Earth Science

Chapter 20

Section 1 - Properties of Ocean Water

E.Q.: *What is the chemical composition and characteristics of ocean water.*

STANDARDS:

SES1.e. Identify the transformations and major reservoirs that make up the rock cycle, hydrologic cycle, carbon cycle, and other important geochemical cycles.

SES6. Students will explain how life on Earth responds to and shapes Earth systems.

a. Relate the nature and distribution of life on Earth, including humans, to the chemistry and availability of water.

Objectives

- **Describe the chemical composition of ocean water.**
- **Describe the salinity, temperature, density, and color of ocean water.**

Properties of Ocean Water

- **Ocean water is a complex mixture of chemicals that sustains a variety of plant and animal life.**
- **Scientists describe ocean water by using a variety of properties, such as the presence of dissolved gases and the presence of dissolved solids, salinity, temperature, density, and color.**

Dissolved Gases

- **While carbon dioxide, CO_2, is not a major component of the atmosphere, a large amount of this gas is dissolved in ocean water.**
- **Other atmospheric gases are also present in the ocean in small amounts.**

Gases can enter the ocean from streams, volcanoes, organisms, and the atmosphere.

Seawater has many different gases dissolved in it, especially nitrogen, oxygen and carbon dioxide. It exchanges these gases with the atmosphere to keep a balance

between the ocean and the atmosphere. This exchange is helped by the mixing of the surface by wind and waves.

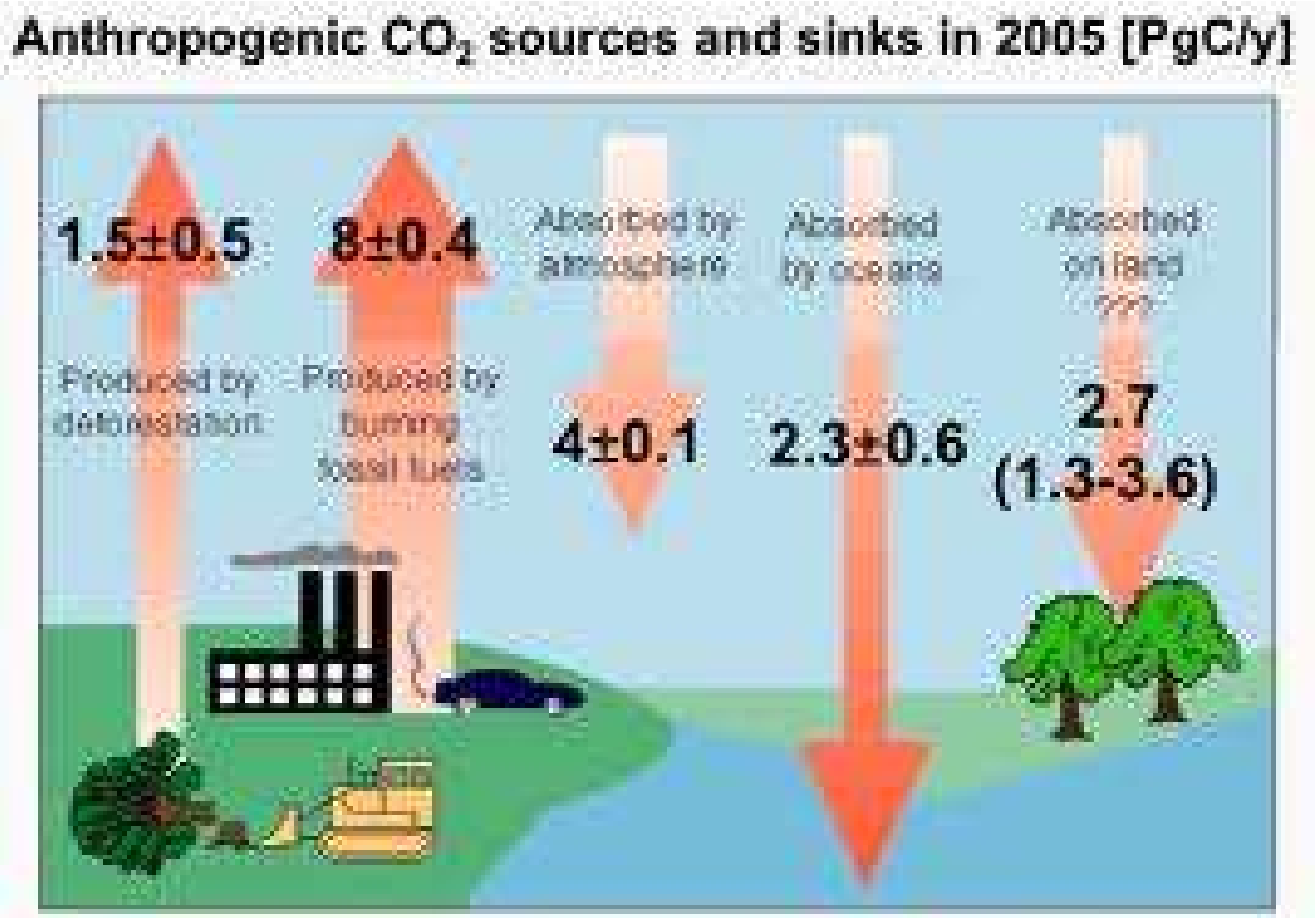
Effects of increasing carbon dioxide and temperature on coral reefs.

