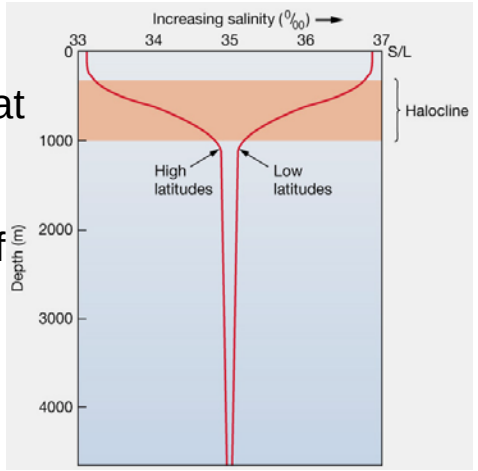
Chapter 6: The chemistry of seawater II

- 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

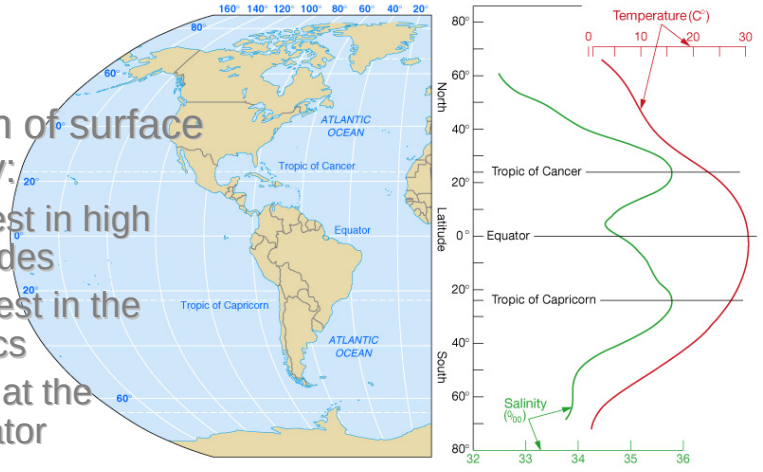


Figure 6-20

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

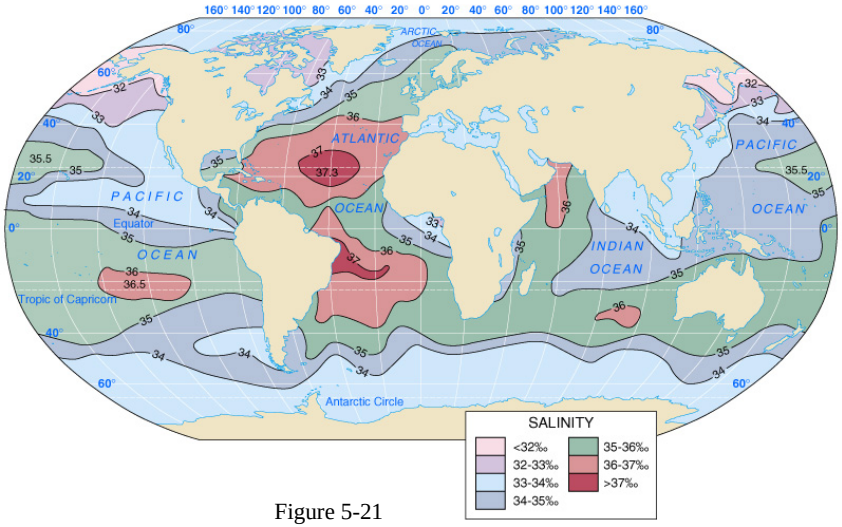


Figure 5-21

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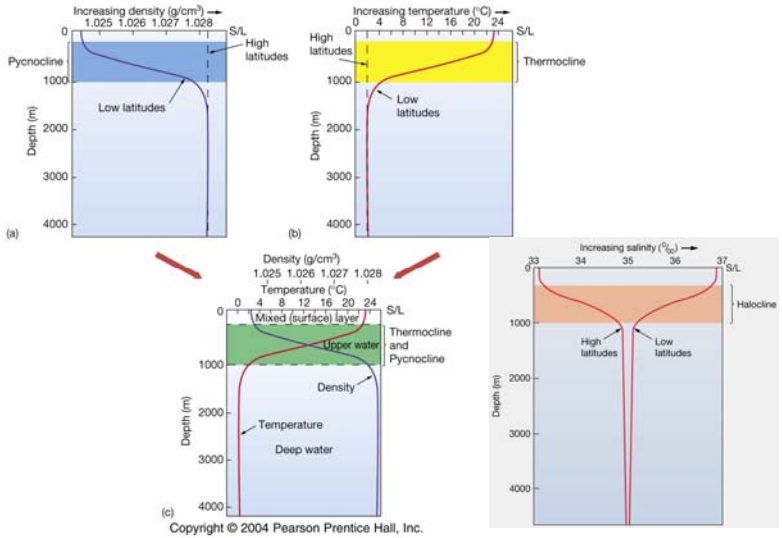
Pycnocline, thermocline and halocline

- **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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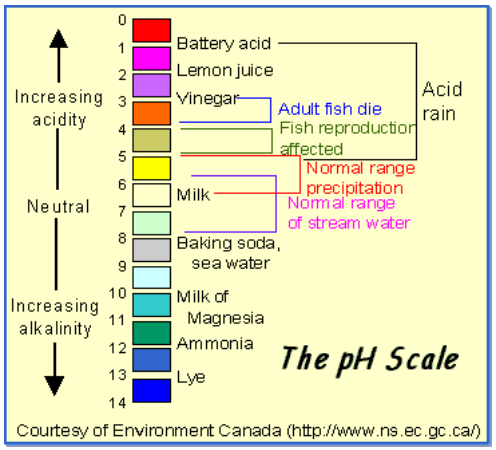
Seawater buffer system



- 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 x 10^{23} atoms, molecules, ions per liter, also called Avogadro's number
- pH = -log[H+]
  Negative logarithm of the hydrogen ion concentration

Note that reaction goes in both directions!

