

Lecture 6 - Seawater and the water column

Where in the world ??

1. The deepest ocean
2. The newest ocean
3. The mid Atlantic ridge
4. An old basalt island
5. A young volcanic island
6. An area of the abyssal plains
7. A possible location for a black smoker
8. A possible location for a white smoker
9. A good place to dive
10. A poor place to fish...



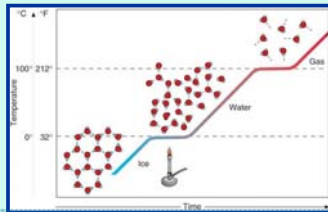
The water molecule



covalent



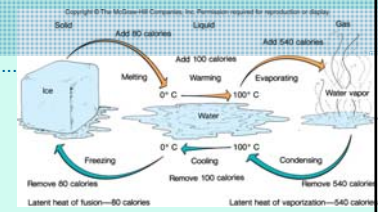
Polarized



3 states

Water

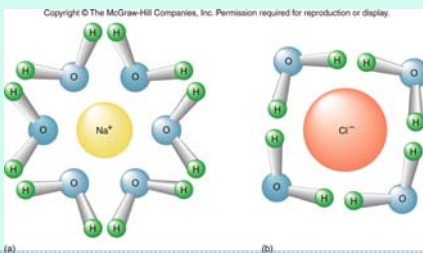
- the wonder molecule....



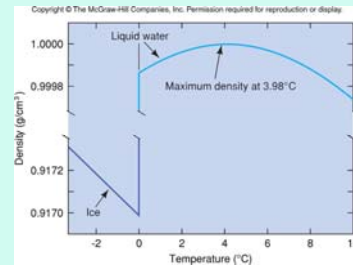
- 1 - liquid across 0 - 100 degrees - high heat capacity
- 2 - high surface tension
- 3 - specific gravity of 1 - anything lighter floats

-Universal solvent:

-other chemicals dissolve water, especially salts




- Density changes in water are unique



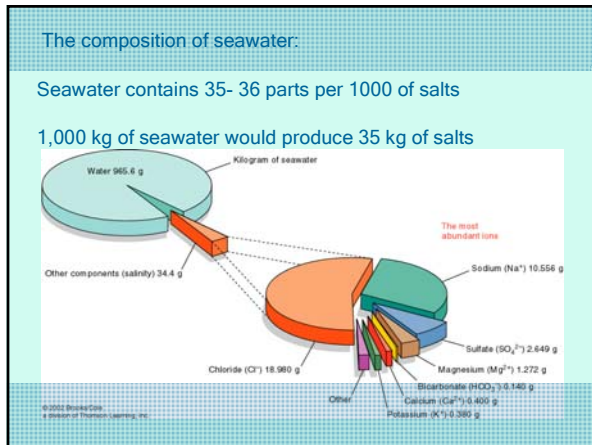


Ice floats
Warm water rises
Cold water sinks

The composition of seawater enhances these effects
Sea water - "earth tea"

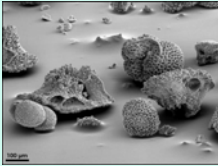


ION	CONCENTRATION ‰	PERCENTAGE OF TOTAL SALINITY
Chloride (Cl ⁻)	19.345	55.03
Sodium (Na ⁺)	10.752	30.59
Sulfate (SO ₄ ²⁻)	2.701	7.68
Magnesium (Mg ²⁺)	1.295	3.68
Calcium (Ca ²⁺)	0.416	1.18
Potassium (K ⁺)	0.390	1.11
Bicarbonate (HCO ₃ ⁻)	0.145	0.41
Bromide (Br ⁻)	0.066	0.19
Borate (H ₂ BO ₃ ⁻)	0.027	0.08
Strontium (Sr ²⁺)	0.013	0.04
Fluoride (F ⁻)	0.001	0.003
Other dissolved material	<0.001	<0.001



The Principle of Constant Proportions

Forchhammer's principle:
The percentage of salts in seawater stays constant



- marine organisms continually absorb and utilize substances such as calcium, silica etc.
- Other substances are bound into sediment
- Gases diffuse in and out at the surface

Residence time =
time an element stays in the ocean

= Chemical equilibrium....