Temperature and Dissolved Gases

- **Gases dissolve more readily in cold water than in warm water.**
- **If the water temperature rises, less gas will remain dissolved, and the excess gas will be released into the atmosphere.**
- **Therefore, the ocean and the atmosphere are continuously exchanging gases as water temperatures change.**

The Oceans as a Carbon Sink

- **Oceans contain more than 60 times as much carbon as the atmosphere does.**
- **Dissolved CO_2 may be trapped in the oceans for hundreds to thousands of years.**
- **Because of this ability to dissolve and contain a large amount of CO_2, the oceans are commonly referred to as a *carbon sink*.**



Dissolved Solids

- **Ocean water is 96.5% pure water, or H_2O.**
- **Dissolved solids make up about 3.5% of the mass of ocean water.**
- **These dissolved solids, commonly called *sea salts*, give the ocean its salty taste.**

Most Abundant Elements

- **The six most abundant elements in ocean water are chlorine, sodium, magnesium, sulfur, calcium, and potassium.**
- **The salt halite, which is made of sodium and chloride ions, makes up more than 85% of the ocean's dissolved solids.**
- ***Trace elements* are elements that exist in very small amounts.**

chlorine *- a chemical element with an atomic number of 17, a toxic, irritant, pale green gas.*
sodium *- a chemical element with an atomic number of 11, a soft silver-white reactive metal of the alkali metal group*
magnesium *- a chemical element with an atomic number of 12,. an alkaline earth metal and the eighth most abundant element in the Earth's crust*


chlorine *sodium* *magnesium*

sulfur *- a chemical element with an atomic number of 16, a pale yellow, odorless, brittle nonmetallic material - smells bad when mixed with some other materials*
calcium *- a chemical element with an atomic number of 20, a soft, grey alkaline metal and the fifth most-abundant element in Earth's crust*
potassium *- a chemical element with an atomic number of 19, a soft silvery-white alkali metal that is reactive with water*



sulfur *calcium* *potassium*

- **Sources of Dissolved Solids**
- **Most of the elements that form sea salts come from three main sources—volcanic eruptions, chemical weathering of rock on land, and chemical reactions between sea water and newly formed sea-floor rocks.**

- **Each year, rivers carry about 400 billion kilograms of dissolved solids into the ocean.**
- **As water evaporates from the ocean, salts and other minerals remain in the ocean.**

READING CHECK

How do dissolved solids enter the ocean?

Dissolved solids enter the oceans from the chemical weathering of rock on land, from volcanic eruptions, and from chemical reactions between sea water and newly formed sea-floor rocks.

