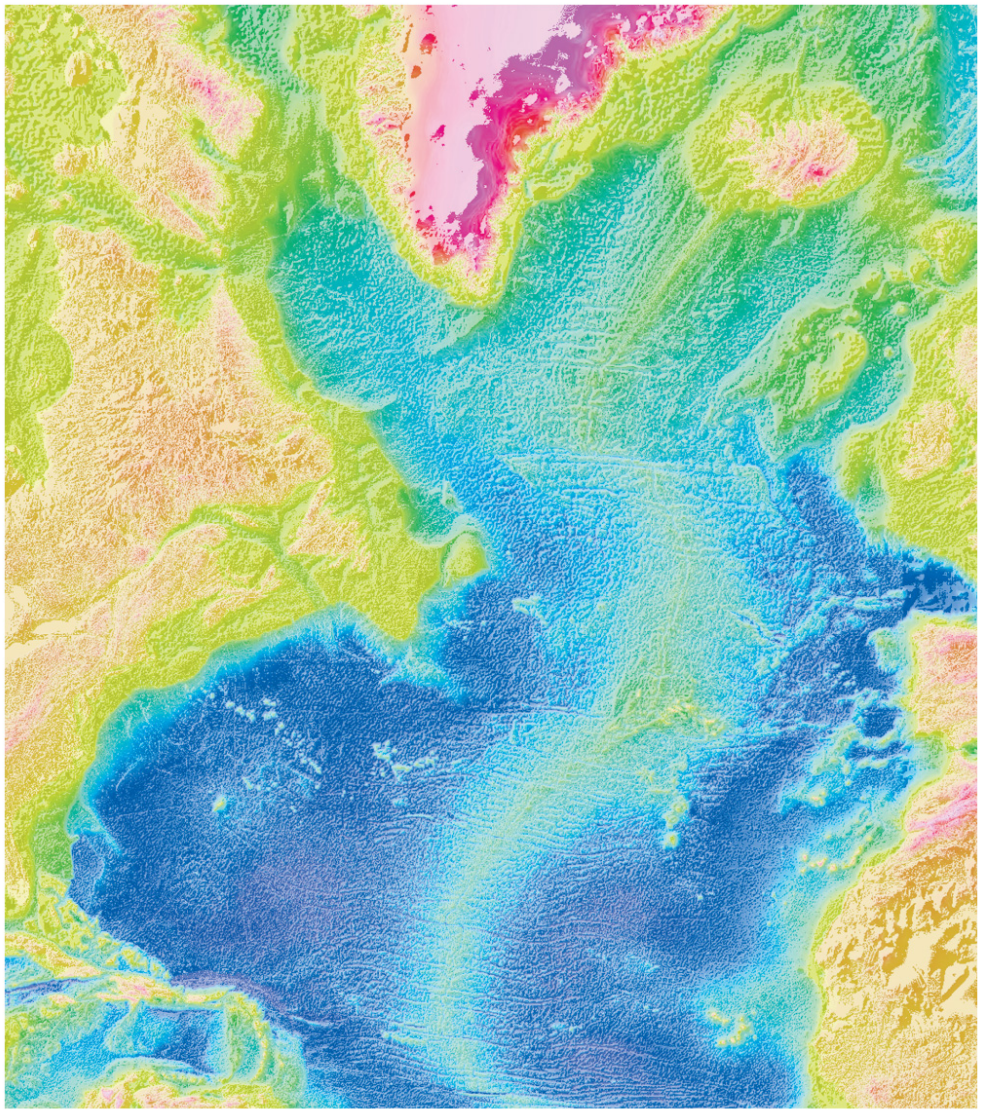
Lecture Marine Provinces



Measuring bathymetry

- Ocean depths and topography of ocean floor
- Sounding
  - Rope/wire with heavy weight
    - *Known as lead lining*
- Echo sounding
  - Reflection of sound signals
  - 1925 German ship *Meteor*

