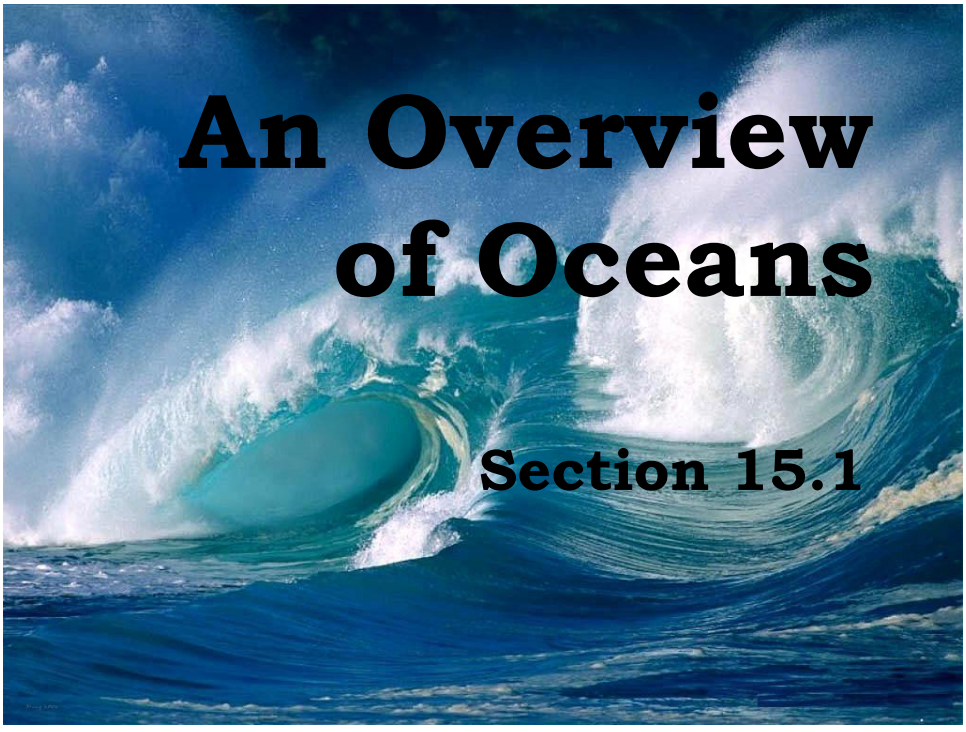


An Overview of Oceans

Section 15.1

Bell Ringer:

- Name Earth's five oceans

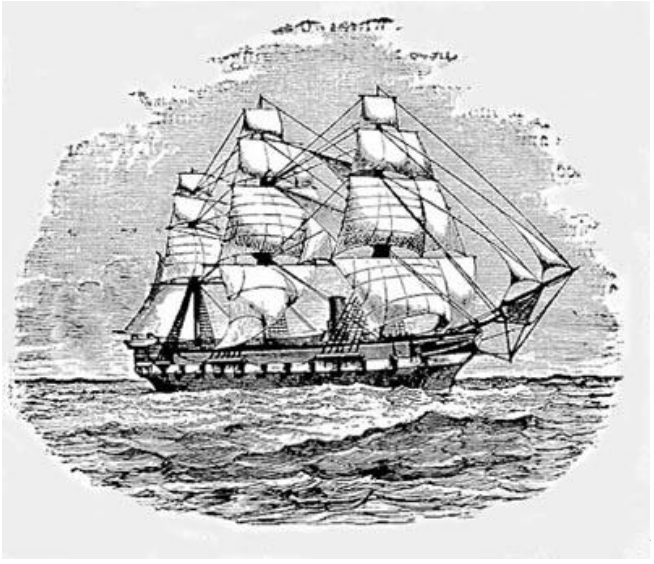
An Overview of Oceans

- Oceanography is the scientific study of Earth's Oceans.
- In the 1800's, the British ship ***H.M.S. Challenger*** became the first research ship to use sophisticated measuring devices to study the oceans.

An Overview of Oceans

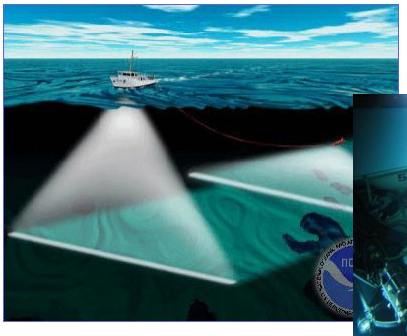
- Since the *Challenger*, oceanographers have been collecting data with instruments both at the surface and from the depths of the ocean floor.

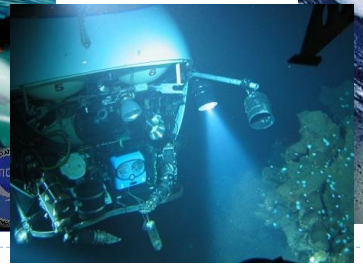
H.M.S. Challenger

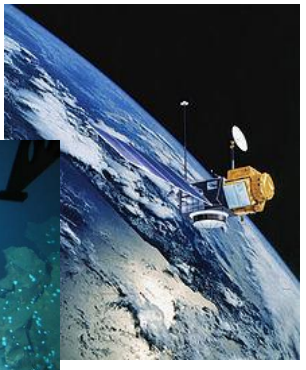


An Overview of Oceans

- Sonar, floats, satellites, submersibles, and computers have all been central to exploring the oceans.

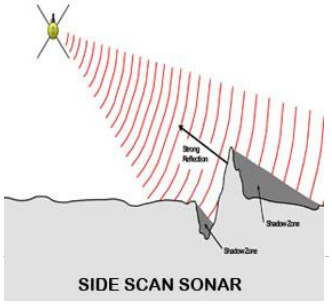


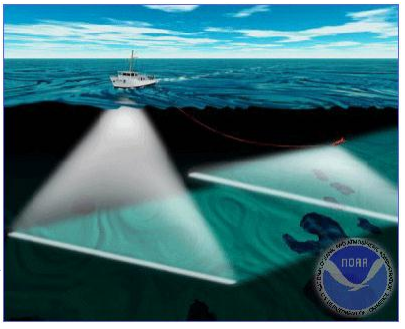




At the Surface

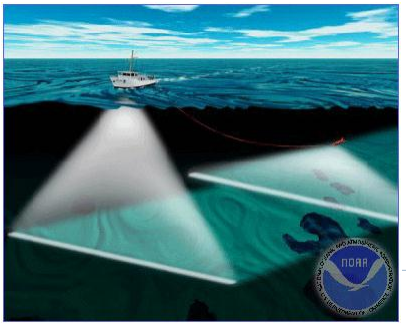
- **Sonar**: **So**und **Na**vigation and **R**anging
- Used by oceanographers to learn about the *topography* of the ocean floor.

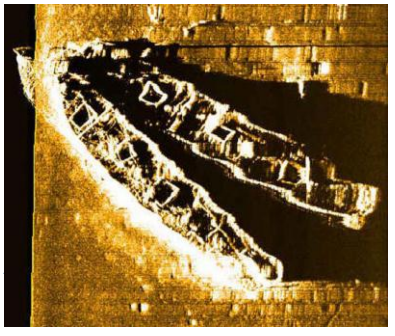




At the Surface

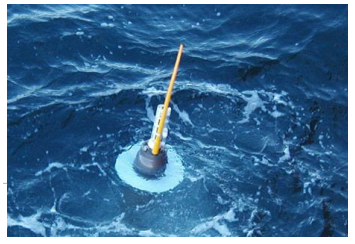
- **Side-Scan Sonar:** Directs sound waves to the sea floor at an angle, so that the sides of underwater hills and other features can be mapped.