Salinity of Ocean Water

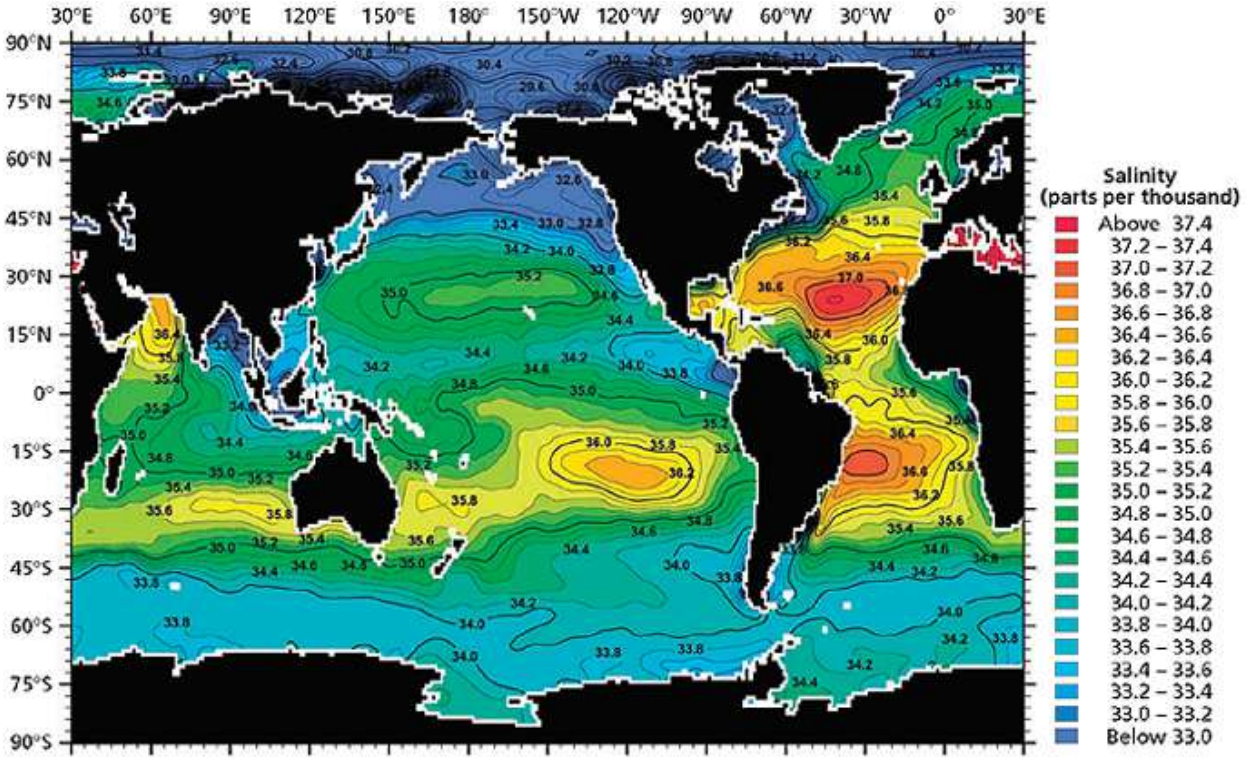
salinity **- a measure of the amount of dissolved salts in a given amount of liquid**

- **One of the biggest differences between ocean water and fresh water is the high concentration of salts in ocean water.**
- **Salinity is measured by the number of grams of dissolved solids in 1,000 g of ocean water.**
- **The ocean is about 3.5% salts. However, fresh water is less than 0.1% salt or has a salinity of 1‰.**