Measuring bathymetry

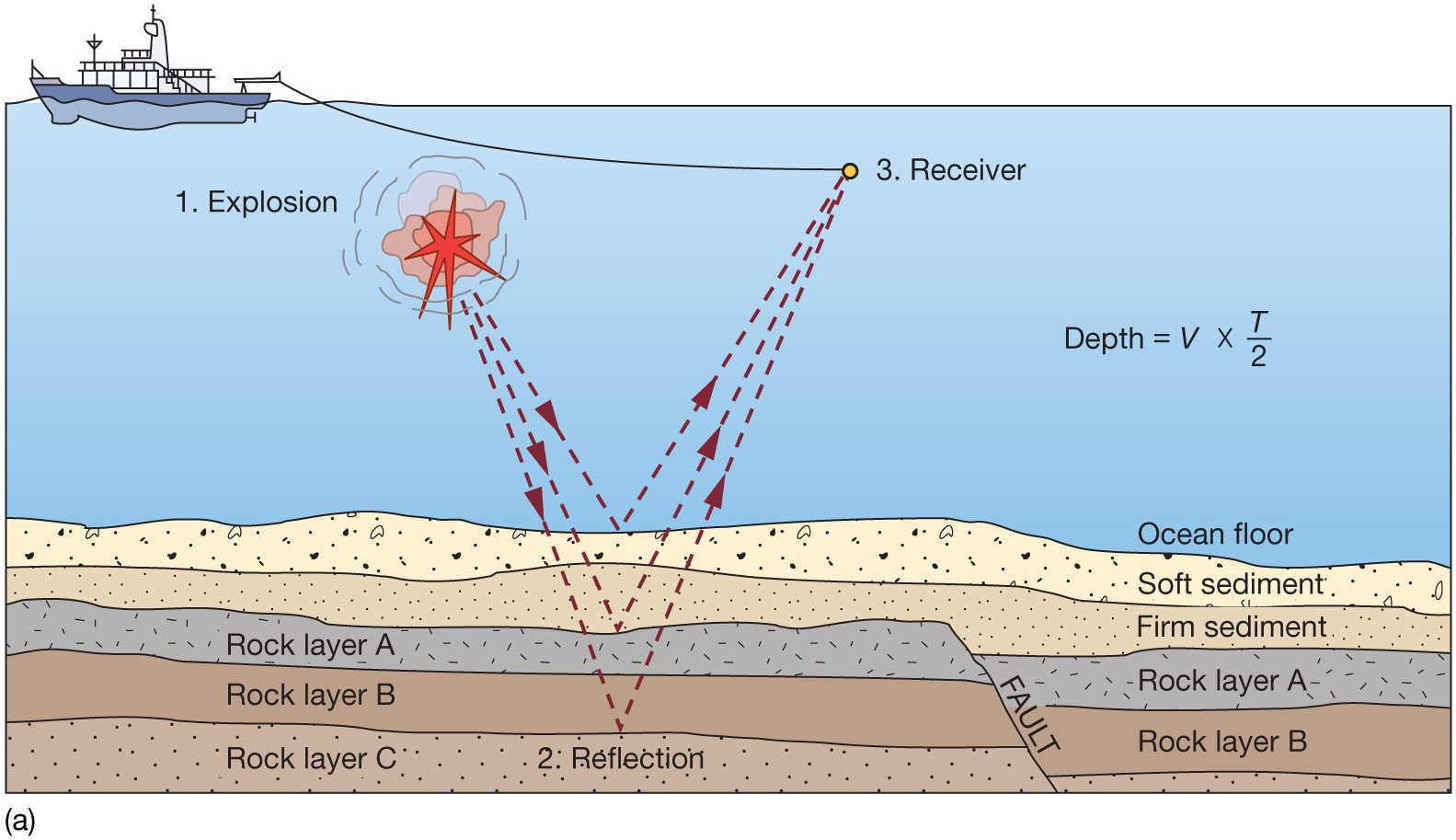


Fig. 3.3a

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 f loor

Measuring bathymetry

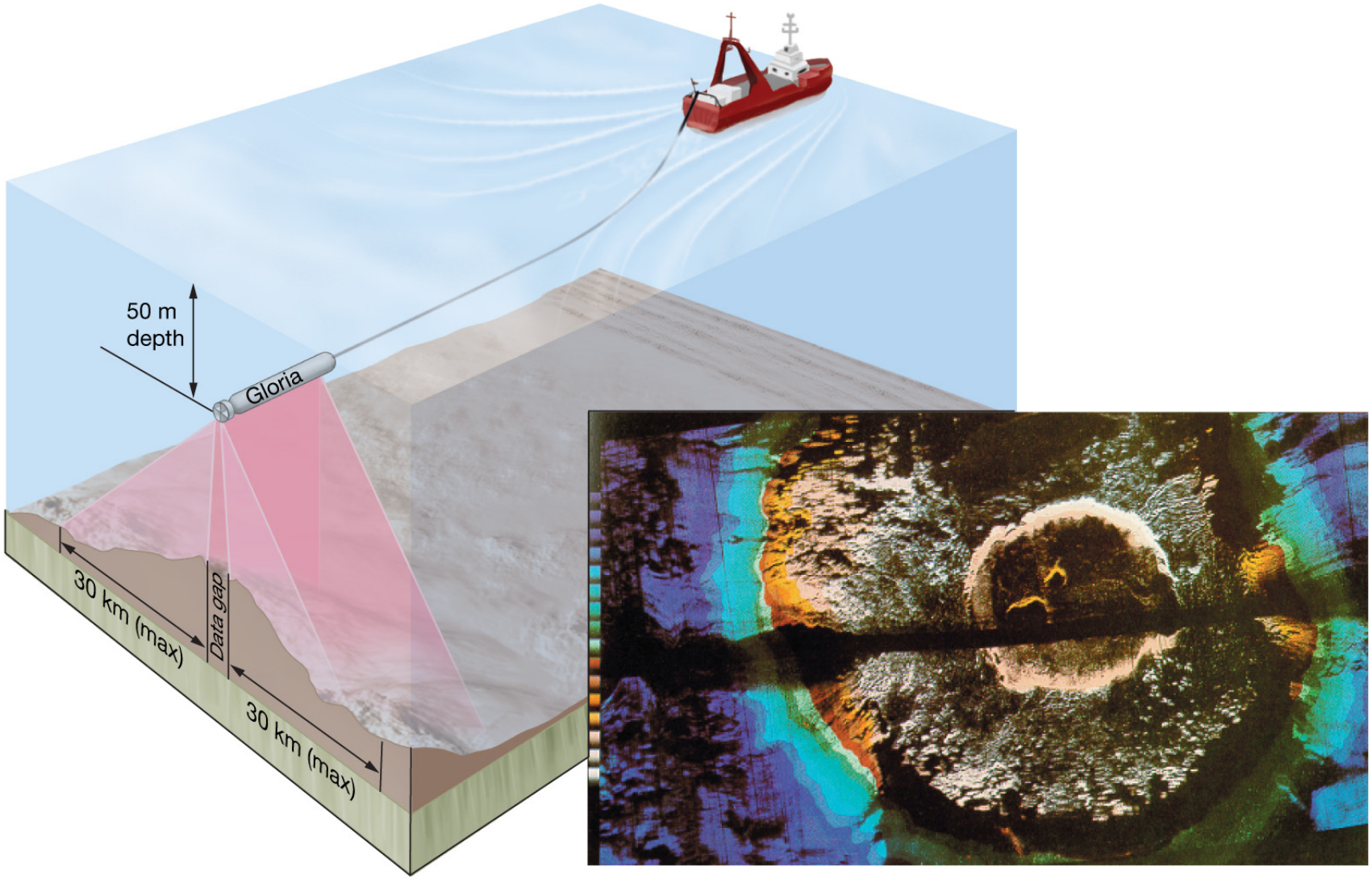


Fig. 3.2

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

Hypsographic curve

- Shape of curve supports plate tectonics
- Earth shaped actively by plate tectonics