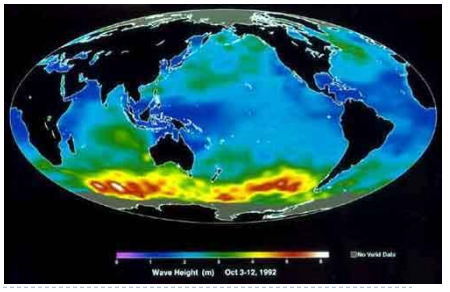
At the Surface

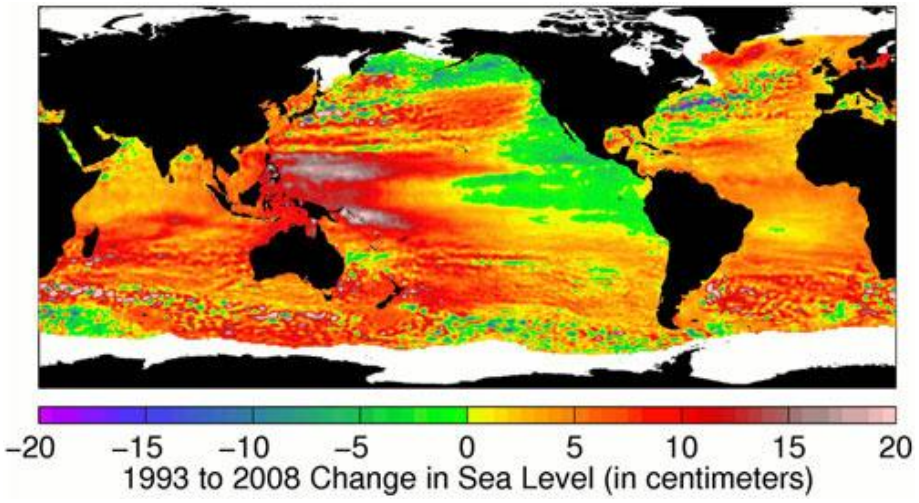
- **Floats** can be used to record wave motion and the speed at which currents are moving
- **Argo Floats** measure the ocean's temperature, pressure, and acidity.



At the Surface

- **Satelites** such as the ***TOPEX/Poseidon*** continually monitor the ocean's surface temperature, currents, and wave conditions.





Calculating Ocean Depth Using Sonar

- Sound travels at a constant velocity of 1500m/s through salt water
- Speed is calculated using the equation: $V = \frac{d}{t}$
- Rearrange to solve for distance: $d = V \times t$
- **Divide your final answer by 2 since the sound is reflected off the ocean floor.**

- $distance\ to\ ocean\ floor\ d = \frac{V \cdot t}{2}$

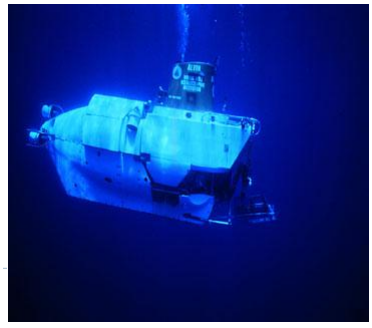
Calculating Ocean Depth Using Sonar

- It takes 5.5 seconds for a sonar signal to be heard after being produced by the ships sonar device.
- Knowing that sound travels 1500 m/s in water, what is the depth of the ocean floor?

- d = V x t
- d = 1500m/s x 5.5s
- d = 8250m
- d = 8250m / 2 = **4125 meters**

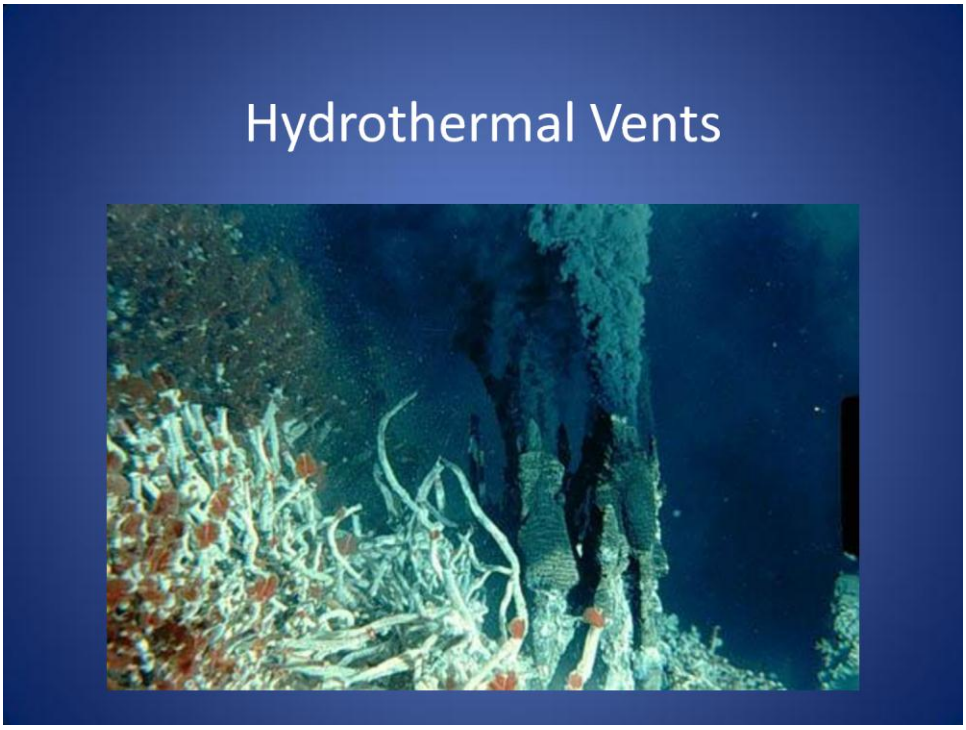
In the Deep Sea

- **Submersibles,** underwater vessels which are remotely operated or carry people to the deepest areas of the ocean, have allowed scientists to explore new frontiers.



In the Deep Sea

- **Alvin,** is a modern submersible that can take two scientists and a pilot to depths up to 4500m.
- *Alvin* has been used to discover hydrothermal vents on the ocean floor as well as previously unknown sea creatures.



Computers

- **Computers,** are an integral tool in the collection and analysis of data from the ocean.
- Information from satellites and float sensors are transmitted and downloaded directly to computers.

Computers

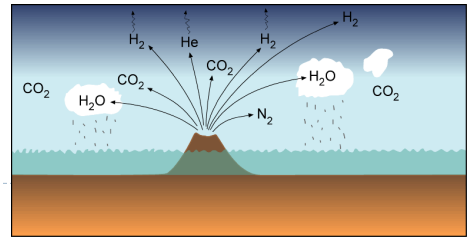
- Sophisticated programs use mathematical equations to analyze data and produce models.
- These models can be used to predict global climate change, tides, tsunamis, and dispersal of coastal pollution.

Origin of the Oceans:

- Where did the water in Earth's oceans come from?

Origin of the Oceans:

- Scientists hypothesize that Earth's water originated from comets, meteorites, and volcanism.



Origin of the Oceans:

- **Comets** are composed of dust and rock particles mixed with frozen water and gases.

Origin of the Oceans:

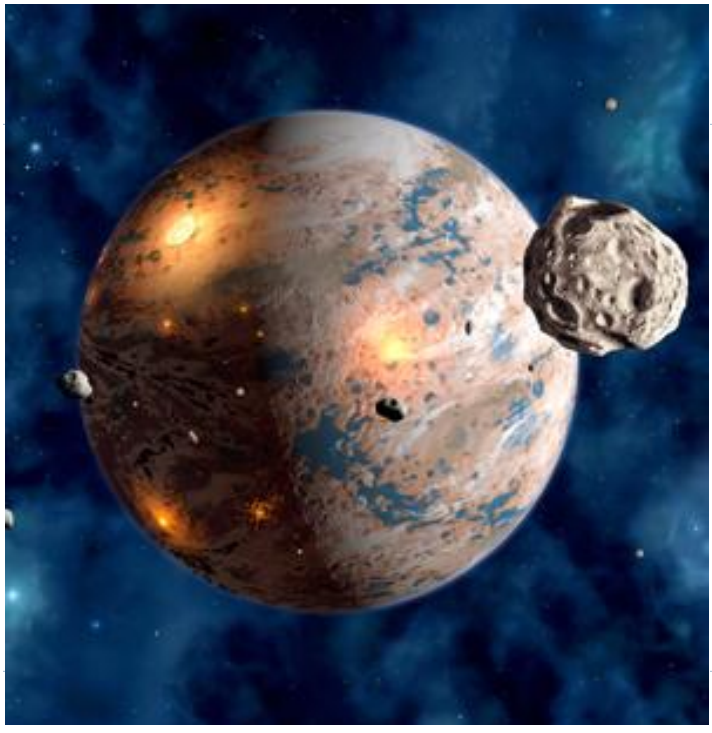
- Comet impacts with Earth may have released enough water to fill ocean basins.

Origin of the Oceans:

- Meteorites are composed of solid metals and minerals.

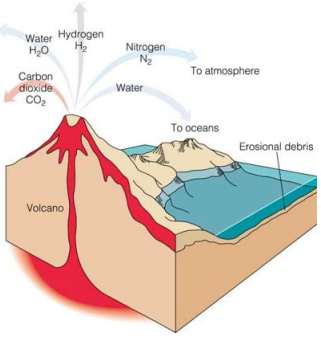
Origin of the Oceans:

- Studies indicate that meteorites contain up to 0.5 percent water.
- Meteorite bombardment with the Earth during the Earth's formation could have contributed to the water in the early oceans.