Factors that Change Salinity

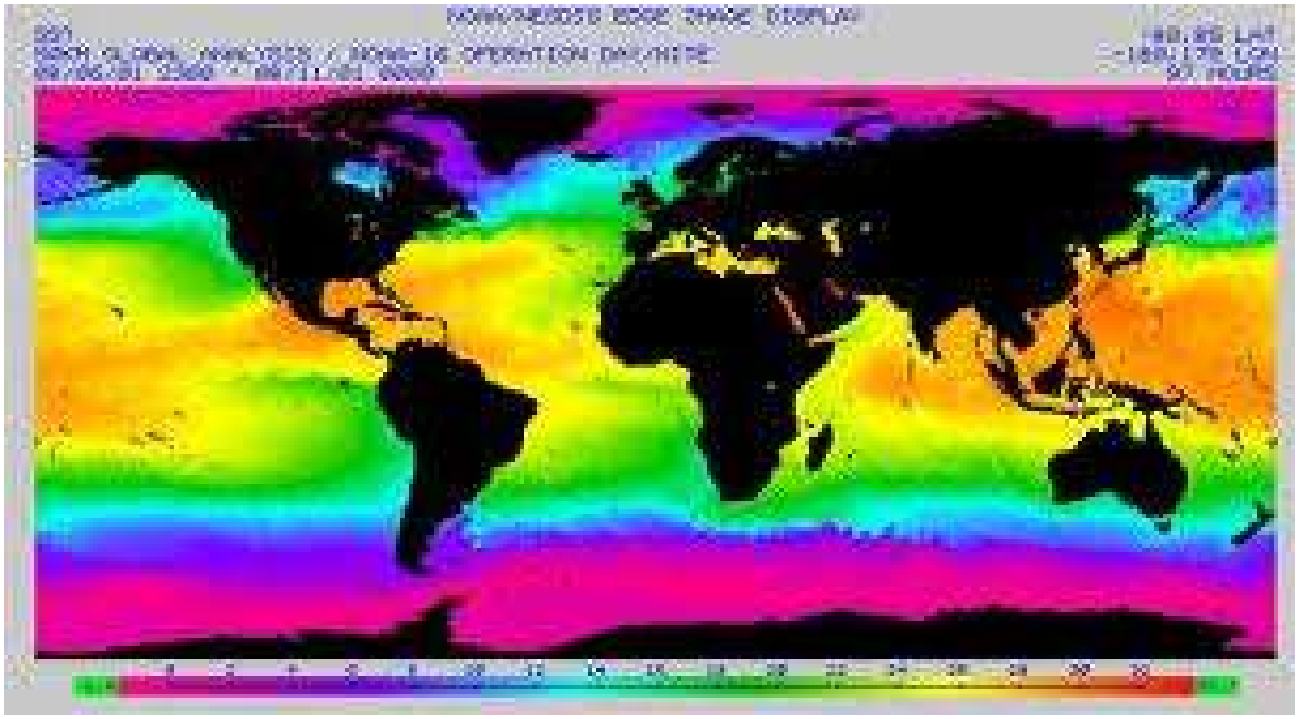
- **Where the rate of evaporation is high, the salinity of surface water increases.**
- **Therefore, tropical waters have a higher salinity at the surface than polar waters do. Salinity also decreases as depth increases.**
- **Over most of the surface of the ocean, salinity ranges from 33‰ to 36‰.**
- **Salinity at particular locations can vary greatly.**

The diagram below shows the surface salinity of the global ocean.



Temperature of Ocean Water

- **Like ocean salinity, ocean temperature varies depending on depth and location on the surface of the oceans.**
- **The range of ocean temperatures is affected by the amount of solar energy an area receives and by the movement of water in the ocean.**



Surface Water

- **The mixing of the ocean's surface water distributes heat downward to a depth of 100 to 300 m.**
- **The temperature of surface water does decrease as latitude increases. Therefore, polar surface waters are much cooler than the surface waters in the Tropics.**

pack ice **- a floating layer of sea ice that completely covers an area of the ocean surface**