The composition of seawater stays constant,
And if you know one, you can figure out the others...

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The Source of the Ocean's Salts

- Continental crust
- Volcanic activity,
- Groundwater
- Hydro-thermal vents
- Cold seeps,
- Dead, but once-living organisms.

The composition of seawater:

Inland "seas"

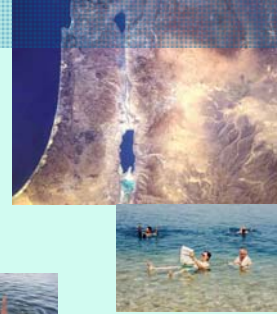
e.g. Salt Lake, Dead Sea.

High levels of salts, that run off locally.

No volcanically derived salts...



Inland Seas



Elevated Salinity



Red Sea

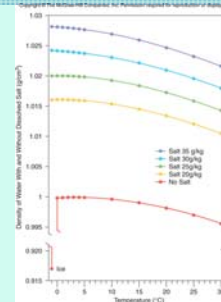
Low Salinities



Baltic Sea

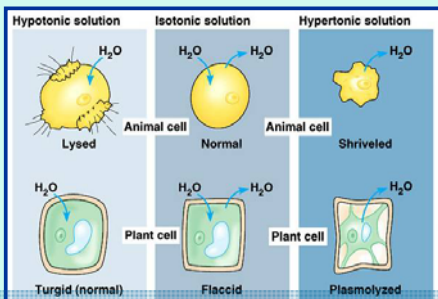


Atlantic Ocean at mouth of Amazon River



Dissolved salts in seawater amplify the changes in density with temperature.

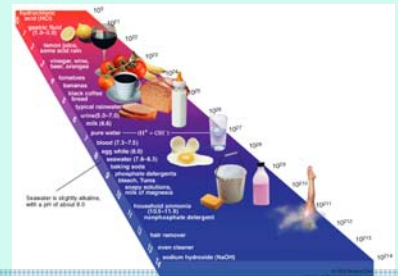
The importance of maintaining equilibrium - Osmolarity