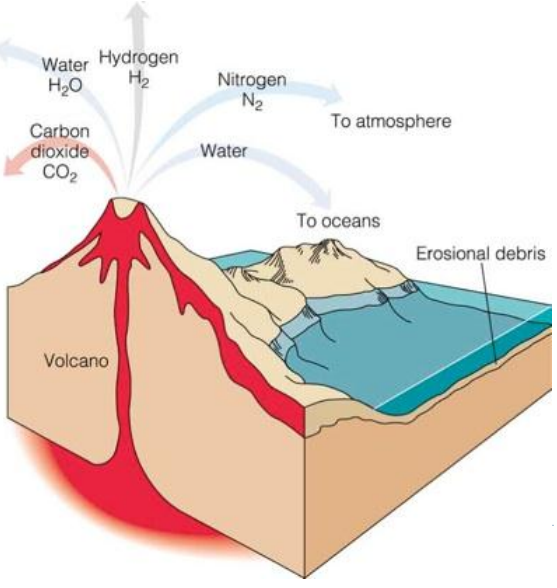


Origin of the Oceans:

- The water trapped in Earth's interior was released by volcanism.
- Intense period of volcanism during early Earth.



Origin of the Oceans:

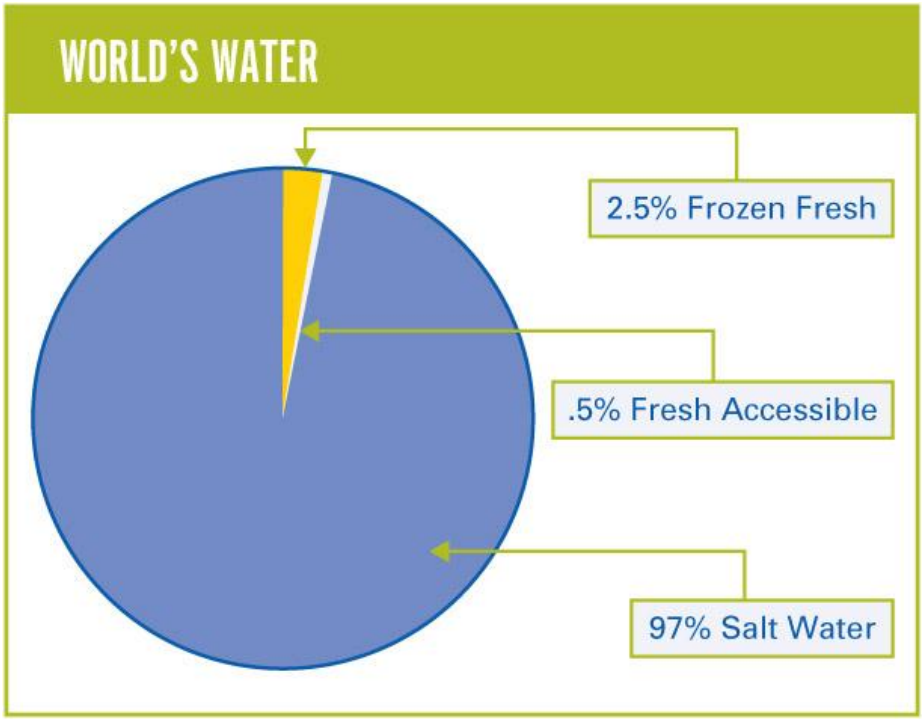


Origin of the Oceans:

- By 4bya (oldest known crustal rock formations), the oceans might have been close to their present size.

Distribution of Earth's Water

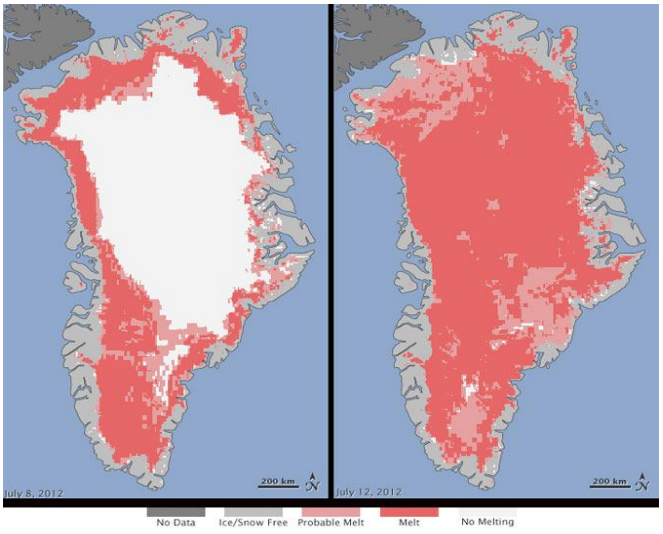
- The oceans contain 97 percent of the water found on Earth.
- The other 3 percent is freshwater.



Distribution of Earth's Water

- The Earth's freshwater is located in the frozen ice caps of Greenland and Antarctica and in rivers, lakes, and underground sources.

Greenland Surface Ice Melt: 2012



The Blue Planet

Northern Hemisphere

61% ocean

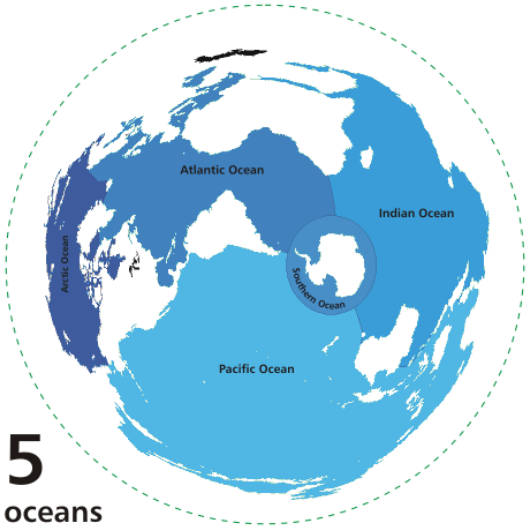
Southern Hemisphere

81% ocean

The Blue Planet

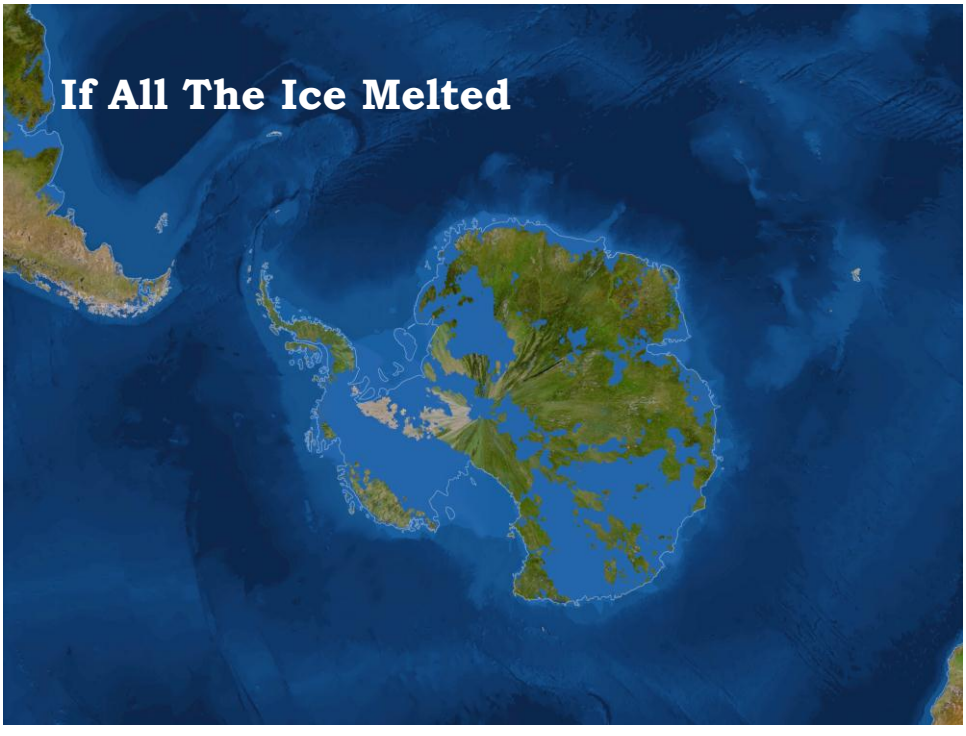
- 71% of the surface of Earth is covered by oceans.
- Average ocean depth is 3800 m (2.36 miles)

Earth's Oceans



5
oceans


If All The Ice Melted
Present-day shoreline


If All The Ice Melted

Sea Level

- Global sea level (the level of the oceans' surface) has risen and fallen by hundreds of meters in response to melting ice during warm periods and expanding glaciers during ice ages.
- Between 1994 and 2004, sea level rose at a rate of 3 mm per year from melting glaciers and thermal expansion due to global warming.