- **Usually, pack ice is no more than 5 m thick because the ice insulates the water below and prevents it from freezing.**
- **In the middle latitudes, the ocean surface temperature varies depending on the seasons.**

pack ice in Antarctica

READING CHECK

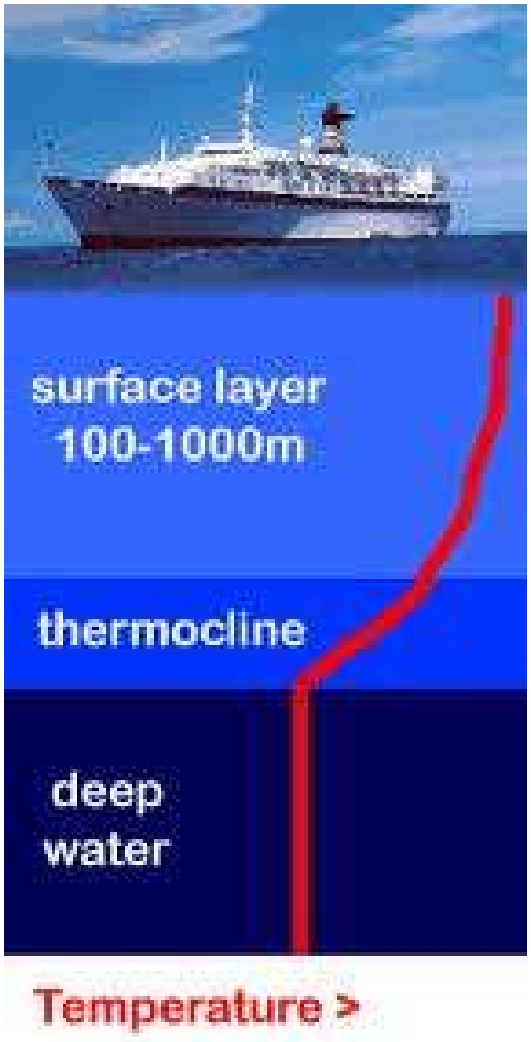
What factors affect the surface temperature of the ocean?

Ocean surface temperatures are affected by the amount of solar energy an area receives and by the movement of water in the ocean.

The Thermocline

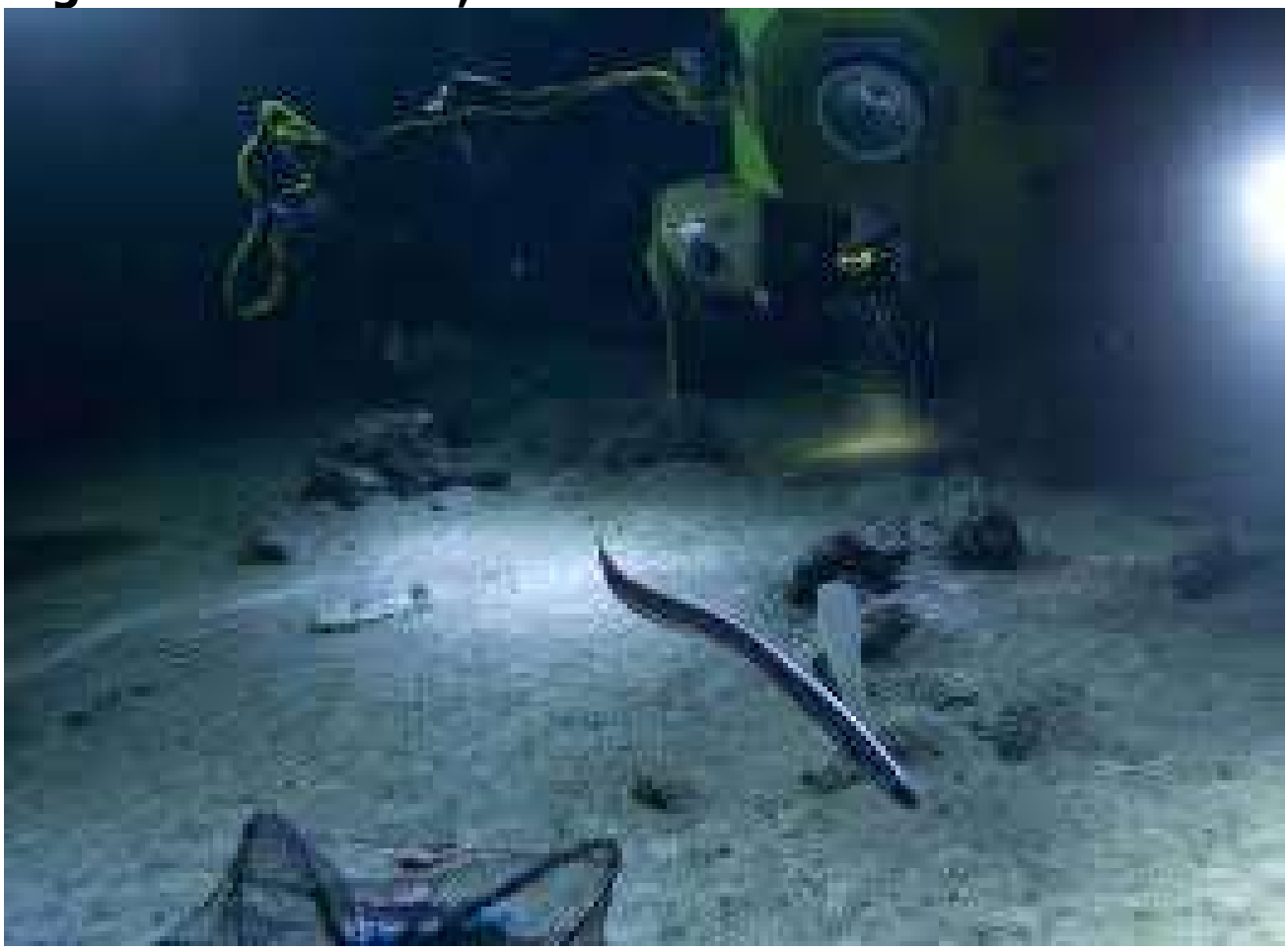
thermocline **- a layer in a body of water in which water temperature drops with increased depth faster than it does in other layers**

