

Section 1

Earth's Oceans

Key Concept The characteristics of ocean water, such as temperature and salinity, affect the circulation of the ocean.

What You Will Learn

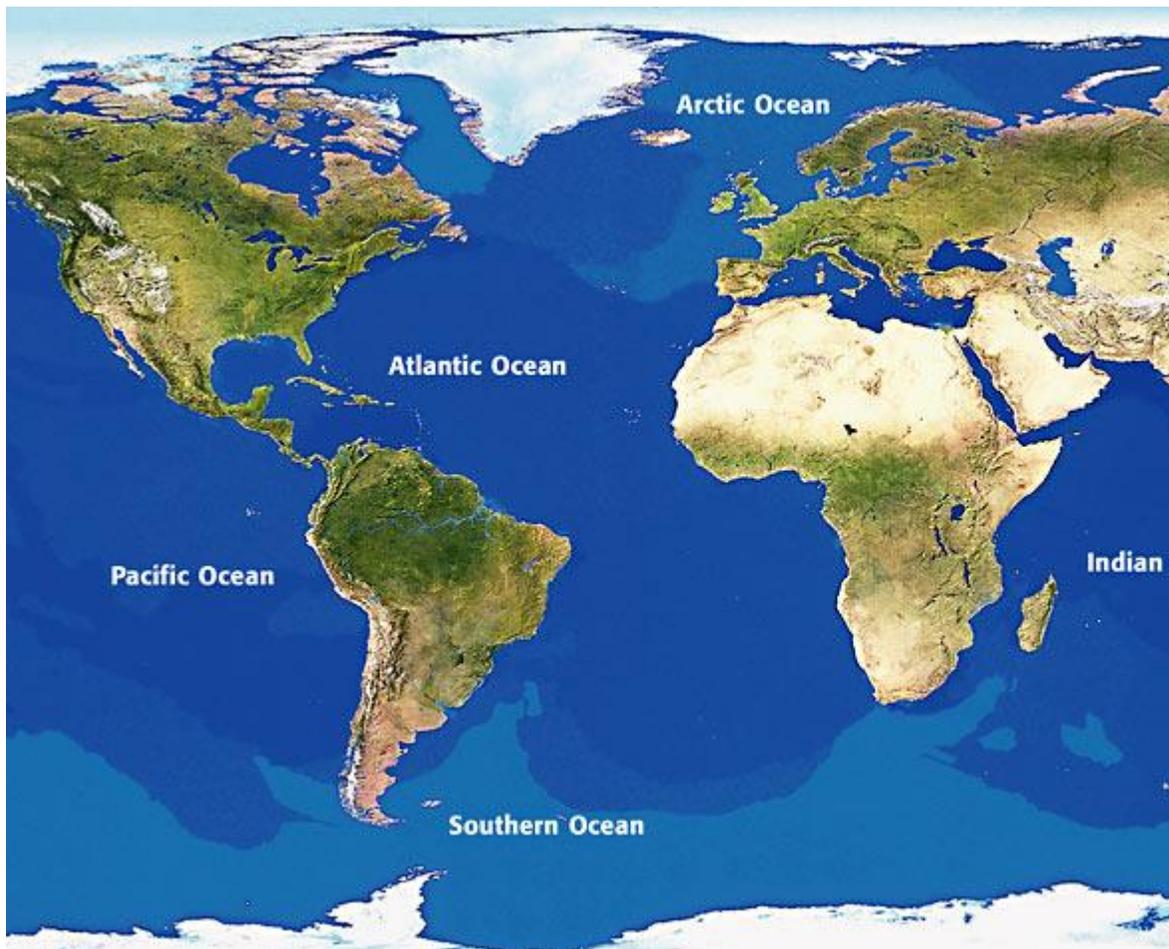
- Ocean water contains dissolved solids that make the water salty.
- The temperature of ocean water varies with depth, latitude, and movement of the water.

Why It Matters

The global ocean's temperature and salinity affect climate and life on Earth.

Earth is unique in our solar system because 71% of its surface is covered with liquid water. Most of Earth's water is in the *global ocean*. The global ocean is divided by the continents into five main oceans. These five main oceans are shown in **Figure 1**. The global ocean has characteristics that play an important role in regulating Earth's climate.