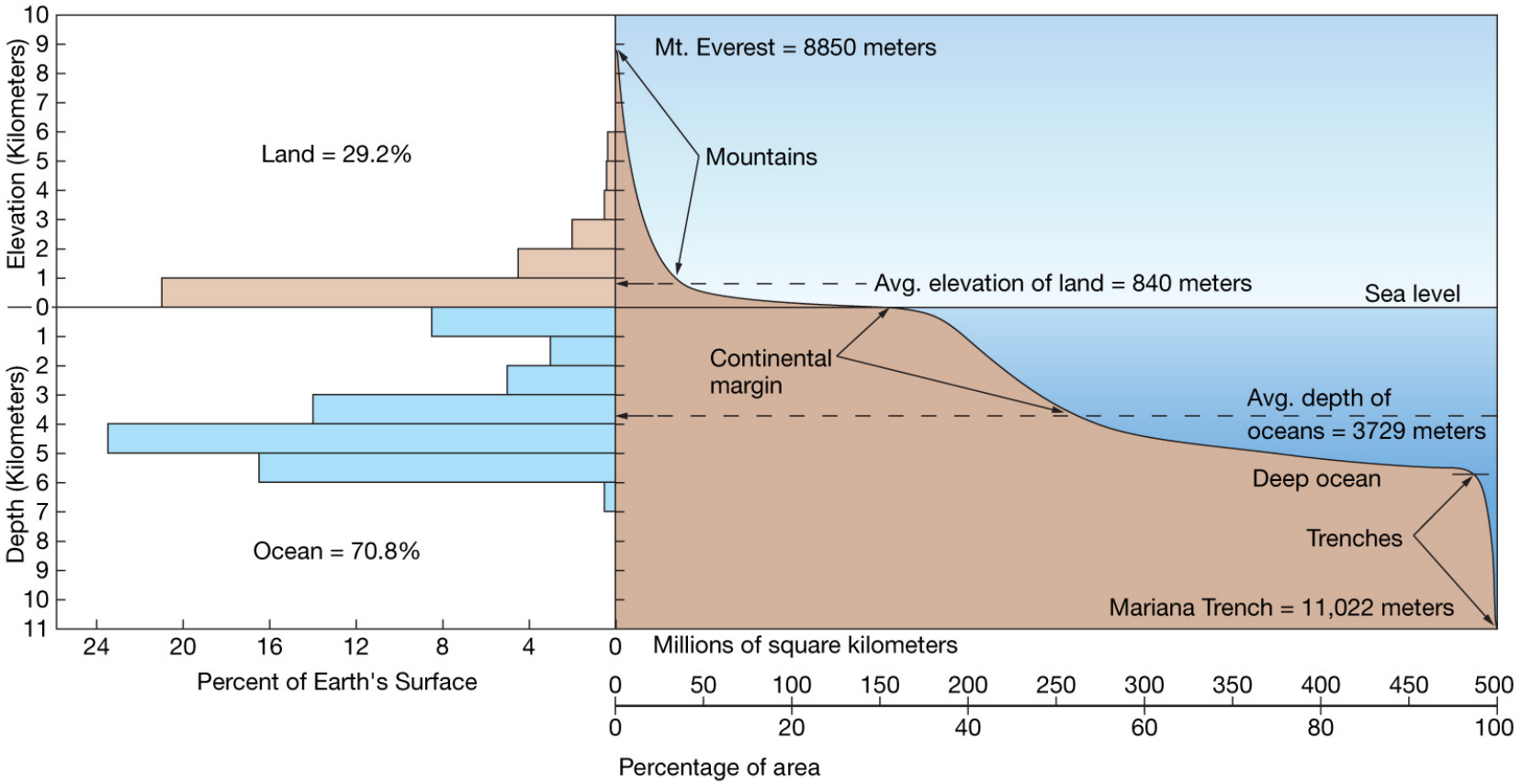


Fig. 3.4

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

Continental margins

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

Continental margins

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

Continental margins

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

Continental margins

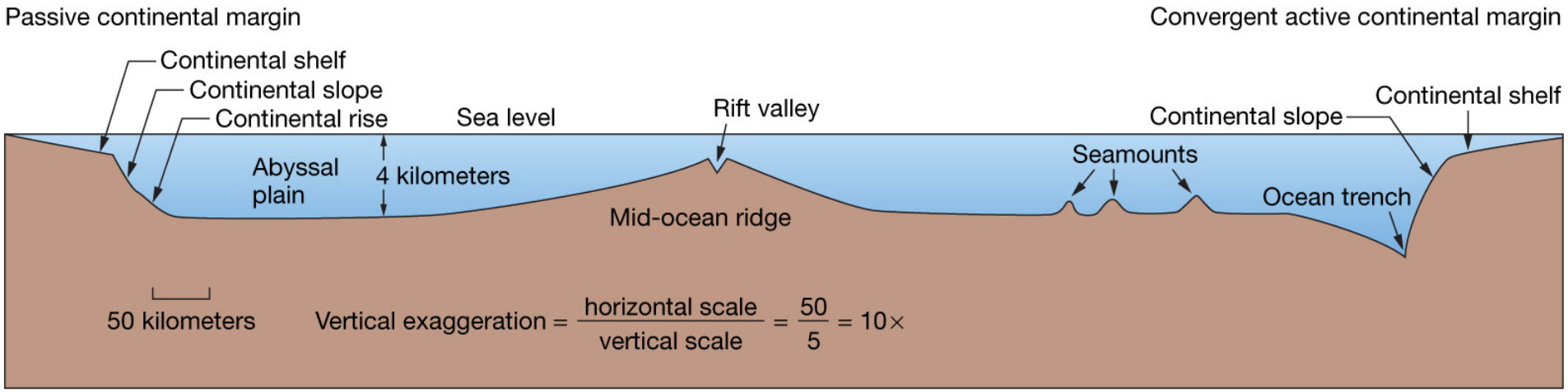


Fig. 3.6

Continental margin features

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

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)