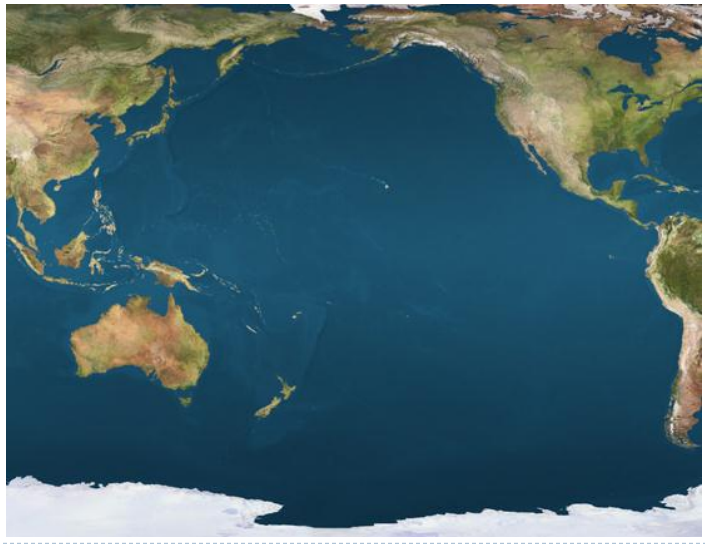
Earth's Oceans

- All oceans are one vast interconnected body of water.
- They have been divided into specific oceans and seas largely because of historic and geographic considerations.

Major Oceans

- Pacific – Atlantic - Indian
- The Pacific Ocean is the largest, containing roughly half of Earth's seawater
- It is larger than all of Earth's landmasses combined

The Pacific Ocean



Major Oceans

- The second-largest ocean is the Atlantic Ocean
- Extends 20,000 km from Antarctica to the Arctic Circle

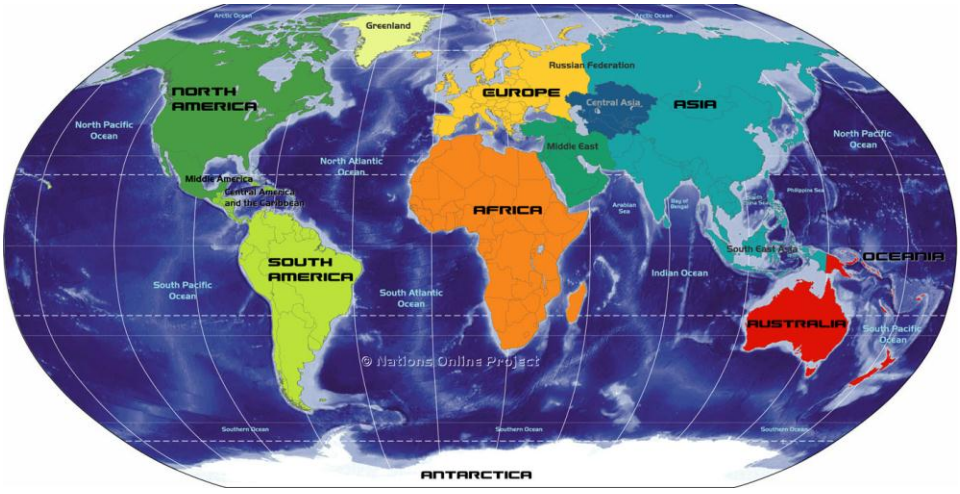
The Atlantic Ocean

Major Oceans

- The Indian Ocean third-largest ocean.
- Located mostly in the southern hemisphere

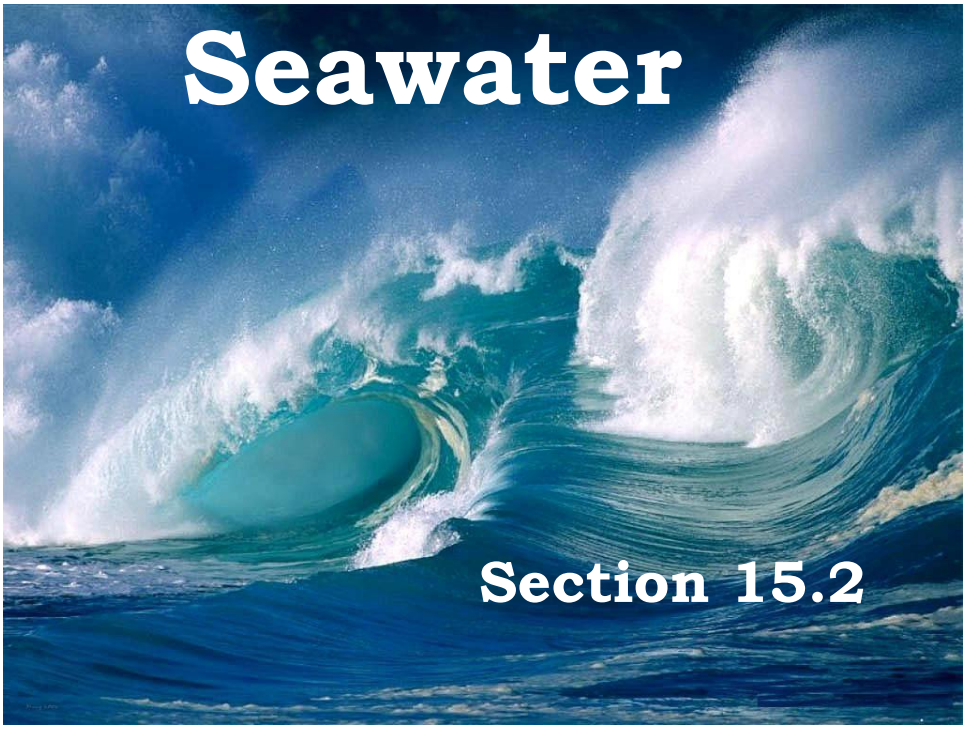
The Indian Ocean

The World's Oceans



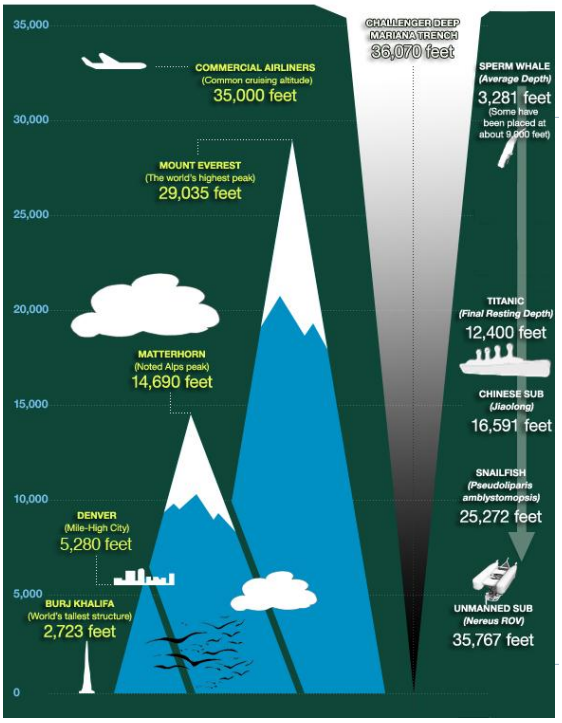
Polar Oceans

- The Arctic and Southern oceans are covered by vast expanses of sea ice, particularly during the winter.
- In the summer, the ice breaks up to form "pancake ice."
- During the winter it freezes into a continuous cover called pack ice.



Seawater

- **Main Point:** Oceans have distinct layers of water masses that are characterized by temperature and salinity.
- **Vocabulary:** Salinity, estuary, temperature profile, thermocline.