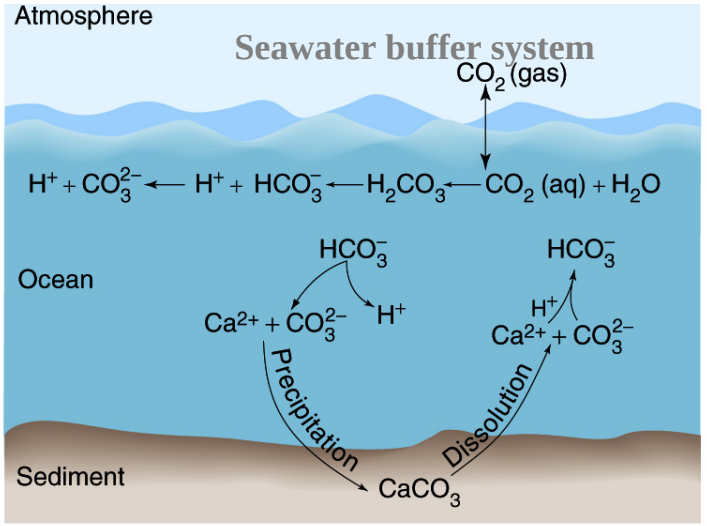
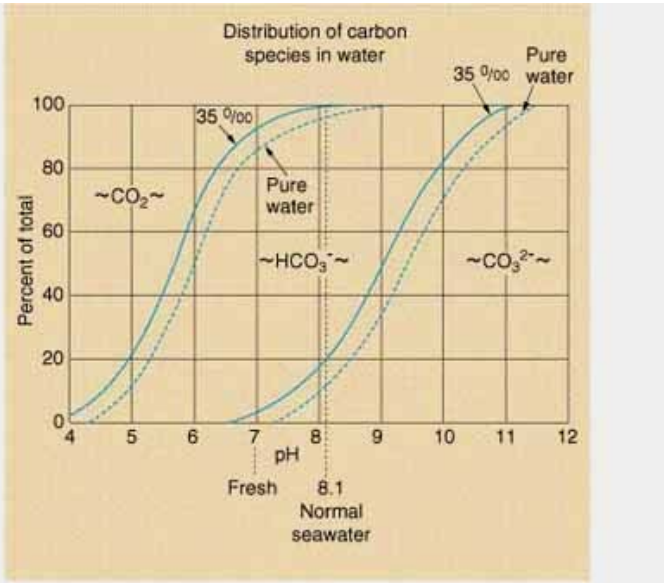


Fig. 6-17. The carbonic acid system in the ocean is responsible for the relatively constant pH of seawater (pH of 7.8-8.2). The bicarbonate ions have the ability to bind with hydrogen ions and thus neutralize most acids.

- 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.

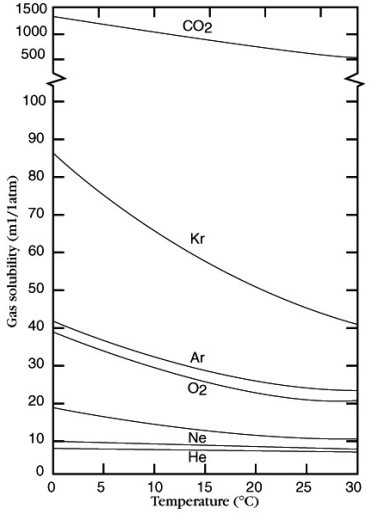


B.

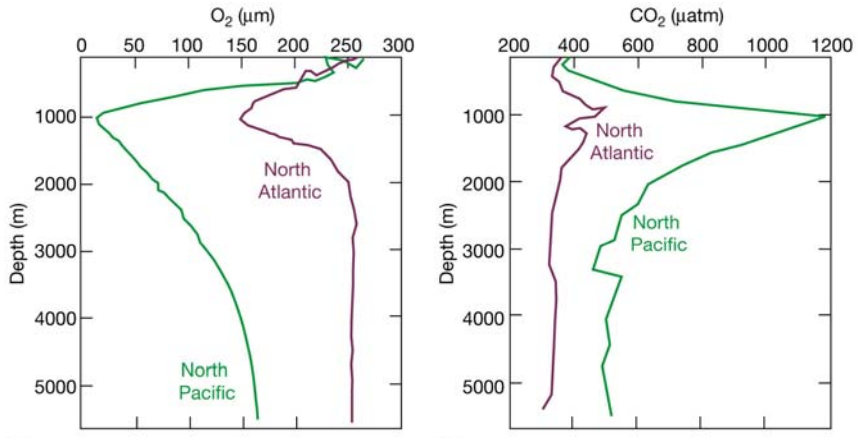
Seawater too basic: $H_2CO_3 \longrightarrow HCO_3^- + H^+$ pH drops

Seawater too acidic: $HCO_3^- + H^+ \longrightarrow H_2CO_3$ pH rises

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