Figure 1 Parts of the Global Ocean



Divisions of the Global Ocean

The largest ocean is the *Pacific Ocean*. It lies between Asia and the Americas. The volume of the *Atlantic Ocean*, the second-largest ocean, is about half the volume of the Pacific. The *Indian Ocean* is the third-largest ocean. It is located between Africa and Australia. The *Arctic Ocean* is the smallest ocean. This ocean is unique because much of its surface is covered by ice. The *Southern Ocean* extends from the coast of Antarctica to 60° south latitude.



Characteristics of Ocean Water

Ocean water is different from the water that flows from your sink at home. For one thing, you can't drink ocean water. It is too salty and doesn't taste very good. But there are other things that make ocean water special.

Ocean Water Is Salty

Have you ever swallowed water while swimming in the ocean? It tasted really salty, didn't it? Most of the salt in the ocean is the same kind of salt that we sprinkle on our food. This salt is called *sodium chloride*. This compound consists of the elements sodium, Na, and chlorine, Cl. There are many other dissolved solids in ocean water, such as magnesium and calcium. **Figure 2** shows the relative amounts of the dissolved solids in ocean water.

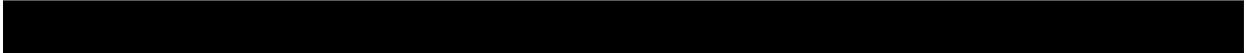


Figure 2 This pie graph shows the relative percentages of dissolved solids (by mass) in ocean water.

Salts have collected in the ocean for billions of years. As rivers and streams flow toward the ocean, they dissolve minerals from the land. The running water carries these dissolved minerals to the ocean. At the same time, water is *evaporating* from the ocean. As the water evaporates, it leaves the dissolved solids behind. The most abundant dissolved solid in the ocean is sodium chloride.

Salinity

A measure of the amount of dissolved solids in a given amount of liquid is called **salinity**. Salinity is usually measured as grams of dissolved solids per kilogram of water. Every 1 kg (1,000 g) of ocean water has 35 g of dissolved solids in it. Therefore, if you evaporated 1 kg of ocean water, 965 g of fresh water would be removed and 35 g of solids would remain.



Climate Affects Salinity

Some parts of the ocean are saltier than others, as shown in **Figure 3**. In places that have hotter, drier climates, salinity is usually higher. In these areas, the evaporation rate is high because the temperatures are high. Evaporation removes water but leaves salts and other dissolved solids behind. The salinity of the Red Sea is very high because the hot, dry climate around the Red Sea causes a high rate of evaporation.