Deepest Place in the Ocean:

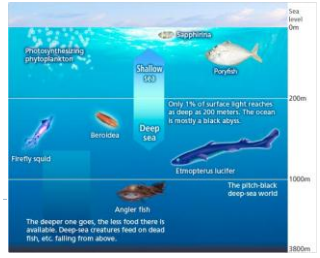
The Mariana Trench
- 36,070 ft
- 6.8 miles

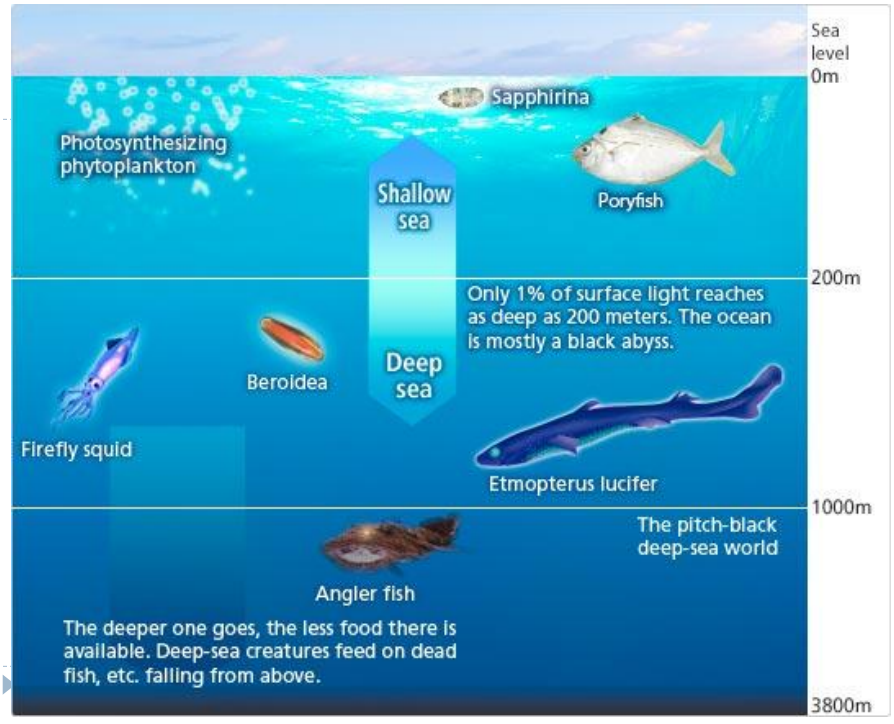
Chemical Properties of Seawater

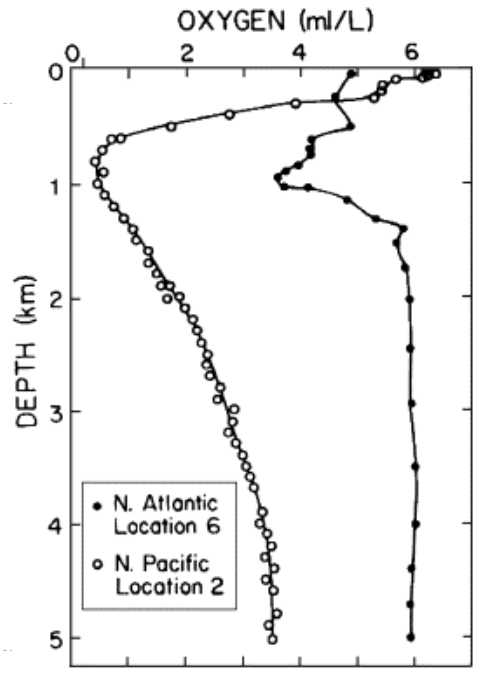
- Ocean water contains dissolved gases, including **oxygen** and **carbon dioxide.**
- Ocean water also contains dissolved nutrients such as **nitrates** and **phosphates**.

Chemical Properties of Seawater

- **Oxygen** levels are high at the surface of both the Atlantic and Pacific oceans.
- This is because oxygen is released by surface-dwelling photosynthetic organisms.







Chemical Properties of Seawater

- **Silica (Si)** levels near the surface of the ocean are usually low.
- This is because many organisms remove silica from the ocean water and use it to make shells.

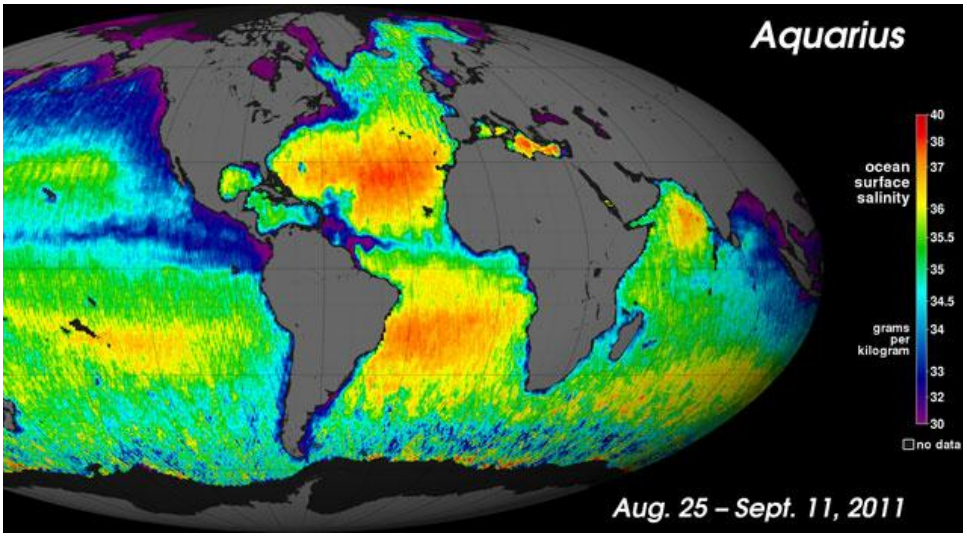
Salinity

- The measure of the amount of dissolved salts in seawater is **salinity.**
- Oceanographers express salinity as grams of salt per kilogram of water, or parts per thousand **(ppt)**
- **Seawater averages 35 ppt or 3.5 percent.**
- The most abundant salt in seawater is sodium chloride (NaCl)

Variations in Salinity

- Salinity is higher in subtropical regions where rates of evaporation exceed rates of precipitation.
- In equatorial regions where precipitation is high, salinity levels are lower than the average.
- The lowest salinity occurs in estuaries, where rivers empty into oceans.

Jet Propulsion Laboratory
California Institute of Technology

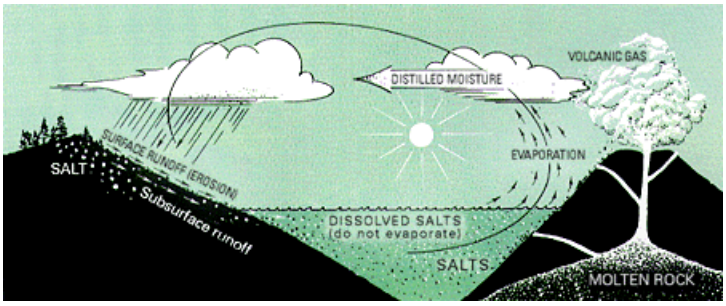


Sources of Sea Salt

- **Geologic evidence indicates that the salinity of ancient seas was not much different from that of todays oceans.**
- **Evidence is based on magnesium levels in the shells of marine organisms.**

Sources of Sea Salt

- The main source of sea salt is from volcanism and weathering of crustal rocks.



Sources of Sea Salt

- Sulfur dioxide and chlorine, gases released by volcanoes, dissolve in water, forming sulfate and chlorine ions.
- Most other ions, including sodium and calcium, come from the weathering of crustal rocks.

Removal of Sea Salts

- **Evaporate Formation:**

  - **Solid salt is left behind when water evaporates from concentrated solutions of salt water**

Removal of Sea Salts

- **Biological Activity:**

  - **Organisms remove calcium ions from water to build shells, bones, and teeth.**

Monday

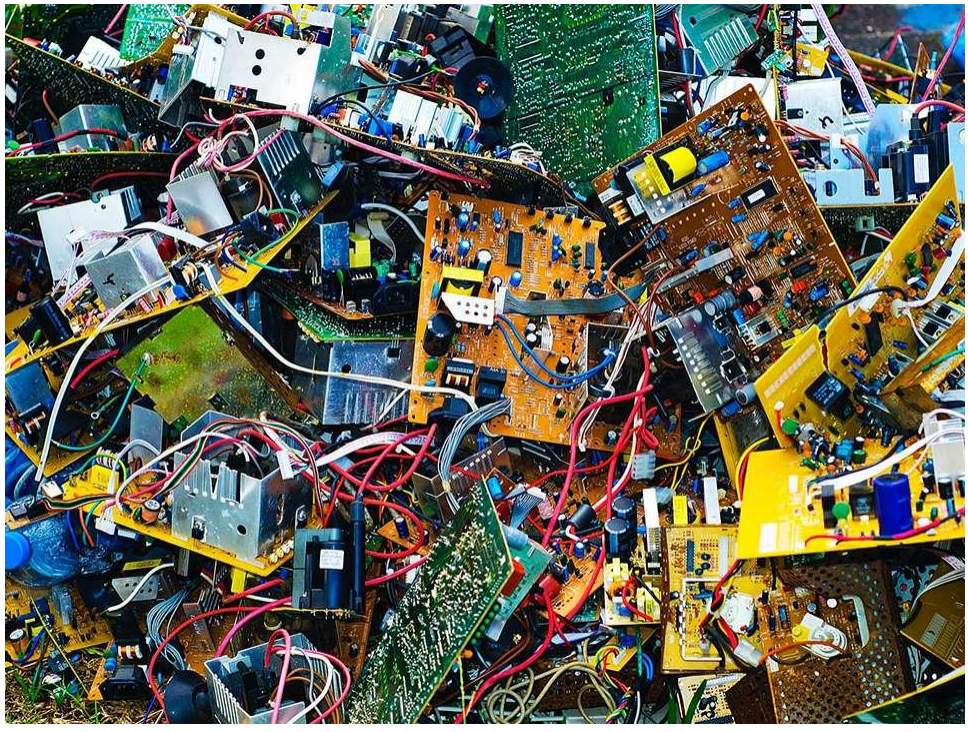
- Physical Properties of Seawater
- Ocean Layering
- Ocean Masses

