


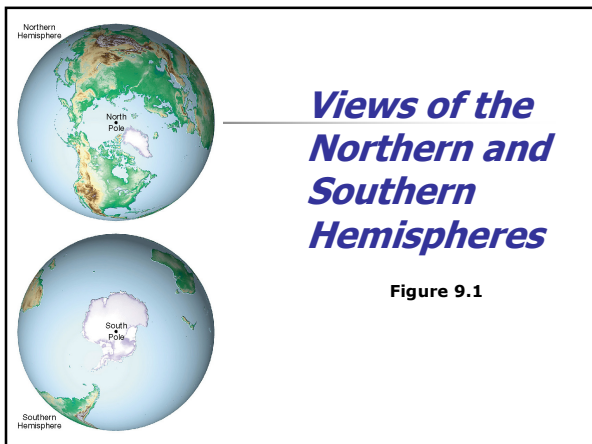
Chapter 9

Oceans: The Last Frontier



The Vast World Ocean

- **Earth is often referred to as the *blue planet***
 - **Seventy-one percent of Earth's surface is represented by oceans and marginal seas**
 - **Continents and islands comprise the remaining 29%**
- **Northern Hemisphere is called the land hemisphere, and the Southern Hemisphere the water hemisphere**





The Vast World Ocean

- Four main ocean basins
 - Pacific Ocean**—The largest and has the greatest depth
 - Atlantic Ocean**—About half the size of the Pacific and not quite as deep
 - Indian Ocean**—Slightly smaller than the Atlantic, largely a Southern Hemisphere body
 - Arctic Ocean**—About 7 percent the size of the Pacific



The Oceans of Earth

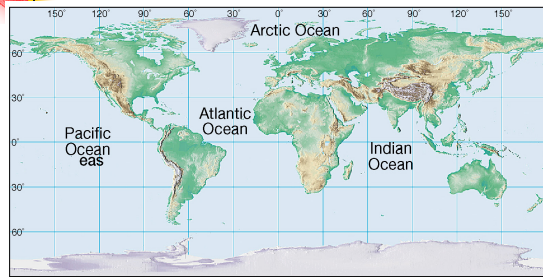


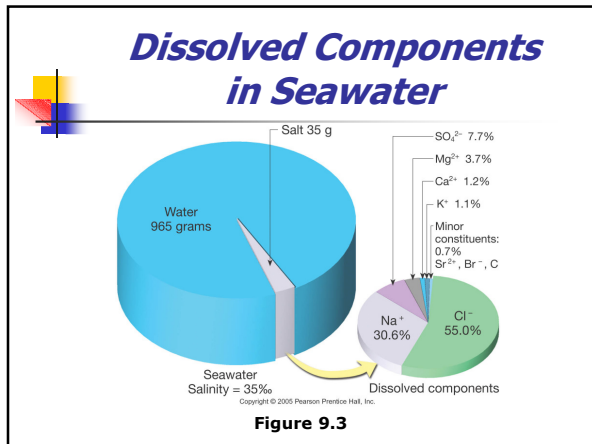
Figure 9.2 B

B.



Composition of Seawater

- Salinity
 - Salinity** is the total amount of solid material dissolved in water
 - Typically expressed as a %
 - Dissolved substances in seawater are small numbers and therefore expressed in *parts per thousand*
 - Most of the salt in seawater is sodium chloride (table salt)



- ### Composition of Seawater
- Salinity
 - Sources of sea salts
 - Chemical weathering of rocks on continents is one source
 - Second major source is Earth's interior through volcanic eruptions
 - Process called *outgassing*
 - Composition of seawater has been relatively stable for millions of years
 - Material is removed just as rapidly as it is added

- ### Composition of Seawater
- Salinity
 - Processes affecting seawater salinity
 - Primarily due to changes in the water content of the solution
 - These include the addition of fresh water due to precipitation, runoff, icebergs melting, and sea-ice melting
 - The removal of fresh water by evaporation and the formation of sea ice also affect salinity

The Ocean's Layered Structure

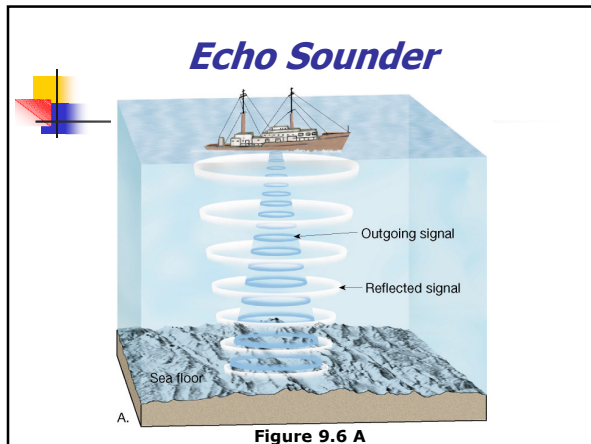
- Temperature and salinity change with depth in the oceans
 - A three-layered structure exists in the open ocean
 - Shallow surface mixed zone
 - Transition zone
 - Deep zone
 - A layer of rapid temperature change below the zone of mixing is known as the *thermocline*

