Chapter 6: The chemistry of seawater

II

- Salinity variations w/depth, latitude
- The three-layered ocean
- Seawater buffer system
- Water’s Heat Capacity

Salinity variation with depth

- Curves for high and low latitudes begin at different surface salinities
- **Halocline** = layer of rapidly changing salinity
- At depth, salinity is uniform

Surface salinity variation

- Pattern of surface salinity:
  - Lowest in high latitudes
  - Highest in the tropics
  - Dips at the Equator

- Surface processes help explain pattern

Surface salinity variation

- High latitudes have low surface salinity
  - High precipitation and runoff
  - Low evaporation
- Tropics have high surface salinity
  - High evaporation
  - Low precipitation
- Equator has a dip in surface salinity
  - High precipitation partially offsets high evaporation
Global surface salinity

Pycnocline, thermocline and halocline

- **Pycnocline** = layer of rapidly changing density
- **Thermocline** = layer of rapidly changing temperature
- **Halocline** = layer of rapidly changing salinity
- Barrier to vertical mixing of water

Ocean layering based on density

- **Mixed surface layer** (surface to 200 meters)
  - Low density; well mixed by waves, currents, tides
- **Upper water** (200 to 1000 meters)
  - Intermediate density water containing thermocline, pycnocline, and halocline (if present)
- **Deep water** (below 1000 meters)
  - Cold, high density water involved in deep current movement
Density and temperature variations with depth

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Seawater buffer system

- pH Scale is a measure of the acidity or alkalinity of a solution.

- Water dissociates (break apart) into OH⁻ and H⁺ ions.

- In pure water there are as many H⁺ as OH⁻: $10^{-7}$ Mol of hydrogen ions = pH of 7 (neutral pH)

- 1 Mol $= 6 \times 10^{23}$ atoms, molecules, ions per liter, also called Avogadro’s number

- $\text{pH} = -\log[H^+]$

  Negative logarithm of the hydrogen ion concentration

Fig. 6-17. The carbonic acid system in the ocean is responsible for the relatively constant pH of seawater (pH of 7.8-8.2). The bicarbonate ions have the ability to bind with hydrogen ions and thus neutralize most acids.
More than 80% of carbon in seawater is in the form of bicarbonate (HCO$_3^-$), maintaining the average ocean pH at about 7.8-8.2.

The abundance of bicarbonate makes seawater an ideal buffer system, i.e. changes in pH are compensated.

Relative gas Solubility in Sea Water with Temperature

Depth profiles of O$_2$ and CO$_2$ for Atlantic and Pacific

Depth profiles of pH for Atlantic and Pacific