Continental margin

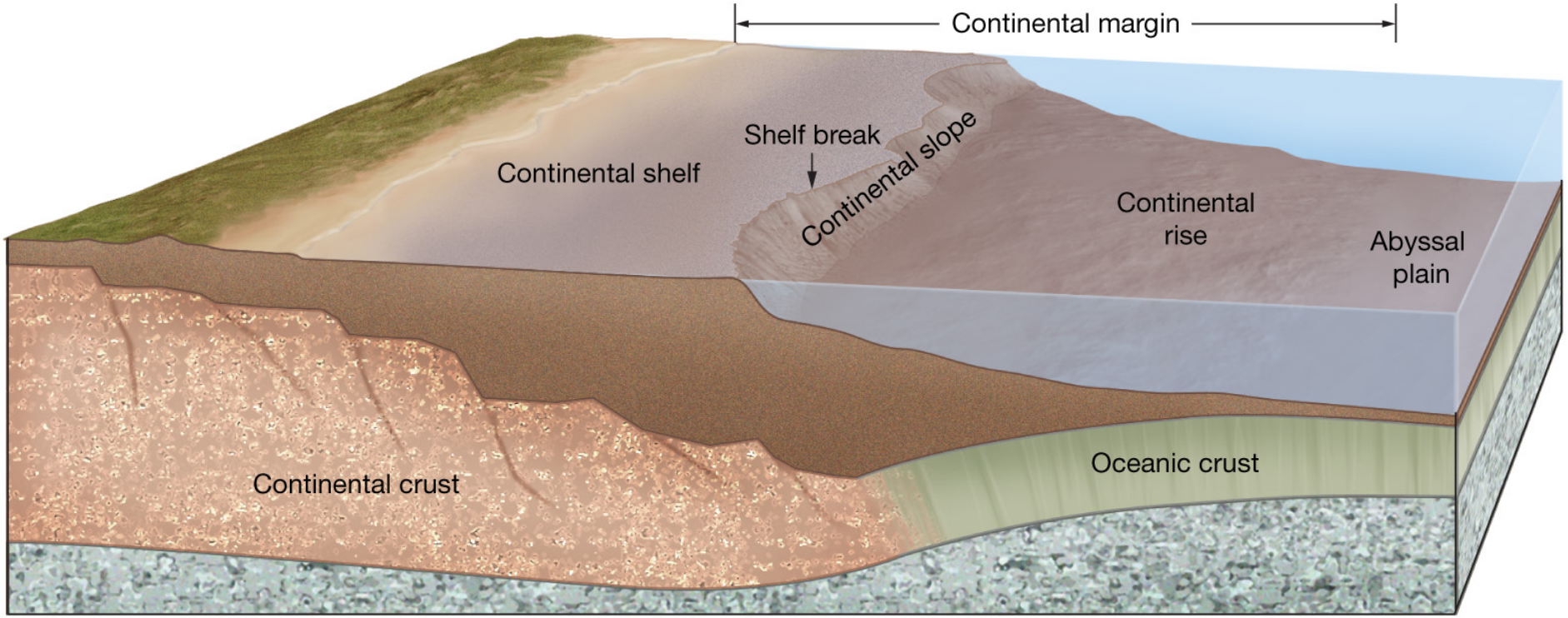


Fig. 3.7

Continental slope

- Change in gradient from shelf
- Average gradient 4^{o}
- 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