The Ocean's Layered Structure

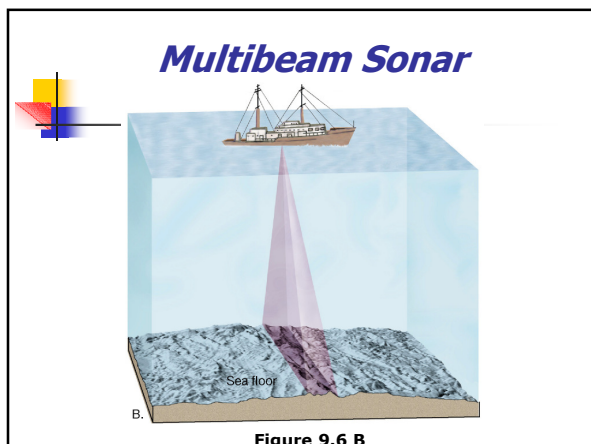
- Temperature and salinity change with depth in the oceans
 - Salinity variations with depth correspond to the general three-layered structure described for temperature
 - A zone of rapidly changing salinity, called the *halocline*, corresponds to the thermocline

Mapping the Ocean Floor

- *Bathymetry*—Measurement of ocean depths and the charting of the shape or topography of the ocean floor
- *Echo sounder* (also called sonar)
 - Invented in the 1920s
 - Primary instrument for measuring depth
 - Reflects sound from ocean floor



-
- Mapping the Ocean Floor**
- **Multibeam sonar**
 - Employs an array of sound sources and listening devices
 - Obtains a profile of a narrow strip of seafloor
 - **Measuring the shape of the ocean surface from space**
 - Employs satellites equipped with radar altimeters





Mapping the Ocean Floor

- Three major topographic units of the ocean floor
 - Continental margins
 - Ocean basin floor
 - Oceanic (mid-ocean) ridge



Major Topographic Divisions of the North Atlantic Ocean

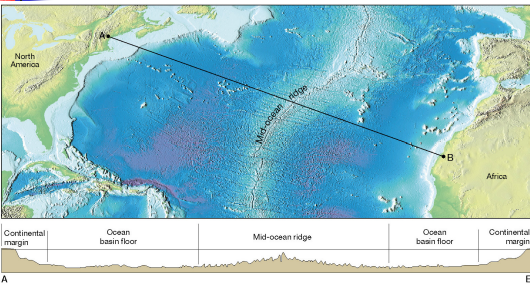


Figure 9.9



Continental Margins

- Passive continental margins
 - Found along most coastal area that surround the Atlantic Ocean
 - Not associated with plate boundaries
 - Experience little volcanism and
 - Few earthquakes



Continental Margins

- **Passive continental margins**
 - **Features comprising a passive continental margin**
 - *Continental shelf*
 - Flooded extension of the continent
 - Varies greatly in width
 - Gently sloping
 - Contains oil and important mineral deposits



Continental Margins

- **Passive continental margins**
 - **Features comprising a passive continental margin**
 - *Continental shelf*
 - Some areas are mantled by extensive glacial deposits
 - Most consist of thick accumulations of shallow-water sediments



Continental Margins

- **Passive continental margins**
 - **Features comprising a passive continental margin**
 - *Continental slope*
 - Marks the seaward edge of the continental shelf
 - Relatively steep structure
 - Boundary between continental crust and oceanic crust



Continental Margins

- **Passive continental margins**
 - **Features comprising a passive continental margin**
 - **Submarine canyons and turbidity currents**
 - *Submarine canyons*
 - Deep, steep-sided valleys cut into the continental slope
 - Some are seaward extensions of river valleys
 - Most appear to have been eroded by turbidity currents



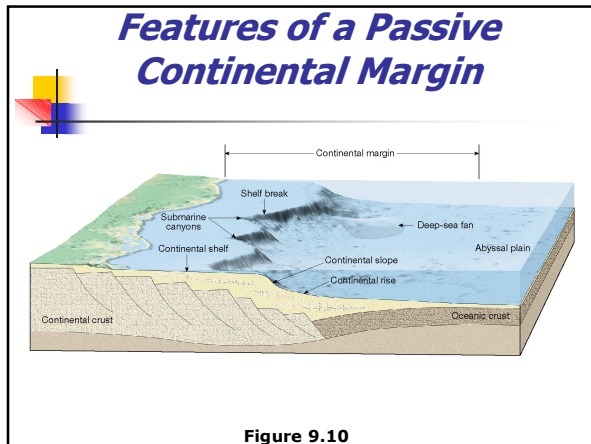
Continental Margins

- **Passive continental margins**
 - **Features comprising a passive continental margin**
 - **Submarine canyons and turbidity currents**
 - *Turbidity currents*
 - Downslope movements of dense, sediment-laden water
 - Deposits are called *turbidites*



Continental Margins

- **Passive continental margins**
 - **Features comprising a passive continental margin**
 - *Continental rise*
 - Found in regions where trenches are absent
 - Continental slope merges into a more gradual incline—The continental rise
 - At the base of the continental slope turbidity currents that follow submarine canyons deposit sediment that forms *deep-sea fans*