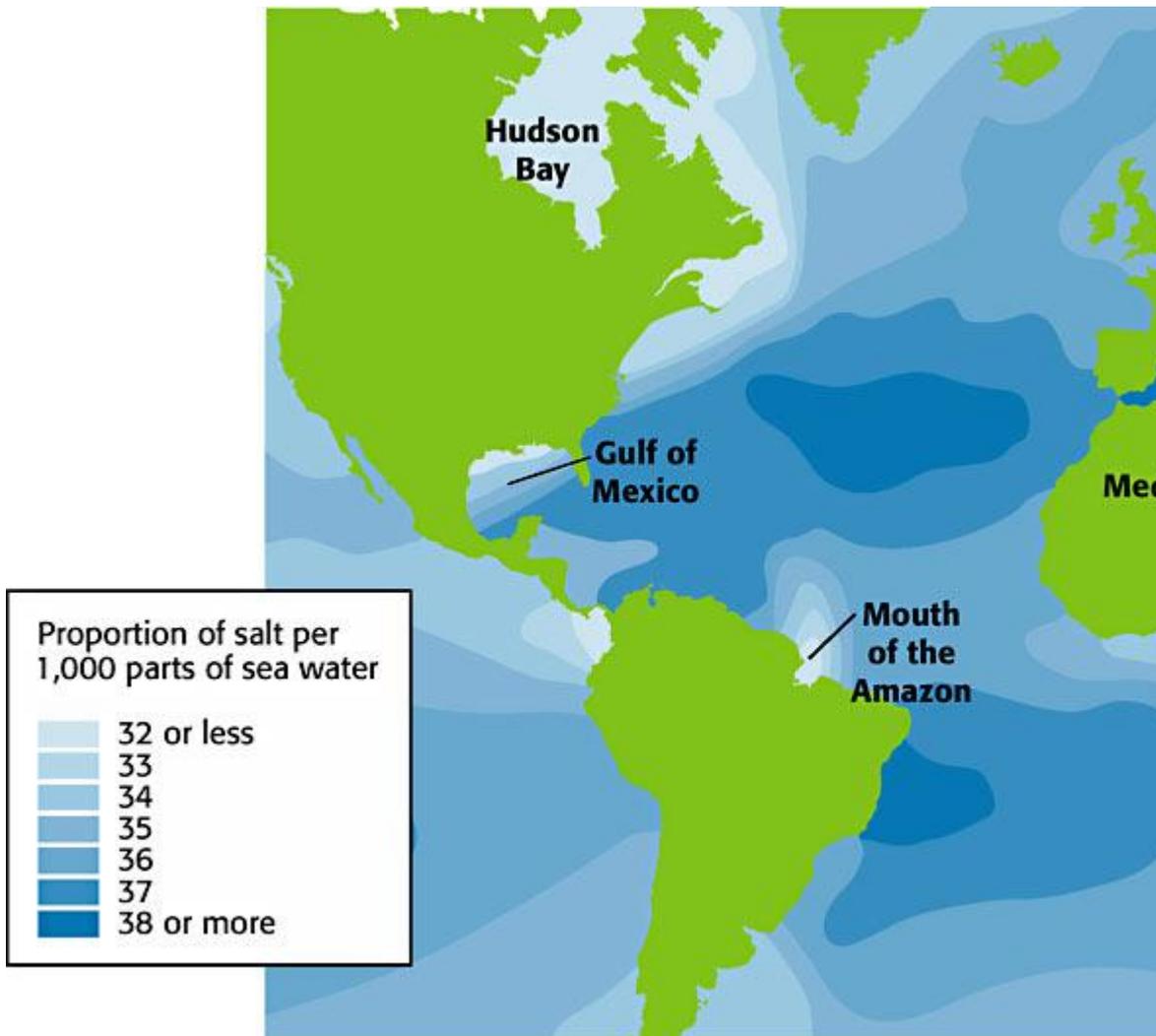


Figure 3 Salinity varies in different parts of the ocean because of variations in evaporation, circulation, and fresh water inflow. **Does the area of the ocean near the mouth of the Amazon have a high or low salinity? Explain your answer.** Coastal waters commonly have lower salinity than waters farther offshore. Fresh water from streams and rivers on land runs into the ocean in these areas. As the fresh water mixes with the ocean water, the concentration of salts in the ocean water decreases. The mouth of the Amazon is one such location, as shown in **Figure 3**.

Water Movement Affects Salinity

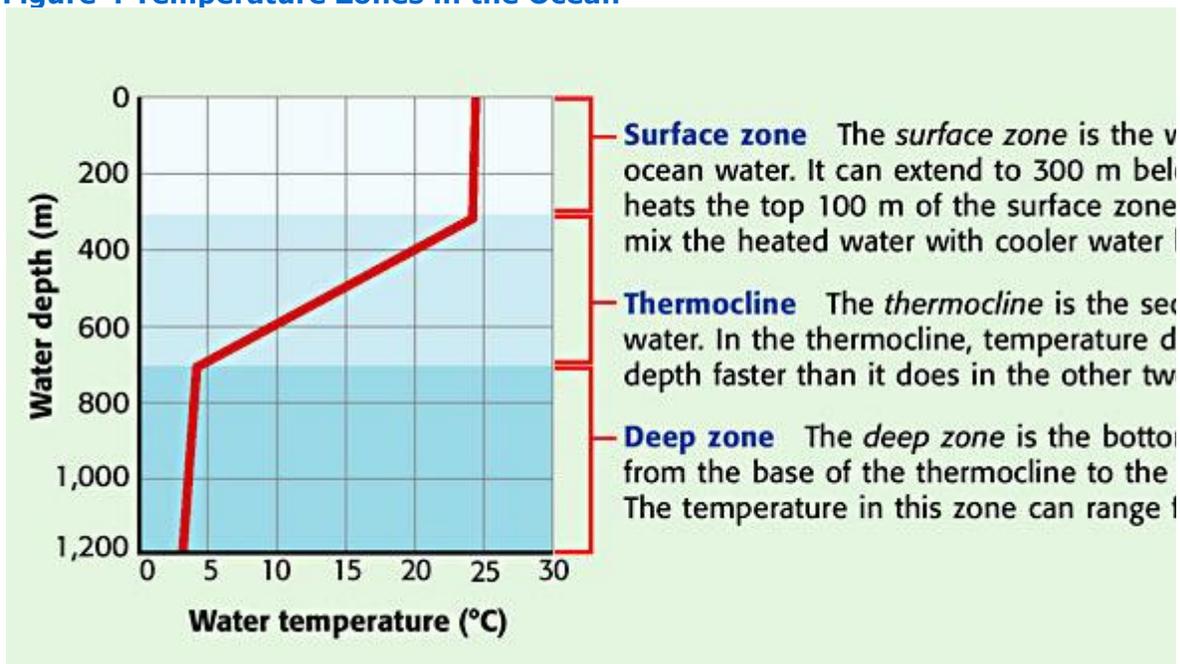
Another factor that affects ocean salinity is water movement. Slower-moving areas of water develop higher salinity. Some parts of the ocean, such as bays, gulfs, and seas, move less than other parts do. Parts of the open ocean that do not have currents running through them can also be slow moving. In **Figure 3**, identify the areas that