Continental slope and submarine canyons

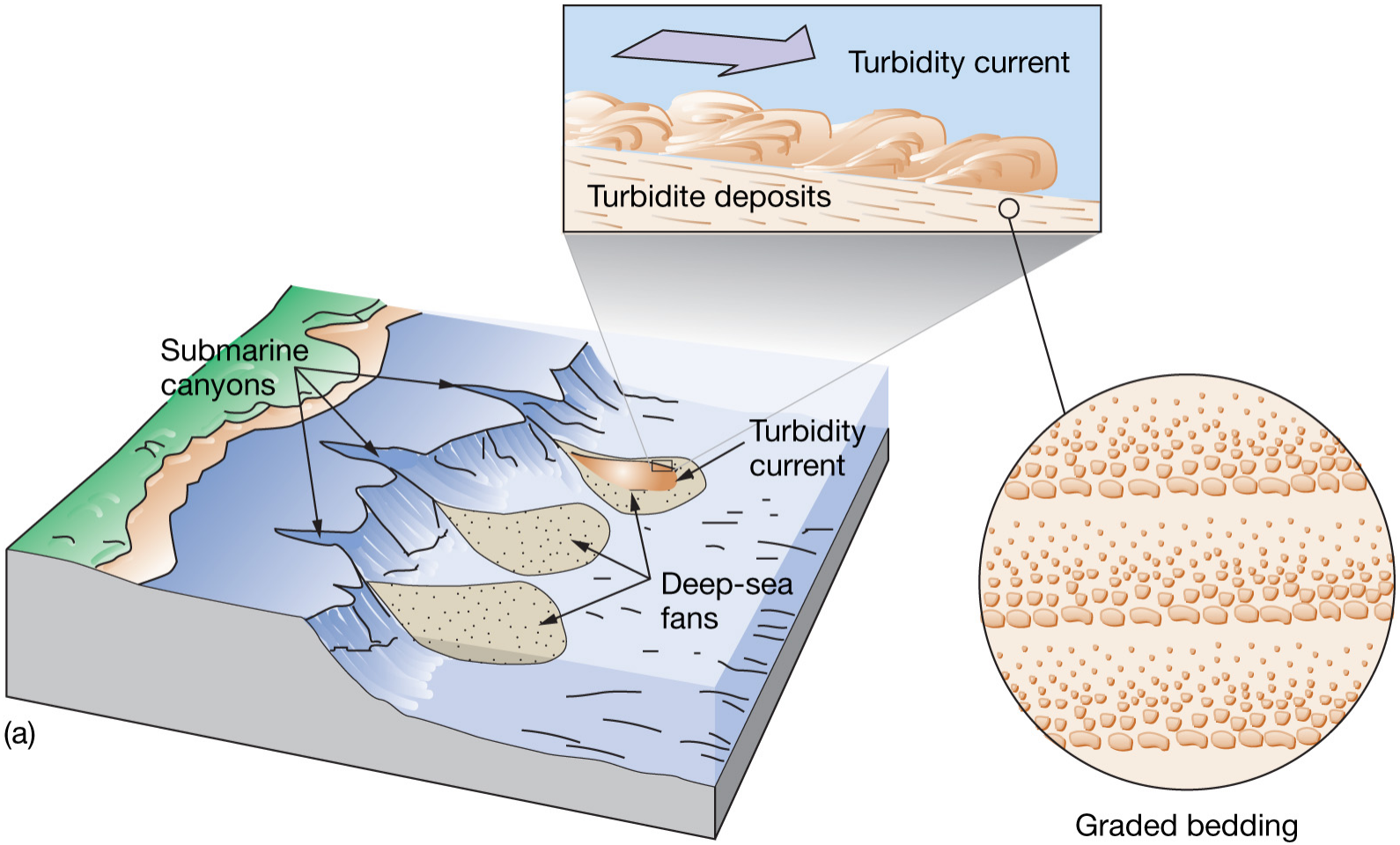


Fig. 3.9a

Continental rise

- Transition between continental crust and oceanic crust
- Turbidite deposits
  - Graded bedding
  - Submarine fans
- Distal end of submarine fans become s flat abyssal plains

