Chapter 7b Earth

1. Crust and Upper mantle
   - History of Plate Tectonics
   - Mountain Chains and Oceanic Ridge
   - Lithosphere and Asthenosphere: Major plates

2. Plate Boundaries
   - Mid Atlantic Ridge
   - Magnetic Anomalies
   - Converging and Diverging Boundaries
   - Hot Spots
   - Changing Surface

3. Tides
   - Neap and Spring

Alfred Wegener (1880-1930)
- proposed continental drift in 1915
- proposed all land mass was once a single body called "Pangaea"
- Pangaea started to drift apart ~200 million years ago

- no one believed his ideas until 1950s!!
- he froze to death on an exploratory trip to Greenland in 1930

Evidence for Pangaea
1. Fit of the Continents
2. Past Climate Belts and Distribution of Fossils
3. Matching Rock Types

Plates: 6 large plates (e.g., Pacific Plate)
7-10 small plates
Plate Boundaries:
Earthquakes and Volcanoes

Plate movement: 1 cm/yr up to 15 cm/yr, with 5 cm/yr being typical.

Crust: Oceanic & Continental
- Oceanic Crust
  - is thin, only about 6 to 11 km deep, and made of relatively dense rock called basalt
  - the rocks are young compared with the rocks of the continental crust, and are not older than 200 million years.

- Continental Crust
  - is quite thick, averaging 25 to 40 km
  - beneath parts of mountain ranges reaching 70 - 90 km.

Upper Mantle
Lithosphere (or plate):
- crust + uppermost, rigid part of the mantle

Asthenosphere:
- Plastic like rock in the upper mantle on which the plates ride.
Driving forces for Plate Motion

Convection cells within the upper mantle (asthenosphere) drag the plates along laterally.

Heat Sources:
- Original accretion from formation of the Earth
- Radioactive decay of U, Th, and K in the core and mantle

Where the convection cells descend they drag crust down, causing subduction.

Where convection rises, sea floor spreading takes place.

Geomagnetic Reversals

- The strength of Earth’s magnetic field has rapidly decreasing over the past 2000 years.

We are in a period of a magnetic reversal – a change in the direction of the magnetic field.

- The mean time between reversals being roughly between 200,000 and 500,000 years with individual reversal events taking only a couple thousand years.
- The last reversal was 780,000 years ago.

Magnetic Record in Rocks

Arrows indicate magnetic domains which are regions in which the magnetic fields of atoms are aligned--- magnetic domains are miniature magnets.

The field reversals occur about every 500,000 years.

- The new crust preserves the magnetic field present at the time it solidified.
- The field reversals occur about every 500,000 years.
- Oceanic crust becomes older with distance from the oceanic ridge.
The rocky lithosphere comprises both the crust and part of Earth’s upper mantle. It is typically between 50 and 100 km thick.

Below it lies the asthenosphere, a relatively soft part of the mantle over which the lithosphere slips.

As the Indian plate drifts northward, the Indian landmass collides with the Eurasian plate. The impact causes Earth’s crust to buckle and fold, thrusting up the Himalayan mountain range.

Boundaries (Transform) - where crust is neither produced nor destroyed as the plates slide horizontally past each other such as the San Andreas fault.
Volcanoes are produced at Plate Boundaries
And over Plates moving over hot spots
Moving plates over hot spots produce chains of volcanoes

Last 200 Million years of Moving Plates

Tides caused by the gravitational pull of the Sun and Moon

If the moon was not orbiting then high (low) tide every 12 hours
The moon does orbit so high (low) tide every 12 hours and 25 minutes
The Sun’s tidal effect on Earth is not as strong as the moon, however it moderates the height of the tides.

When the Sun & Moon pull in the same direction (new & full phases) high tide is higher than usual (spring).

When the Sun & Moon pull at right angles (first & last quarter phases) high tide is lower than usual (neap).

Tidal Braking of the Earth
There is friction between the ocean and the seabed as the Earth turns out from underneath the ocean tidal bulges. The friction acts like a brake. This effect slows the Earth’s rotation a tiny amount.

The Day is getting gradually longer by 0.0023 seconds per century.

The increase in the Earth-Moon distance is about 3.8 cm per year.

Another effect is that the ocean bulge leading the Moon causes a small net forward tug. It forces the Moon into a slightly larger orbit.

What is special about the Earth
1. Its precisely-tuned amount of water, not too much to cover the mountains, and not so little that it’s a dry desert.
2. Has held on to its oceans while those on other planets freeze or fry.
3. Plate tectonics allows for the carbon-silicate cycle to operate over geological timescales. The carbon-silicate cycle keeps the level of carbon in the atmosphere so the surface temperature around that of liquid water.
4. An atmosphere of nitrogen/oxygen and LIFE.
5. Its size—if it was much smaller, it wouldn’t be able to hold on to our atmosphere, but much larger and it might be a gas giant too hot for life.
6. Our moon stabilizes our planet’s rotation, preventing drastic movements of the poles. The moon also helpfully pulls the ocean's tides.

Moonrise 4 Billion years ago - a young, close moon rises above the ancient sea, invoking huge tides that scour the continents.
End of Chapter 7b
The Earth

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