are most likely to have slower-moving water.

Temperature of Ocean Water

The temperature of ocean water decreases as depth increases. However, this temperature change is not uniform. Water in the ocean can be divided into three layers by temperature. Those three layers are the surface zone, the thermocline, and the deep zone, as shown in **Figure 4**.

Figure 4 Temperature Zones in the Ocean



Surface Zone

The *surface zone*, or top layer of ocean water, is heated by the sun's energy. Heated ocean water becomes less dense and rises above the denser, cool water. This movement of water caused by differences in density forms convection currents. The convection currents distribute heat in the surface zone down to a depth of about 100 m to 300 m. The convection currents distribute the heat until the temperature is fairly uniform throughout the surface zone.

Standards Check How is heat distributed in the surface zone of the ocean?



Thermocline

The sun cannot directly heat ocean water below the surface zone. And the heated, less dense water of the surface zone cannot easily mix with the cold, dense water below. Therefore, below the surface zone, the temperature of the water decreases sharply as depth increases. The layer of the ocean in which temperature drops with increased depth faster than it does in other layers is called the **thermocline**. The thermocline's depth varies in different parts of the ocean. However, it may extend between 100 m and 1000 m below the ocean's surface.

Deep Zone

The layer of the ocean directly below the thermocline is called the *deep zone*. In the deep zone 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. This movement begins when the cold, dense water at the poles sinks and flows beneath warm water.

Surface Temperature Changes

Surface temperatures of different parts of the ocean are different depending on the latitude. Water along the equator is warmer because it receives more direct sunlight than water closer to the poles does. At low latitudes, ocean surface temperatures can be as high as 30°C. But in the polar oceans, temperatures of the ocean surface can be as low as -1.9°C!

The temperature of surface water also changes depending on the time of the year. The ocean surface at higher latitudes receives more direct sunlight during the summer season than during the winter season. Therefore, during summer, the

surface water is warmer. For this reason, the Maine beach shown in **Figure 5** is crowded during the summer.



Figure 5 People in Maine enjoy swimming in the ocean during the summer because the water is warmer during the summer.

Density

Salinity and temperature affect the density of ocean water. The large amount of dissolved solids in ocean water makes ocean water denser than pure fresh water. Ocean water also becomes denser as it becomes colder. 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 coldest. Differences in density throughout the global ocean drive the circulation of ocean water, which distributes heat in the ocean.

Standards Check What factors affect the circulation of ocean water?



Section Summary

- The global ocean is divided by the continents into five main oceans: Pacific Ocean, Atlantic Ocean, Indian Ocean, Southern Ocean, and Arctic Ocean.
- Salts have collected in the ocean for billions of years. Salinity is a measure of the amount of dissolved salts in a given mass of liquid.
- The three temperature zones of ocean water are the surface zone, the thermocline, and the deep zone.
- Temperature and salinity determine the density of ocean water. The density of ocean water drives convection currents.