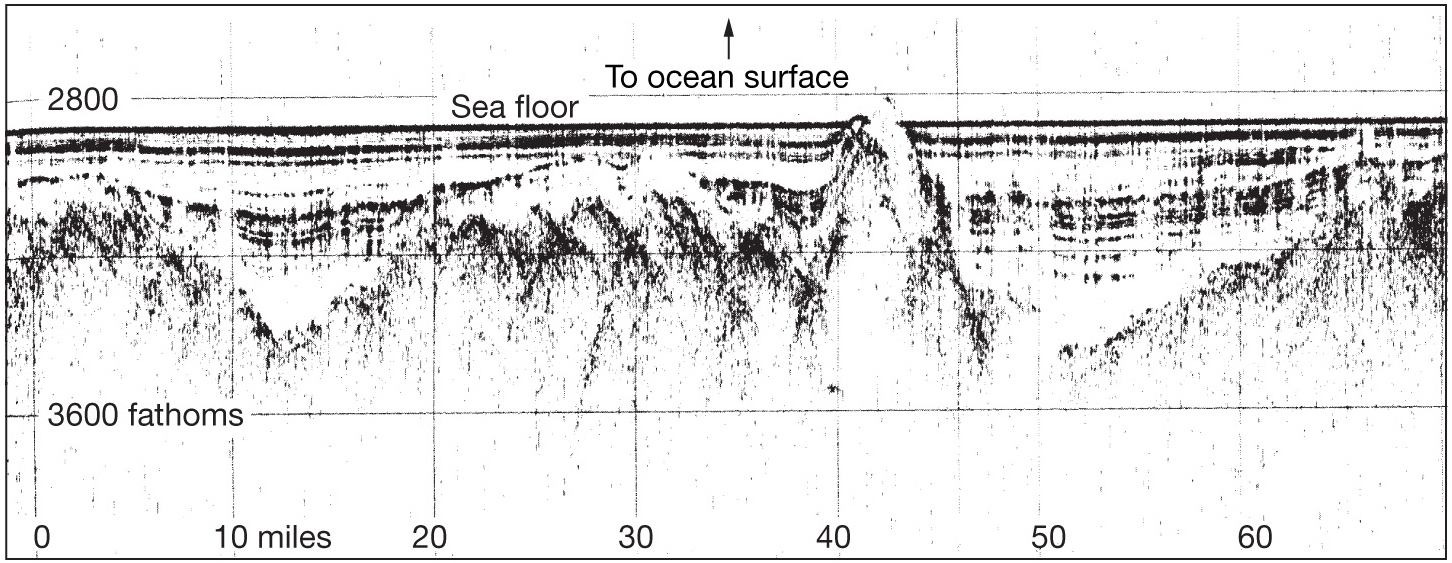
Deep ocean basin features

- Abyssal plains
- Volcanic peaks
- Ocean trenches
- Volcanic arcs

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

Abyssal plains



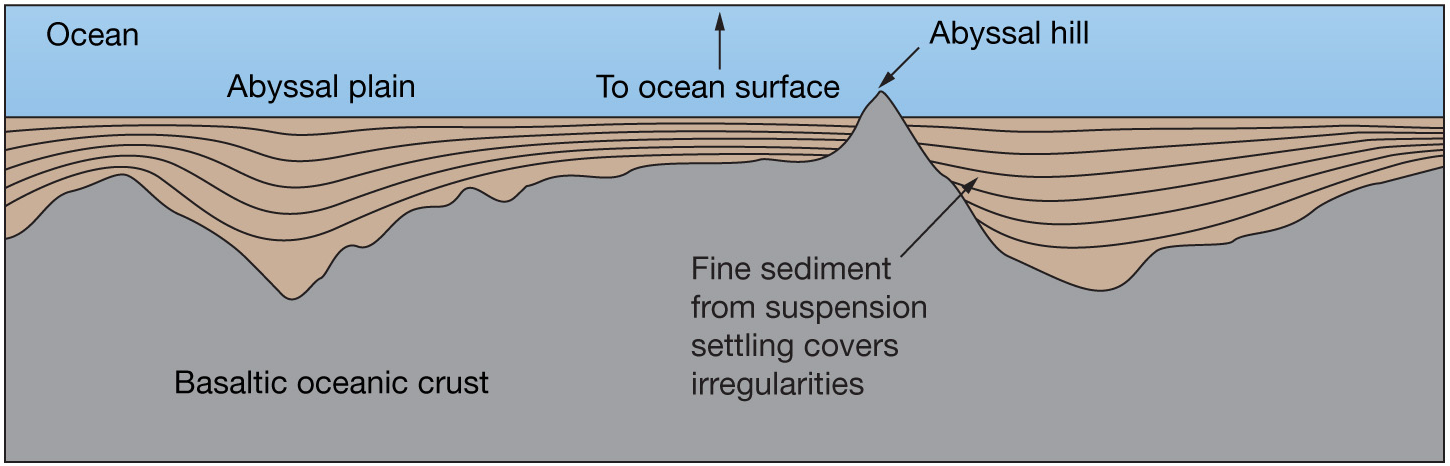


Fig. 3.11

Volcanic peaks

- Poke through sediment cover
- Below sea level:
  - Seamounts, tablemounts, or guyots at least 1 km (0.6 m) above sea floor
  - Abyssal hills or seaknolls are less than 1 km
- Above sea level:
  - Volcanic islands

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

Ocean trenches

Fig. 3.12

Volcanic arcs

- Landward side of ocean trench
- Island arc
  - Chain of islands, e.g., Japan
- Continental arc
  - Volcanic mountain range, e.g., Andes M ountains

