CHAPTER 2
Plate Tectonics and the Ocean Floor
Plate Tectonics

• Alfred Wegener first proposed in 1912
• Called it “Continental Drift”
Evidence for Continental Drift

1. Noted puzzle-like fit of modern continents
   - Wegener proposed **Pangaea** – one large continent existed 200 million years ago
   - **Panthalassa** – one large ocean
Evidence for Continental Drift

2. Matching sequences of rocks and mountain chains

3. Similar rocks on different continents
Evidence for Continental Drift

4. Glacial ages and other climate evidence
   • Evidence of glaciation in now tropical regions
   • Direction of glacial flow and rock scouring
   • Plant and animal fossils indicate different climate than today
Evidence for Continental Drift

5. Distribution of organisms
   - Same fossils found on continents that today are widely separated
   - Modern organisms with similar ancestries
Objections to Early Continental Drift Model

• Hostile criticism and open ridicule
• Continents cannot plow through ocean basins
• Tidal gravitational attractions too small
• More evidence was needed
Earth’s Magnetic Field

(a) Geographic north, Magnetic north

(b) Lines of magnetic force

Geographic North Pole, Magnetic pole

Dip needle

Equator, Magnetic equator
Evidence for Plate Tectonics

• Apparent polar wandering
• Location of North Pole changed over time
• Magnetic dip data
Magnetic Polarity Reversals

- Earth’s magnetic polarity reverses periodically
- Recorded in ancient rocks
Sea Floor Spreading

- Harry Hess
Sea Floor Spreading Evidence

- Frederick Vine and Drummond Matthews (1963)
- Sea floor stripes record Earth’s magnetic polarity
Global Distribution of Earthquakes
Global Plate Boundaries
Plate Tectonics Theory

• Lithosphere – tectonic plates that float on ductile asthenosphere

• Large scale geologic features occur at plate boundaries

• Two major tectonic forces
  – Slab pull
  – Slab suction
Types of Plate Boundaries

(a) Plate boundary where two plates are moving away from each other, forming an oceanic rift.

(b) Plate boundary where one plate is subducting beneath another, forming an oceanic trench.

(c) Plate boundary where two plates are colliding, forming a continental collision zone.
Divergent Boundary Features

- Plates move apart
- Mid-ocean ridge
  - Rift valley
- New ocean floor created
- Shallow focus earthquakes
Types of Spreading Centers

- Mid-Atlantic Ridge
- East Pacific Rise
Convergent Boundary Features

- Plates move toward each other
- Oceanic crust destroyed
  - Ocean trench
  - Volcanic arc
- Deep focus earthquakes
Three Types of Convergent Boundaries

1. **Oceanic-Continental Convergence**
   - Ocean plate is subducted
   - Continental arcs generated
   - Explosive andesitic volcanic eruptions
Three Types of Convergent Boundaries

2. Oceanic-Oceanic Convergence

- Denser plate is subducted
- Deep trenches generated
- Volcanic island arcs generated
Three Types of Convergent Boundaries

3. Continental-Continental Convergence
   - No subduction
   - Tall mountains uplifted
Transform Boundary Features

- Oceanic Transform Fault – ocean floor only
- Continental Transform Fault – cuts across continent
- All transform faults occur between mid-ocean ridge segments.
Global Hotspot Locations

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Hawaiian Island – Emperor Seamount Nematah
Plate Tectonics and Intraplate Features

- **Seamounts**
  - Rounded tops
- **Tablemounts or guyots**
  - Flattened tops
- **Subsidence of flanks of mid-ocean ridge**
- **Wave erosion may flatten seamount**
Detecting Plate Motion with Satellites
Paleogeographic Reconstructions

- 540 million years ago
- 480 million years ago
- 420 million years ago
- 360 million years ago
- 300 million years ago
- 240 million years ago
- 190 million years ago
- 120 million years ago
- 60 million years ago
- Present
World Map 50 million Years in Future
End of CHAPTER 2
Plate Tectonics and the Ocean Floor