

## Class 17: SALINITY AND COMPOSITION OF SEA WATER

Water's solvent properties- review

Salinity

Composition of dissolved salts

"Constant proportions"

"Conservative" and "nonconservative" species

Salinity distribution in surface ocean waters

-- controlling factors

Review: WATER IS AN EXCELLENT SOLVENT for ions -- dissolves many substances

Polar H<sub>2</sub>O molecule interacts with other polar substances (solids)

- negative H<sub>2</sub>O ends -- rotate around to neutralize positive charges of + ions
- positive H<sub>2</sub>O end -- rotate to neutralize negative charges of - ions
- so many ions are "happy" dissolved in water
- attraction of water overcomes ionic bonding in solids --> dissolution

Which ions are found in seawater and how much of each is there?

Recall from before: Ave. S = 35 g/kg; range = 30-37 g/kg

Preview: S variations due to gains vs. losses of H<sub>2</sub>O ("water budget") not salts

### COMPOSITION OF DISSOLVED SALTS in Ocean water

Dissolved substances are ions: cations (+ charge) & anions (- charge)

99.7% of salinity is made up of only 7 ionic species ("major species")

Cation	Concentration (g/kg) or ‰
Na <sup>+</sup>	10.8
Mg <sup>2+</sup>	1.3
Ca <sup>2+</sup>	0.4
K <sup>+</sup>	0.4

Anion	Concentration (g/kg) or ‰
Cl <sup>-</sup>	19.1
SO <sub>4</sub> <sup>2-</sup>	2.7
HCO <sub>3</sub> <sup>-</sup>	0.1

Other elements -- "minor" and "trace" elements (less abundant, but some are vitally important)

Major dissolved species (& a few minors) are always present in "**constant proportions**"

e.g., [Na<sup>+</sup>] / [Cl<sup>-</sup>] = a constant value everywhere

[Na<sup>+</sup>] / Salinity = a constant value everywhere

Why does this occur?

- **Mixing time of oceans (<2,000 yr) much less than rates of addition and removal**
- The fact that these dissolved species are present in constant proportions implies they are "**conservative**" **constituents** (conserved; no loss or gain over short periods of time- for long periods, see later)
- If there were significant gains or losses in less than 2,000 years, then the concentration would vary from place to place

Most minor and trace species are **not** present in constant proportions -- "non-conservative"

Example: Nutrients are removed rapidly from sea water (life processes)  
..So nutrient concentrations vary greatly between different areas and between different depths

**SALINITY IN SURFACE OCEAN WATER-** How does it vary from place to place?

**Highest S** can be found in...

- 1) center of oceans at  $\sim 25^\circ$  lat.
- 2) enclosed seas at same lat.

**Lowest S...**

- 1) temperate lats. ( $\sim 40-50^\circ$ ) lots of rain
- 2) near coasts where rivers empty into ocean
- 3) equatorial regions

Controlling process: variations in the "water budget" at any given area.

**Losses of  $H_2O$  from Evaporation (E) vs. Gains from Precipitation (P)**

Global hydrologic cycle –

evap. --> ppt. (rain) --> runoff (rivers) --> oceans --> evap. --> and so on...

Salinity variations with latitude – E vs. P balance depends on latitude

Temperate and equatorial (rainy climates):  $P > E$  ---> low S

Tropics, about  $25^\circ$  Latitude N or S (dry climates):  $E > P$  ---> high S

Salinity near continents can be very high or very low...

Runoff from major rivers --> low S

Semi-enclosed seas of high E --> high S

Effect of currents -- move water (and S) around

**Gulf Stream:** saline water transported N and E (helps drive convection in N. Atlantic)

**Eastern Pacific:** cool, "dilute" water transported northward (affects climate of Chile, e.g.)