continental Lithosphere (EARV)
- B. Rifting of continental lithosphere
- C. Linear sea develops between separating continents
- D. Linear sea evolves into a mature ocean basin
    - East African Rift Valley→A
    - Red Sea→C
    - Atlantic Ocean→D

Sketch and identify the different parts of a subduction zone; be able to locate them on a map

- ***Trench***: deep depression on seafloor where oceanic plate bends downward
- ***Accretionary Wedge/prism***: the sediment and pieces of oceanic crust that scrape off the downriding plate and accumulate along the leaning edge of the overriding plate
- ***Forearc basin***: volcanic material and sediment accumulate within forearc basin
- ***Volcanic Arc:*** when the melting of a subducting plate at depth generates magma that then rises to the surface, it sometimes reaches surface and erupts forming this.

Describe the 3 kinds of convergent boundaries

- Convergent boundaries can form between:
    - ***Two oceanic plates*** (much like one oceanic plate and one continental plate)→partial melting→*VOLCANIC ARC ISLANDS or ISLAND ARC*
    - ***One oceanic plate and one continental plate***→partial melting (water driven from subducting plate triggers melting in the mantle)→possible volcanic eruptions→*CONTINENTAL VOICANIC ARCS*
        - E.g., The Cascade range is a continental volcanic arc formed by the subduction of the Juan de Fuca plate under the North American plate
    - ***Two continental plates***→thick buoyant continental lithosphere inhibits it from being subducted→a collision b/t two converging continental fragments ensues→*formation of a new mountain belt composed of deformed sedimentary and metamorphic rocks that often contain slivers of oceanic crust*
        - Pacific northwest=ocean-continent
        - Aleutian Islands=ocean-ocean
        - Andes of South America=ocean-continent
        - Himilayan=continent-continent

Describe the various mechanisms that can drive plate tectonics

- ***Whole-Mantle convection***: sinking slabs of cold oceanic lithosphere are the downward limbs of convection cells, while rising mantle plumes carry hot material from the core-mantle boundary toward the surface
- ***Slab pull***: results from the sinking of a cold, dense slab of lithosphere
- ***Ridge push***: a gravity driven force that results from the elevated position of the ridge
- ***Layer Cake Model***: two zones of convection—a thin, dynamic layer in the upper mantle and thick, larger, sluggish one located below; limited support among geologists but it's gaining popularity

Describe collage tectonics. Along what type of plate boundary is collage tectonics most likely to occur? What region(s) of North America formed as a result of collage tectonics?