Modeling Water Mass

- 4x 200mL Beakers
- 100ml Graduated Cylinder
- Thermometer
- Dropper
- Measuring Spoon
- Salt
- Food Coloring

Modeling Water Mass

- Fill each beaker with 100mL of water
- In two of the beakers, add 1 tbsp of salt.
- Add 3-4 drops of red food coloring to one beaker containing salt water.
- Add 3-4 drops of yellow food coloring to the other
- Place these two in the refrigerator for 30 mins
- Add 3-4 drops blue food coloring in one freshwater beaker.
- Add no food coloring to the 4th beaker.
- Keep these two at room temperature.



Salinity and Density

- The presence of various salts causes the physical properties of seawater to be different from those of freshwater.
- Freshwater has a maximum density of 1.00g/cm^3
- Salts add to the mass of water which increases its density with salinity.

Salinity and Density

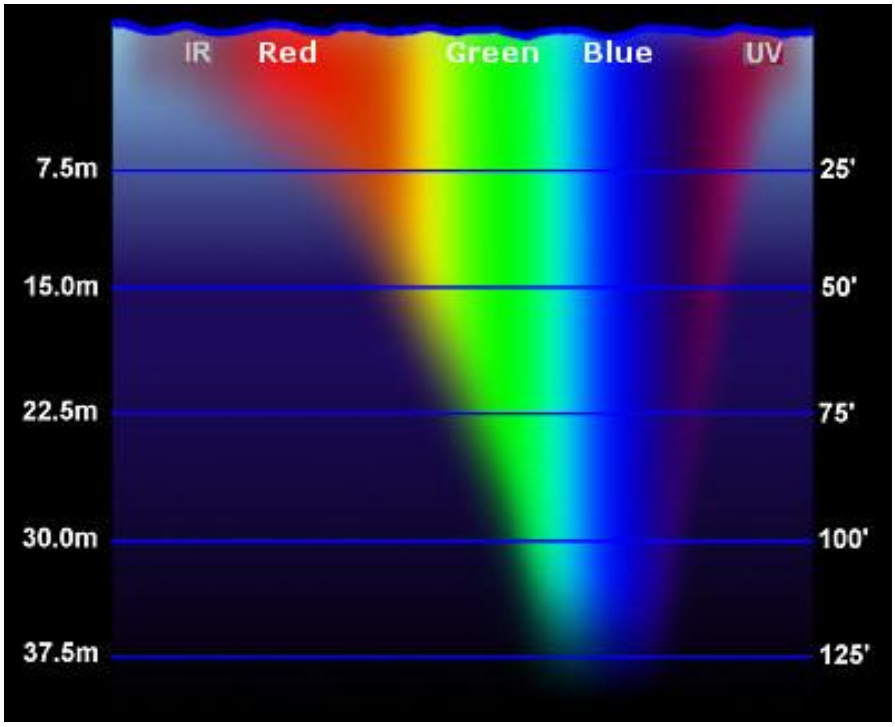
- Temperature also affects density.
- Cold water is more dense than warm water.
- Because of salinity and temperature, the density of seawater ranges from 1.02g/cm^3 to 1.03g/cm^3

Freezing Point

- Variations in salinity also cause the freezing point of seawater to be somewhat lower than that of freshwater.
- Freshwater freezes at 0°C.
- Because salt ions interfere with the formation of ice, seawater has a freezing point of -2°C.

Absorption of Light

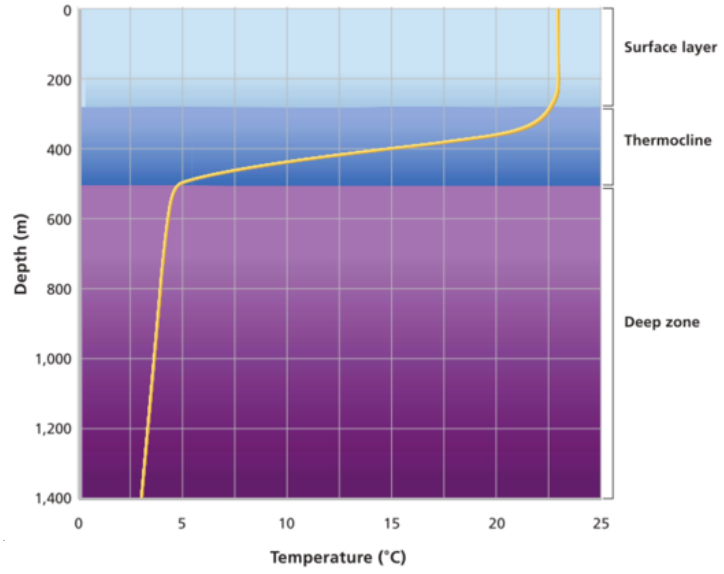
- Water absorbs light, which gives rise to the physical property of oceans – darkness.
- Red light does not penetrate as far as blue light.
- Photosynthesis can only occur in the top 100m of the ocean.



Ocean Layering

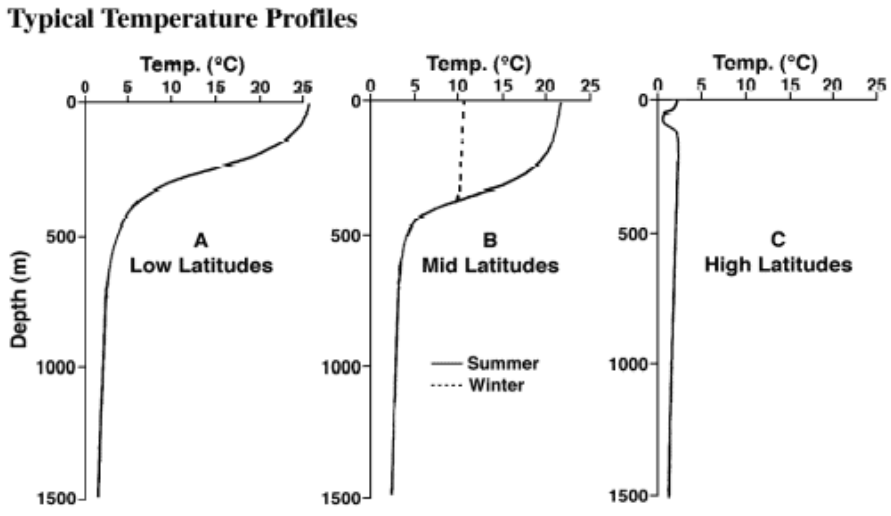
- Surface temperatures range from -2°C in polar waters to 30°C in equatorial regions.
- Ocean water temperatures decrease significantly with depth.
- Deep ocean water is always cold, even in tropical oceans.

Ocean Layering



Ocean Layering

- Temperature profiles plot changing water temperatures with depth.
- Based on temperature profiles, the ocean is divided into three layers.



