





















- 1  **CHAPTER 3**
- 2  **Marine Provinces**
- 3  **Chapter Objectives**
 - Describe the methods of direct and remote sea floor investigation.
 - Know how the hypsographic curve relates to topography, bathymetry, and plate tectonics.
 - Understand how satellites can be used to investigate the sea floor.
 - Recognize features of the continental margins, the ocean basin floor, and the mid-ocean ridge.
- 4  **Chapter Objectives (continued)**
 - Discuss differences between active and passive continental margins.
 - Explain the origin of submarine canyons and turbidity currents.
 - Differentiate between the various volcanic features of the sea floor.
 - Be familiar with the dynamics of subduction zones and associated deep-sea trenches.
 - Understand differences between transform faults and fracture zones.
- 5  **Measuring bathymetry**
 - Ocean depths and topography of ocean floor
 - Sounding
 - Rope/wire with heavy weight
 - Echo sounding
 - Reflection of sound signals
 - 1925 German ship *Meteor*
- 6  **Measuring bathymetry**
 - Precision depth recorder (PDR) 1950s
 - Focused beam
 - Multibeam echo sounders
 - Side-scan sonar
 - More detailed “picture” of the sea floor
 - Satellite measurements
 - Seismic reflection profiles looks at ocean structure beneath sea floor
- 7  **An Echo Sounder Record**
- 8  **Measuring bathymetry**
- 9  **Side-scan image of a volcano**
- 10  **Sea Floor Mapping from Space**
- 11  **Ship bathymetry**
- 12  **Satellite bathymetry**
- 13  **Global Sea Surface Elevation Map**
- 14  **Seismic Profiling**
- 15  **S.R. profile of western Mediterranean**
- 16  **Table 3.1**
- 17  **Hypsographic curve**
 - Amount of Earth’s surface (%) at different elevations and depths
 - 70.8% of Earth covered by oceans
 - Average depth ocean 3729 m
 - Average elevation land 840 m
 - Uneven distribution of areas of different depths/elevations
- 18  **Hypsographic curve**
 - Shape of curve supports plate tectonics
 - Earth shaped actively by plate tectonics
- 19  **Ocean provinces**
 - 3 major provinces
 - Continental margins

- Shallow-water areas close to shore
- Deep-ocean basins
 - Deep-water areas farther from land
- Mid-ocean ridge
 - Submarine mountain range

19  **Major Regions of the North Atlantic**

20  **Continental margins**

- Passive or active
 - Passive
 - Not close to any plate boundary
 - No major tectonic activity
 - Example: east coast of United States

21  **Features of a passive continental margin**

22  **Continental margins**

- Active
 - Associated with convergent or transform plate boundaries
 - Much tectonic activity
- Convergent active margin
 - Oceanic-continental convergence
 - Example: western South America

23  **Passive vs. Active**

24  **Continental margins**

- Transform active margin
 - Associated with transform plate boundaries
 - Example: Coastal California along the San Andreas fault

25  **Continental Borderland**

26  **Continental margin features**

- Continental shelf
- Shelf break
- Continental slope
- Continental rise


27  **Continental shelf**


- Extends from shoreline to shelf break
- Shallow, low relief, gently sloping
- Similar topography to adjacent coast
- Average width 70 km (43 m) but can extend to 1500 km (930 m)
- Average depth of shelf break 135 m (443 ft)


28  **Continental margin**
















29  **Continental slope**










- Change in gradient from shelf
- Average gradient 4°
- Submarine canyons cut into slope by turbidity currents
 - Mixture of seawater and sediments
 - Move under influence of gravity
 - Erode canyons
 - Deposit sediments at base of slope

30  **Continental slope and submarine canyons**

31  **Figure 3.9b**

32  **Figure 3.9c**

- 33  **Continental rise**
- Transition between continental crust and oceanic crust
 - Turbidite deposits
 - Graded bedding
 - Submarine fans
 - Distal end of submarine fans becomes flat abyssal plains
- 34  **Figure 3.9d**
- 35  **Figure 3.9e**
- 36  **Figure 3.10**
- 37  **Figure 3.10a**
- 38  **Figure 3.10b**
- 39  **Deep ocean basin features**
- Abyssal plains
 - Volcanic peaks
 - Ocean trenches
 - Volcanic arcs
- 40  **Abyssal plains**
- Very flat depositional surfaces from base of continental rise
 - Suspension settling of very fine particles
 - Sediments cover ocean crust irregularities
 - Well-developed in Atlantic and Indian oceans
- 41  **Volcanic peaks**
- 42  **Volcanic peaks**
- Poke through sediment cover
 - Below sea level:
 - Seamounts, tablemounts or guyots at least 1 km (0.6 m) above seafloor
 - Abyssal hills or seaknolls are less than 1 km
 - Above sea level:
 - Volcanic islands
- 43  **Ocean trenches**
- Linear, narrow, steep-sided
 - Associated with subduction zones
 - Deepest parts of ocean
 - Mariana Trench, 11,022 m (36,161 ft)
 - Majority in Pacific Ocean
- 44  **Ocean trenches**
- 45  **Volcanic arcs**
- Landward side of ocean trench
 - Island arc
 - Chain of islands, e.g., Japan
 - Continental arc
 - Volcanic mountain range, e.g., Andes Mountains
- 46  **Mid-ocean ridge**
- Longest mountain chain
 - On average, 2.5 km (1.5 miles) above surrounding sea floor
 - Wholly volcanic
 - Basaltic lava
 - Divergent plate boundary
- 47  **Mid-ocean ridge features**
- Central rift valley, faults and fissures
 - Seamounts
 - Pillow basalts

- Hydrothermal vents
 - Deposits of metal sulfides
 - Unusual life forms
- Fracture zones and transform faults
- 48  **Rift valley, faults and fissures**
 - Downdropped rift valley at central crest
 -
-
- 49  **Mid-ocean ridge features**
 - Oceanic ridge
 - Prominent rift valley
 - Steep, rugged slopes
 - Example: Mid-Atlantic Ridge
 - Oceanic rise
 - Gentler, less rugged slopes
 - Example: East Pacific Rise
- 50  **Volcanic features of mid-ocean ridge**
 - Pillow lava or pillow basalts
 - Hot lava chilled by cold seawater
 - Smooth, rounded lobes of rock
- 51  **Volcanic features of mid-ocean ridge**
 - Hydrothermal vents
 - Heated subsurface seawater migrates through cracks in ocean crust
 - Warm-water vents <30°C or 86°F
 - White smokers >30°C <350°C or 662°F
 - Black smokers > 350°C
- 52 
- 53  **Hydrothermal vents**
 - Dissolved metals precipitate to form metal sulfide deposits
 - Unusual biological communities
 - Able to survive without sunlight
 - Archaeons and bacteria oxidize hydrogen sulfide gas to provide food
- 54  **Fracture zones and transform faults**
 - Long linear zones of weakness offset axes of mid-ocean ridge
 - Transform faults: movement in opposite directions
 - Fracture zones: extensions of fracture zones (aseismic)
- 55  **Fracture zones and transform faults**
- 56  **End of CHAPTER 3**
- Marine Provinces**