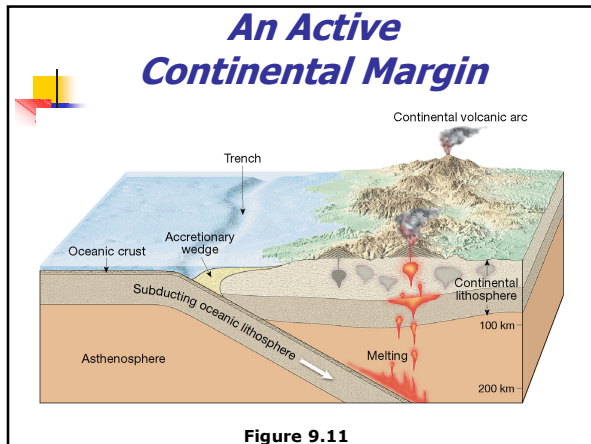


Continental Margins

- **Active continental margins**
 - Continental slope descends abruptly into a *deep-ocean trench*
 - Located primarily around the Pacific Ocean
 - Accumulations of deformed sediment and scraps of ocean crust form *accretionary wedges*
 - Some subduction zones have little or no accumulation of sediments

Deep-Ocean Basin

- **Deep-ocean trenches**
 - Long, relatively narrow features
 - Deepest parts of ocean
 - Most are located in the Pacific Ocean
 - Sites where moving lithospheric plates plunge into the mantle
 - Associated with volcanic activity
 - Volcanic islands arcs
 - Continental volcanic arcs



- ### Deep-Ocean Basin
- **Abyssal plains**
 - Likely the most level places on Earth
 - Sites of thick accumulations of sediment
 - Found in all oceans
 - **Seamounts and guyots**
 - Isolated volcanic peaks
 - Many form near oceanic ridges

- ### Deep-Ocean Basin
- **Seamounts and guyots**
 - May emerge as an island
 - May sink and form flat-topped seamounts called *guyots* or *tablemounts*
 - **Mid-ocean ridge**
 - Characterized by
 - An elevated position
 - Extensive faulting
 - Numerous volcanic structures that have developed on newly formed crust



Deep-Ocean Basin

- **Mid-ocean ridge**
 - **Interconnected ridge system is the longest topographic feature on Earth's surface**
 - **Over 70,000 kilometers (43,000 miles) in length**
 - **Twenty-three percent of Earth's surface**
 - **Winds through all major oceans**
 - **Along the axis of some segments are deep downfaulted structures called *rift valleys***



Deep-Ocean Basin

- **Mid-ocean ridge**
 - **Consist of layer upon layer of basaltic rocks that have been faulted and uplifted**
 - **Mid-Atlantic Ridge has been studied more thoroughly than any other ridge system**



Seafloor Sediments

- **Ocean floor is mantled with sediment**
- **Sources**
 - **Turbidity currents**
 - **Sediment that slowly settles to the bottom from above**
- **Thickness varies**
 - **Thickest in trenches—Accumulations may approach 10 kilometers**



Seafloor Sediments

- **Thickness varies**
 - Pacific Ocean—About 600 meters or less
 - Atlantic Ocean—From 500 to 1000 meters thick
- **Mud is the most common sediment on the deep-ocean floor**



Seafloor Sediments

- **Types of seafloor sediments**
 - *Terrigenous sediment*
 - Material weathered from continental rocks
 - Virtually every part of the ocean receives some
 - Fine particles remain suspended for a long time
 - Oxidation often produces red and brown colored sediments



Seafloor Sediments

- **Types of seafloor sediments**
 - *Biogenous sediment*
 - Shells and skeletons of marine animals and plants
 - Most common are *calcareous oozes* produced from microscopic organisms
 - *Siliceous oozes* composed of skeletons of diatoms and radiolarians
 - *Phosphate rich materials* derived from the bones, teeth, and scales of fish and other marine organisms

Seafloor Sediments

- **Types of seafloor sediments**
 - **Hydrogenous sediment**
 - Minerals that crystallize directly from seawater
 - Most common types include
 - Manganese nodules
 - Calcium carbonates
 - Metal sulfides
 - Evaporites

Distribution of Marine Sediments

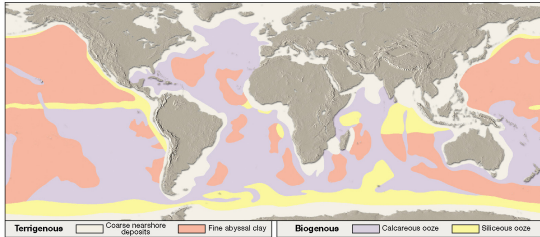


Figure 9.5

Seafloor Sediments

- **Distribution**
 - Coarse terrigenous deposits dominate continental margin areas
 - Fine-grained terrigenous material is common in deeper areas of the ocean basin



Seafloor Sediments

- **Distribution**
 - Hydrogenous sediment comprises only a small portion of deposits in the ocean
 - There are a few places where very little sediment accumulates (mid-ocean ridges)



End of Chapter 9