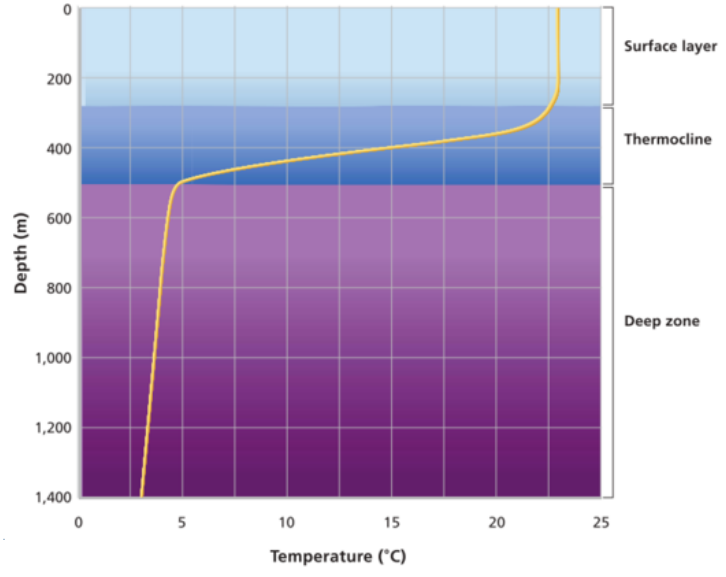
Ocean Layering

- The first layer is the relatively warm, sunlight **surface layer** approximately 100m thick. (also called the mixed layer)
- Under the surface is the transitional layer known as the **thermocline,** characterized by rapidly decreasing temperatures with depth

Ocean Layering

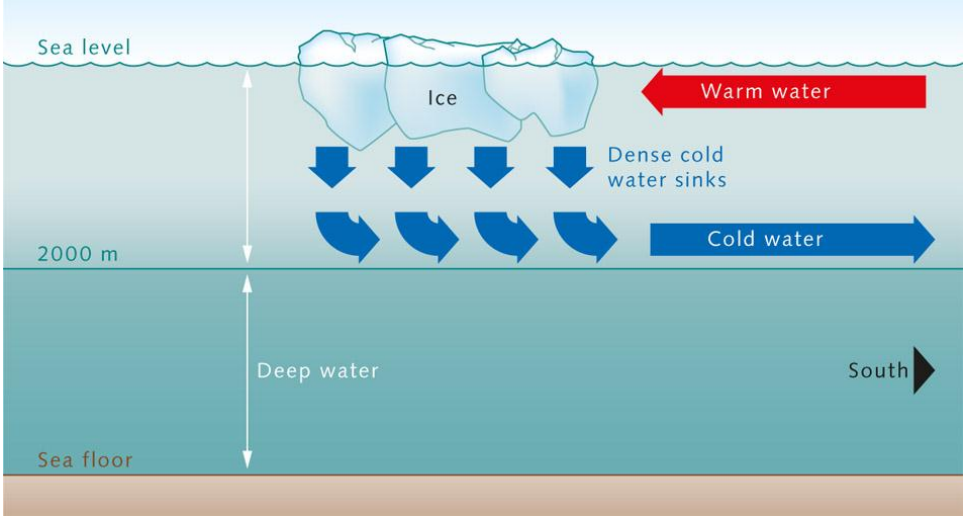
- The **bottom layer** (or deep zone), is cold and dark with temperatures near freezing.
- In general, ocean layering is caused by density differences.
- Cold water which is more dense sinks to the bottom.

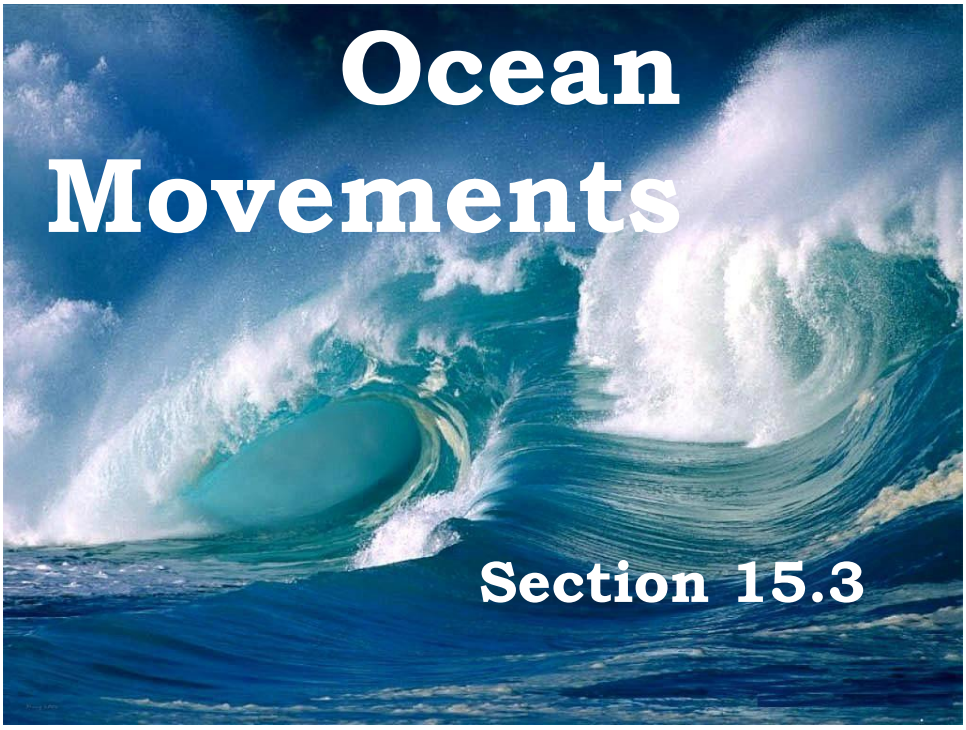
Ocean Layering



Water Masses

- The temperature of the bottom layer of ocean water is near freezing. This is true even in tropical regions.
- Cold water comes from Earth's polar oceans, which is also higher in salinity.
- Dense polar water sinks, producing a deepwater mass.





Objectives

- Describe the physical properties of waves
- Explain how tides form
- Compare and contrast various ocean currents.

New Vocabulary

- Wave
- Crest
- Trough
- Breaker
- Tide
- Spring Tide
- Neap Tide
- Surface Current
- Upwelling
- Density Current

Waves:

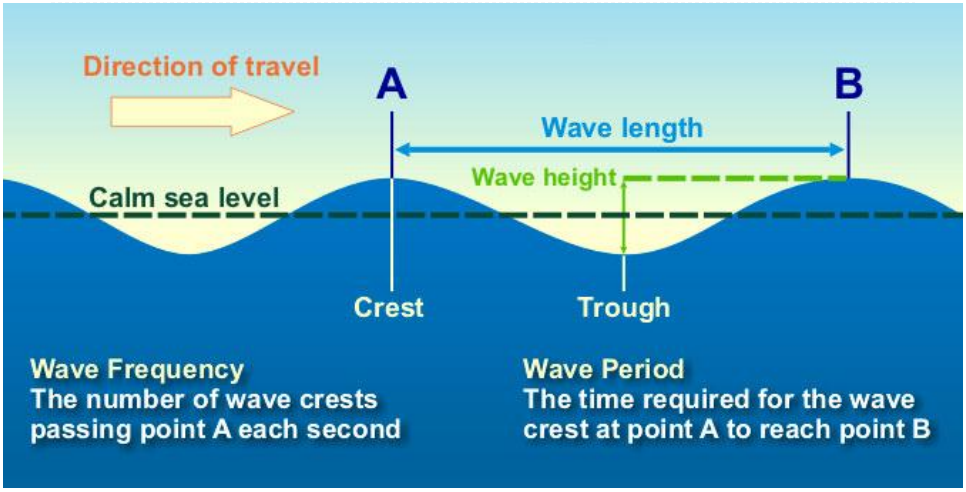
- Oceans are in constant motion
- Their most obvious movement is that of waves.
- A **wave** is a rhythmic movement that carries energy through space or matter – In this case, ocean water.

Waves:

- The highest point of a wave is the crest, and the lowest point is the trough.
- The vertical distance between crest and trough is the wave height.

Waves:

- The horizontal crest-to-crest distance is the wavelength.
- λ = wavelength



Wave Height:

- Wave height depends on three factors:
  - **Fetch**
  - **Wind duration**
  - **Wind speed**

Wave Height:

- Fetch refers to the expanse of water the wind blows across.
  (surface area of water)

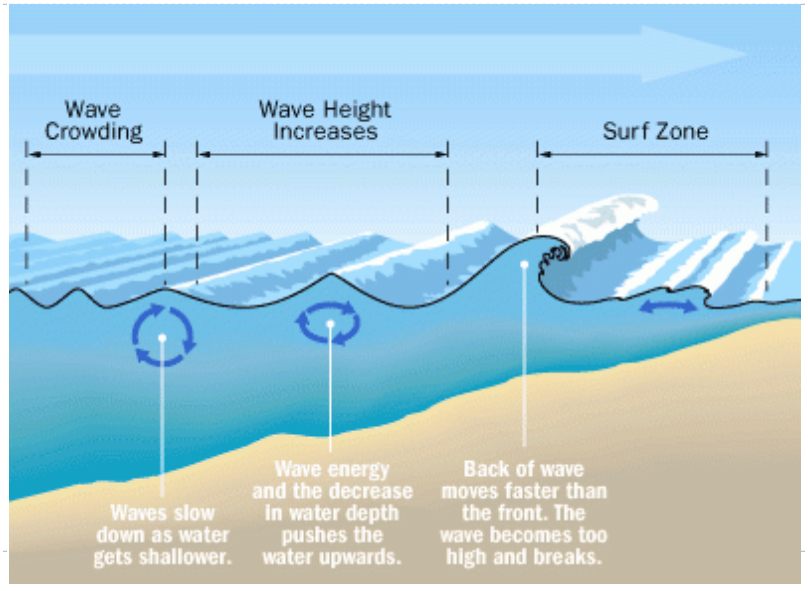
Wave Height:

- Wind duration is the length of time wind can blow across the surface of the water without being interrupted.