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

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

Rift valley, faults, and fissures

- Downdropped rift valley at central crest

Cracks (fissures) and faults common

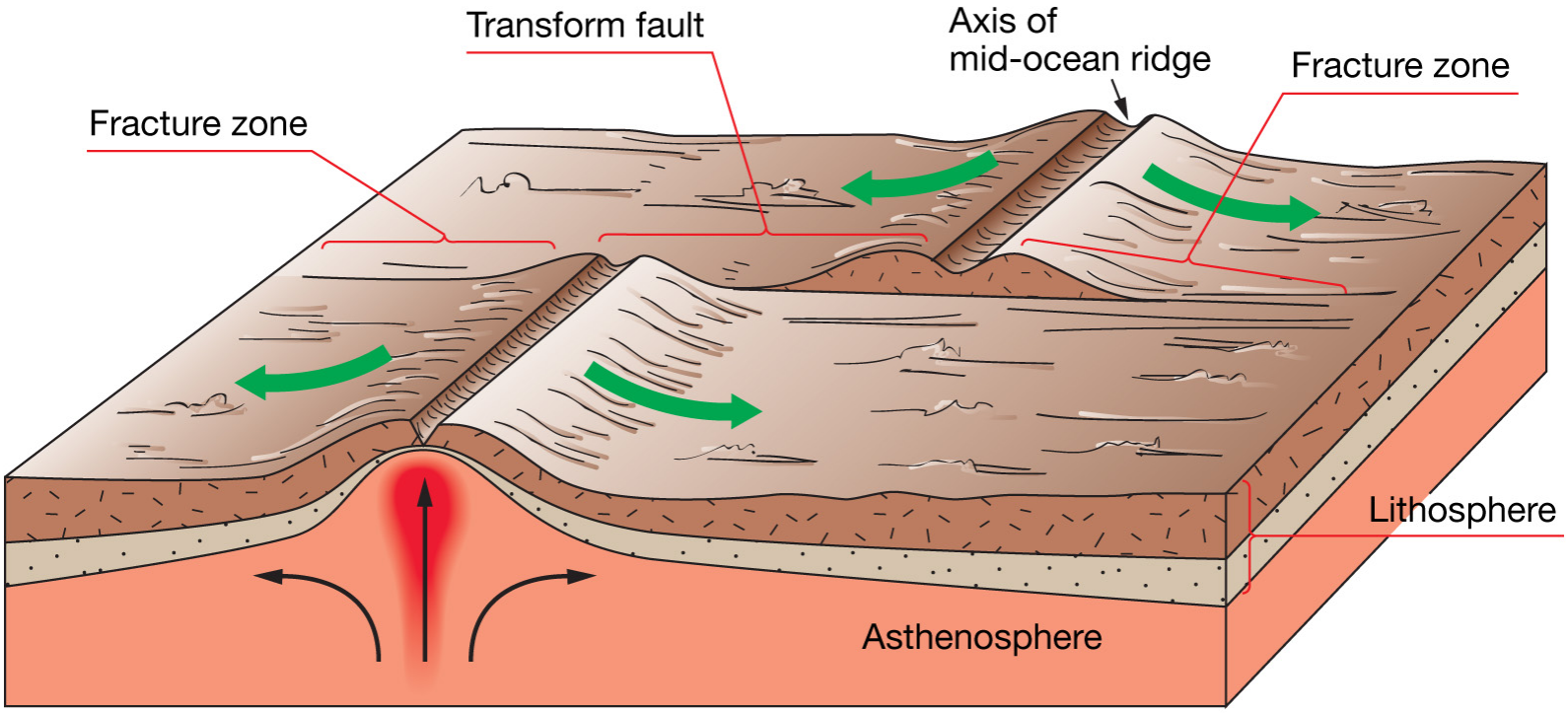


Fig. 3.17

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

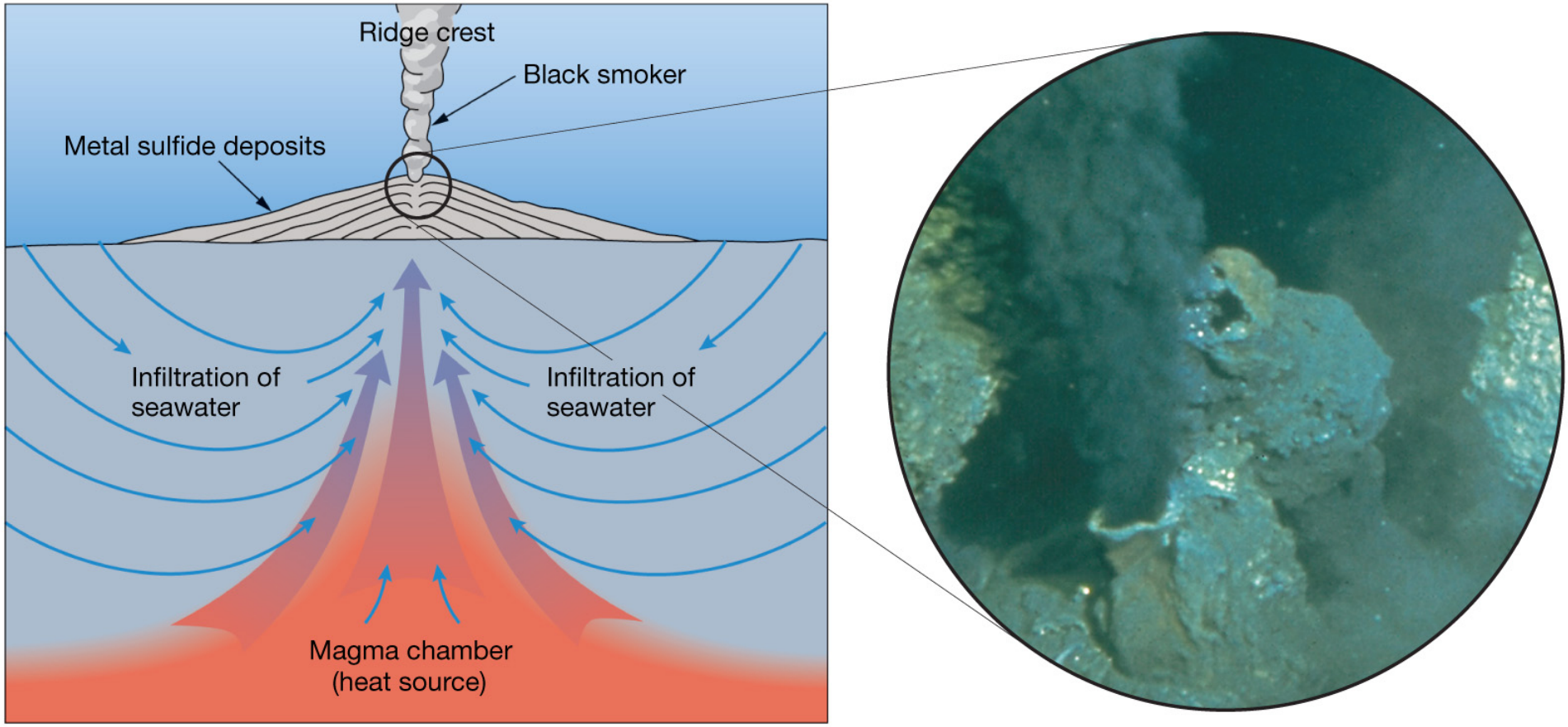
Volcanic features of mid-ocean ridge

- Pillow lava or pillow basalts
  - Hot lava chilled by cold seawater
  - Smooth, rounded lobes of rock

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

Hydrothermal vents



(a)

Fig. 3.16a

Hydrothermal vents

- Dissolved metals precipitate to form metal sulfide deposits
- Unusual biological communities
  - Able to survive without sunlight
  - Archaeons and bacteria oxidize hydroge n sulfide gas to provide food

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)

