Seismic Waves: Deep Earth Probes
The Navy Reveals The Sea Floor
CH 17 & 18

Seismic Waves:
Deep Earth Probes

Some Waves Reflect

Some Waves Refract
(Bend)

P Wave Paths Through Earth

P Wave Refraction Produces Shadow Zone
Seismic Waves Reveal Earth’s Layers

Seismic Waves Reveal Earth’s Layers
Details of Upper Layers

Isostacy

Mountains Have Roots

Isostacy
Erosion (Unloading) Causes Uplift; Deposition (Loading) Causes Subsidence

Whole Earth Structure

Temperatures & Pressures in the Earth
Earth's Magnetic Field

May Stem from Convection in Liquid Outer Core!

Inclination: Deviation from Horizontal
Declination: Deviation from True N-S

Earth's Changing Magnetic Field

Variable Strength & Orientation
Normal: Magnetic N ~ True N
Reversal: Magnetic N ~ True S (last one: 788,000 y)
Chrons: Paleomagnetic Time Interval
How Can We Study Paleomagnetic Fields?  Remnant Magnetism

Direction of Earth's magnetic field

Cooling lava

Magnetic alignment preserved in magnetite records orientation of Earth's field

Remnant Magnetism

Present orientation of Earth's magnetic field

Lava flows showing reverse magnetism

Magnetic Anomalies
Gravity is NOT Constant

High "Normal" Low

Gravity Reveals Underlying Rock

Bouger Anomaly

Gravity profile

North American Gravity

Sierra Nevada Rocky Mountains Interior Appalachian Mountains

Depth, Km

Crust M-discontinuity

Gravity units (milligals) µ
Alfred Wegener’s Evidence for Continental Drift

1. Continental “Fit”

Include Continental Shelves for Best “Puzzle” Fit

Continental Drift

• Bacon, 1620
Alfred Wegener’s Evidence for Continental Drift

1. Continental “Fit”
2. Similar Rocks, Ages
Alfred Wegener's Evidence for Continental Drift

1. Continental “Fit”
2. Similar Rocks, Ages
3. Similar Fossils

Similar Fossils

*Glossopteris* (Common Tree in Coal Seams)
Fresh-Water Fish
Mammal-Like Reptiles

http://toad.asu.edu/rschmag/gloss.html
Similar Fossils: Different Continents

Alfred Wegener's Evidence for Continental Drift

1. Continental “Fit”
2. Similar Rocks, Ages
3. Similar Fossils
4. Widespread Glaciation

Widespread Glaciation

Gondwana Glaciation of Antarctica, South America, Africa, Australia and India during Permian

Strange Climate Zones

Laurasia: North America, Europe, most of Asia

Gondwanaland: Antarctica, South America, Africa, Australia and India

Source: http://vishnu.glg.nau.edu/rcb/Jur.jpg
Alfred Wegener's Evidence for Continental Drifts Was NOT Accepted in USA.

Problem: No Mechanism for Continents to Plow Through Oceanic Crust

Answer lies on the Sea Floor & in Ch. 18 + 19
Submarine Science
Mapping of Ocean Basins

Seismic & Sonar Study Reveals Sea-Floor Topography

Ocean Basin Bathymetry
Know these mega-scale Landforms
- Continental Shelf
- Continental Slope
- Continental Rise
- Abyssal Plain
- Mid-Ocean Ridge (~ Mid-Ocean Rise)
- Trench

Know differences between Oceanic Crust and Continental Crust

Ocean Basin Bathymetry
See Figures 18.6 to 18.12 in Plummer & Others 9th ed.
See Figures 18.5 to 18.15 in Plummer & Others 10th ed.

Ocean Basin Bathymetry
See Figures 18.5, 18.15 in Plummer & Others 9th ed.
Cold War
More Submarine Science
Magnetic Anomalies in Ocean Basin

Deep-Sea Magnetic Anomalies

Deep Sea Drilling Project (DSDP)
Studied Geology of Ocean Basins
Continental Record = Incomplete
Deep Ocean Basin Record Was Thought to be More Complete

Glomar Challenger
Harry Hess
DSDP Surprise Finding:

Ocean Basins are <200,000,000 y Old

Much Younger than the Continents

Very Young Sediments at the Mid Ocean Ridges