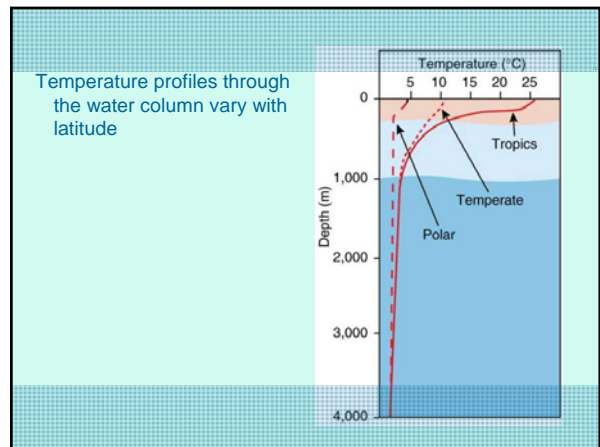
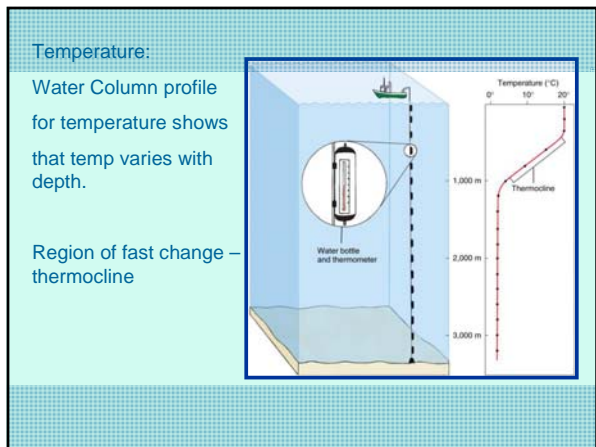
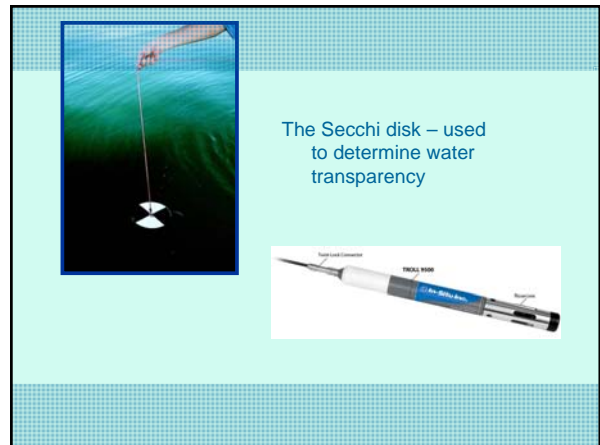
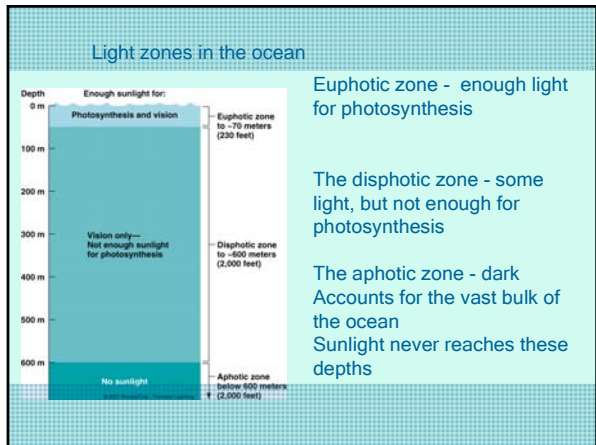
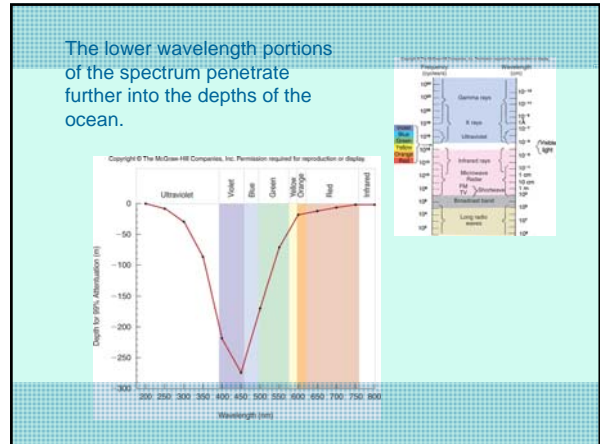
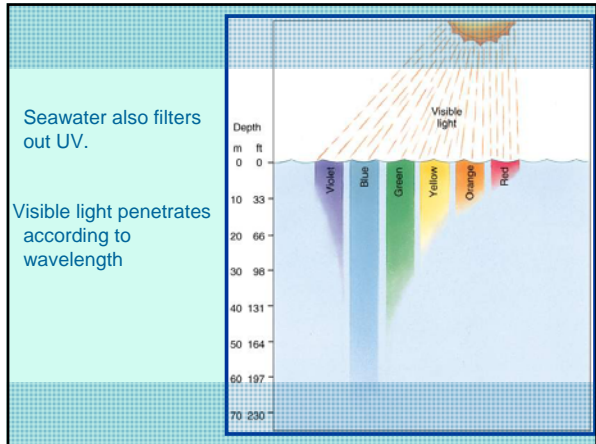


Acid-Base Balance

Some other properties of seawater

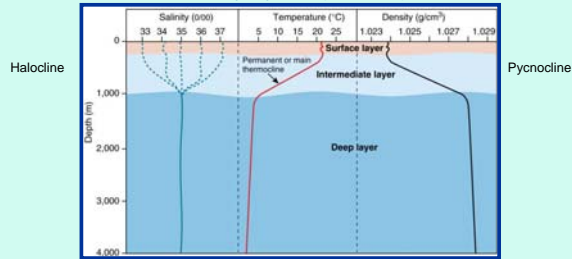
Seawater has a pH of 7.8 and a built in buffering system.