Fracture zones and transform faults

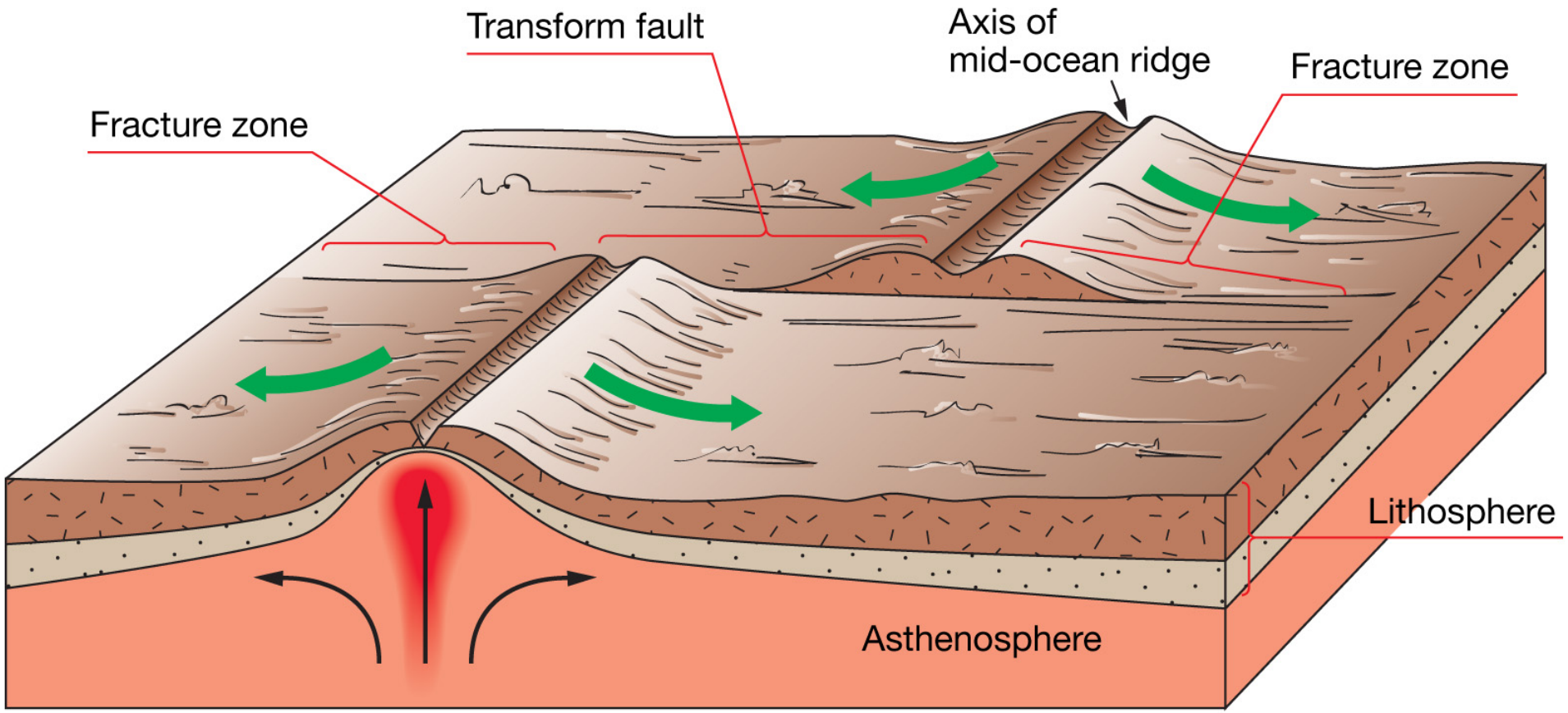


Fig. 3.17

End of CHAPTER 3
Marine Provinces

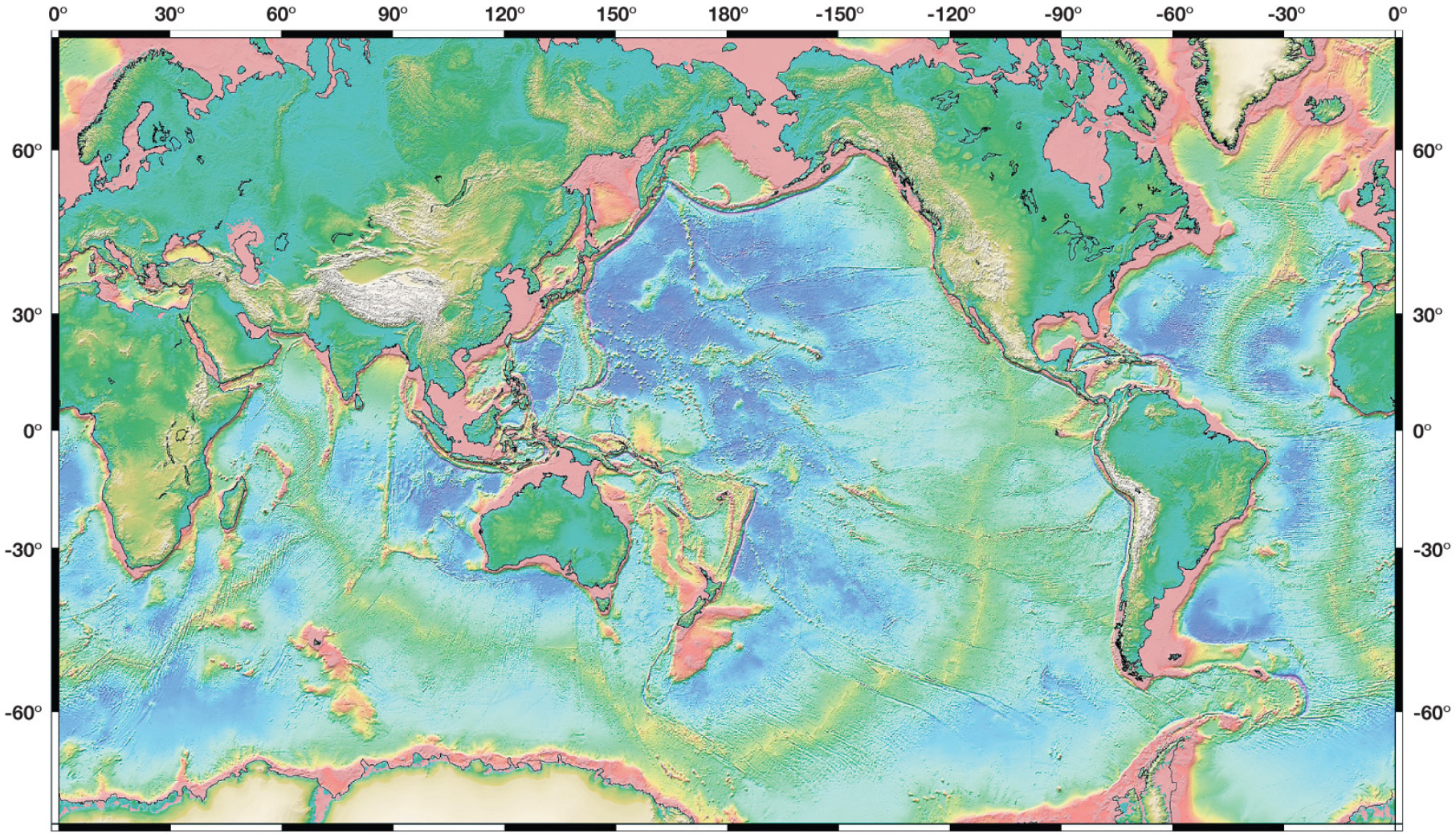


Fig. 3C