- **The thermocline exists because the water near the surface becomes less dense as energy from the sun warms the water.**
- **A thermocline marks the distinct separation between the warm surface water and the cold surface water.**



Deep Water

- **In the deep zones of the ocean, the temperature of the water is usually about 2°C.**
- **The colder the water is, the denser it is. The density of cold, deep water controls the slow movement of deep ocean currents.**
- **Cold, deep ocean water also holds more dissolved gases than warm, shallow ocean water does.**



April, 2012 - James Cameron deep-diving team sea dive photo

Density of Ocean Water

density the ratio of the mass of a substance to the volume of the substance; commonly expressed as grams per cubic centimeter for solids and liquids and as grams per liter for gases

- **Two factors affect the density of ocean water: salinity and the temperature of the water.**
- **Dissolved solids, which are mainly salts, add mass to the water. The large amount of dissolved solids in ocean water makes it denser than pure fresh water.**
- **Ocean water becomes denser as it becomes colder and less dense as it becomes warmer.**
- **Water temperature affects the density of ocean water more than salinity does.**
- **Therefore, the densest ocean water is found in the polar regions, where the ocean surface is the coldest. This cold, dense water sinks and moves through the ocean basins near the ocean floor.**

READING CHECK

Explain why ocean water is denser than fresh water.

Ocean water contains dissolved solids (mostly salts) that add mass to a given volume of water. The large amount of dissolved solids in ocean water makes ocean water denser than fresh water.

Color of Ocean Water

- **The color of ocean water is determined by the way it absorbs or reflects sunlight.**
- **Much of the sunlight penetrates the surface of the ocean and is absorbed by the water.**
- **Only the blue wavelength tends to be reflected. The reflection of this blue light makes ocean water appear blue.**

Honolulu Star-Bulletin/Associated Press

Why is Ocean Color Important

- **Substances or organisms in ocean water, such as phytoplankton, can affect the color of the water.**
- **Phytoplankton absorb red and blue light, but reflect green light.**

- **Because phytoplankton require nutrients, the presence or absence of phytoplankton can indicate the health of the ocean.**

Belugas underwater – ocean life