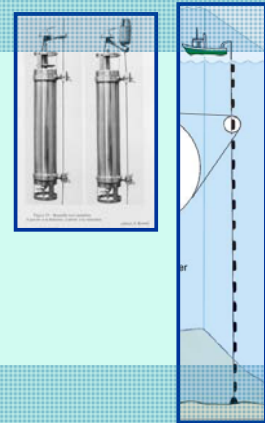
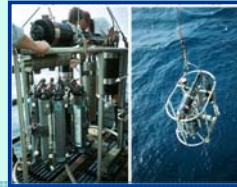


Water Column Profiles –

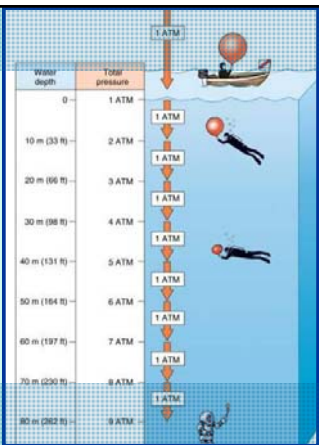
The water column is clearly layered (stratified)



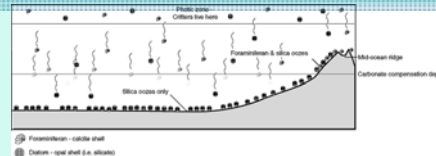
The Niskin bottle



Within the water column pressure increases with depth.

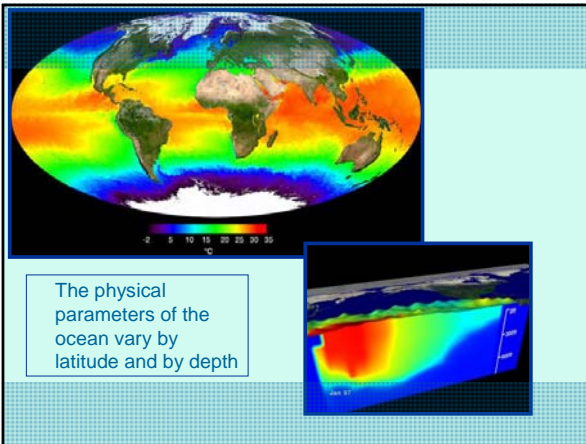
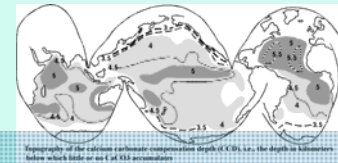


Increasing depth has many consequences: The CCD



Cold seawater holds more CO₂ than warm water

This causes the acidity to rise with depth

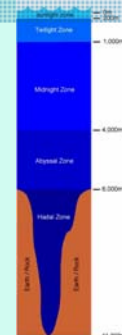


The physical parameters of the ocean vary by latitude and by depth

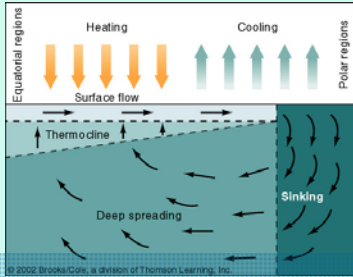
Thermohaline Circulation

The movement of water due to different densities

The ocean is density stratified, with the densest water at the bottom.



Thermohaline Circulation Patterns



Thermohaline Current - The Global Heat Connection

The global pattern of deep circulation resembles a vast "conveyor belt" that carries surface water to the depths and back again.