Breaking Waves:

- As waves approach the shore, the wave gets taller and the back of the wave moves faster than the front, causing the wave to collapse.
- These waves are called breakers.

Breaking Waves



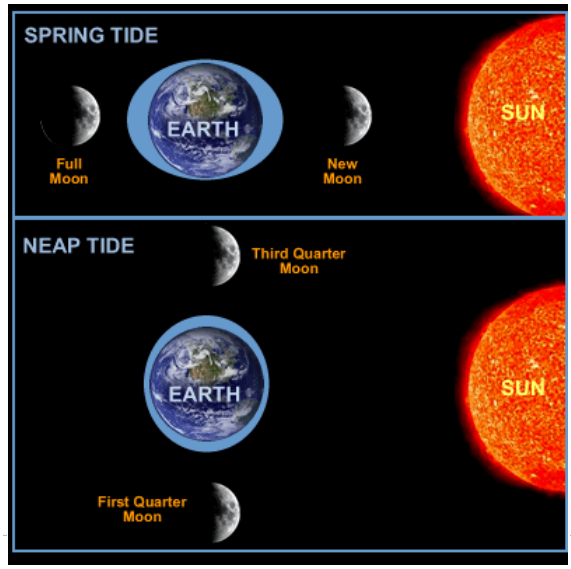
Bell Ringer:

- What are tides?
- What causes Earth to have tides?

Tides:

- The Sun and the Moon both contribute to Earth's tides by their gravitational pull which creates bulges of ocean water.
- **Tides** are observed every 12 hours as the Earth rotates and the Moon orbits the Earth.

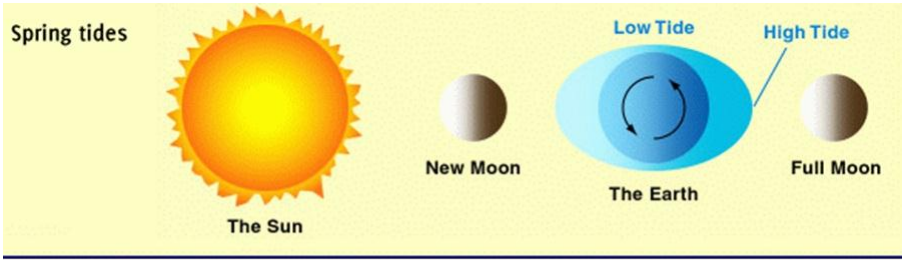
Spring and Neap Tides:



Spring Tide:

- When the Sun, the Moon, and Earth are all aligned, high tides are higher than normal, and low tides are lower than normal.
- These types of tides are called **Spring Tides.**

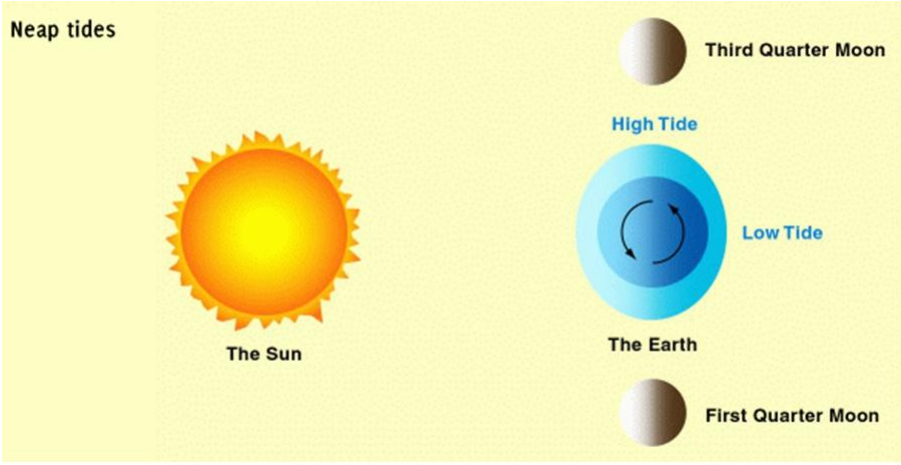
Spring Tide:



Neap Tide:

- When the Sun, the Moon, and Earth form a right angle during a first or third-quarter moon, high tides are lower than normal, and low tides are higher than normal.
- These types of tides are called **Neap Tides.**

Neap Tide:



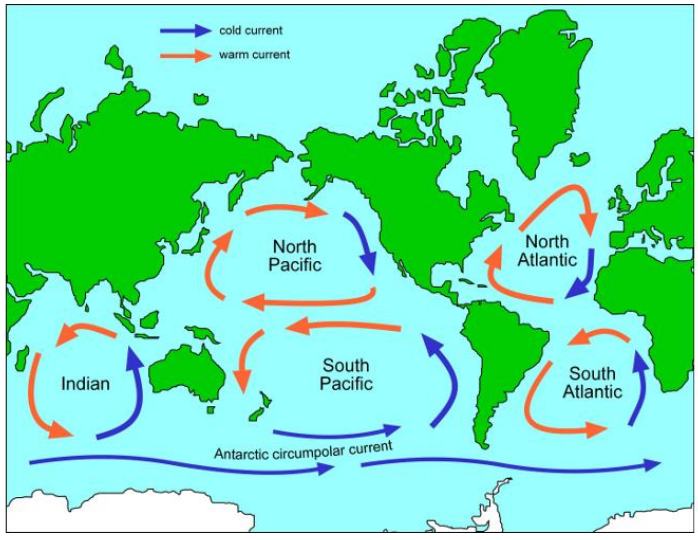
Currents:

- Currents in the ocean can move horizontally or vertically.
- They can also move at the surface or deep in the ocean.
- Currents at the surface are usually generated by wind.
- Deep ocean currents are the result from differences in density between water masses.

Surface Currents:

- The top 100 to 200 m of the ocean experience surface currents, which can move at a speed of 100km/day.
- **Surface currents** are driven by Earth's global wind system.

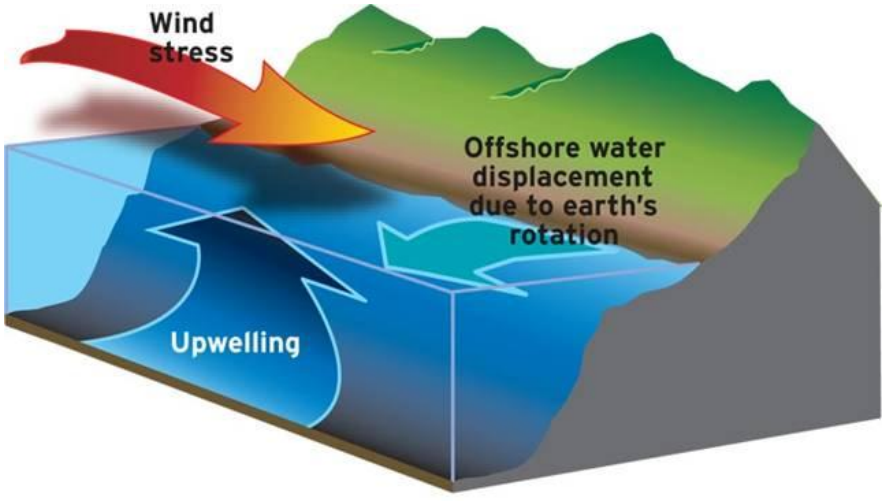
Ocean Gyres:



Upwelling:

- In addition to moving horizontally, ocean water moved vertically.
- The upward motion of ocean water is called **upwelling**.
- Upwelling waters originate in deeper waters, below the thermocline, and thus are usually cold.

Upwelling:



Density Currents:

- The sinking of Antarctic water is an example of an ocean current.
- In this case the current is called a **density current** because it is caused by a difference in temperature and salinity of ocean water.

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- What geologic process released large amounts of water vapor into Earth's early atmosphere?
  A. precipitation as ice, water, or snow
  B. melting of glacial ice
  C. movement of ocean currents
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