Lecture 5

Continental Drift

- Continents move relative to each other
- Wegener was right

How does drift occur?

The Ocean floor

- Prior to 1950s, very little was known about sea-floor bathymetry (shape of the sea floor surface)
- Invention of echo sounding (sonar) permitted mapping of the ocean floor
- Velocity= distance/time
- Distance=velocity x time

Oceanographers were surprised to discover that…

- The deepest parts of the ocean occur near land
- A mountain range runs through every ocean basin
- Submarine volcanoes form lines across oceans floors

Sonar mapping delineated bathymetric features

- Abyssal plain (~4-5 below sea level)
- Mid oceans ridges (Mors): submarine mountain ranges (peaks ~2-3km below sea level)
- Trenches (near land, >5km).
- Volcanic islands
- Seamount, guyots
- Fractures zones

Modern views of the ocean floor reveal

- Mid-ocean ridges
- Trenches
- Fracture zones

Global Sea floor topography

Oceanic Crust

By 1950, we had learned much about oceanic crust

Oceanic crust is covered by sediment

- Thickest near the continents
- Thinnest (or absent) at the mid-ocean ridge

Oceanic crust is mafic (basalt and gabbro)

- No granitic rocks
- No metamorphic rocks

High heat flow characterizes the mid-ocean ridge

Belts of concentrated subsea earthquakes were found

- Parts of oceanic fracture zones
- Mid ocean axes
- Deep ocean trenches

The earthquakes were limited to…

- Parts of oceanic fracture zones
- Mid ocean ridge axes
- Deep ocean trenches

Sea Floor Spreading

In 1960, Harry Hess published his "essay in Geopoetry."

He called his theory "sea-floor spreading"

- Upwelling mantle erupts at the mid ocean ridges
- New crust moves away from ridges, gathering sediment
- At trenches the sea-floor dives back into the mantle

Provided a potential mechanism for continental drift

Magnetic Anomalies

- Strength of Earth's magnetic field can be measured by magnetometer
- At any given location, the magnetic field includes two parts:
- One created by the main dipole of the Earth
- Another created by the magnetism of near surface rock
- Anomaly –difference between the expected strength of the Earth's main field at a certain location and the actual measured strength of the magnetic field at that location
- + Or – magnetic anomalies
- Towed magnetometers measure ocean crust
- Magnetic anomaly oscillates perpendicular to the MOR
- Anomalies (+ And -) are linear belts that parallel MOR

Magnetic Reversals

- Layered lava flows reveal reversals in polarity
- When reversed, the north magnetic pole is near the south geographic pole
- Reversals are geologically rapid

- Radioactivity permits rock age-dating
- A geomagnetic reversal time scale has been assembled
- Reversals occur every 500-700 ka
- 171 are known since the end Cretaceous

Magnetic-Reversal Chronology

- Reversals do not occur regularly
- The lengths of different polarity chrons (i.e. time intervals between reversals) are different

Sea floor spreading: Proof

- Polarity reversals explain magnetic anomalies
- Positive anomalies –crust with normal polarity
- Negative anomalies –crust with reversed polarity
- Magnetic anomalies are symmetric across the MOR

Magnetic anomalies mimic layered lava flows

- Magnetic "stripes" form as lava cools at a MOR
- Ocean crust spreads away from MOR
- Reversals are recorded with cooled lava

Sea Floor spreading is the mechanism of continental drift

Sea Floor Spreading

- Age of oceanic crust increases away from the MOR
- Ages are "mirror images" across the MOR
- Sediments atop oceanic basalts become thicker away from the MOR
- Lower-most (oldest) layers become progressively older away from the MOR

Sea Floor Spreading supported by:

- Global earthquake belts
- Sea-Floor topography oceanic transform fault motion
- Linear magnetic anomalies
- Young age of oceanic crust
- Thickness and ages distribution of sediments atop oceanic basalts