

Earth's Oceans

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What affects the salinity of ocean water?
- What affects the temperature of ocean water?
- How does the ocean affect air temperatures?

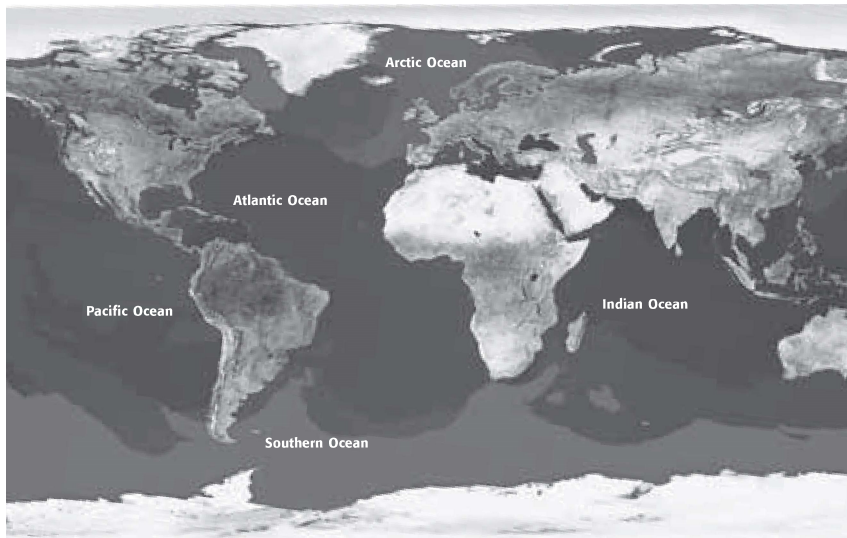
National Science Education Standards

ES 1b, 1f, 1g, 1h, 1j, 2a

What Is the Global Ocean?

Earth has more liquid water on its surface than any other planet in the solar system. In fact, 71% of Earth's surface is covered by liquid water. Most of Earth's water is found in its oceans. There are five main oceans on Earth. However, the oceans are all connected to each other. Therefore, scientists often refer to all the oceans on Earth as the *global ocean*.

The continents divide the global ocean into the five main oceans. The largest ocean is the *Pacific Ocean*. The *Atlantic Ocean* is the second largest ocean. It has half the volume of the *Pacific Ocean*. The *Indian Ocean* is the third largest ocean. The *Southern Ocean* extends from the coast of Antarctica to 60°S latitude. The *Arctic Ocean* is the smallest ocean. Much of its surface is covered by ice. The figure below shows where these oceans are found. ✓



STUDY TIP

Ask Questions As you read this section, write down any questions you have. After you read, discuss your questions in a small group.

READING CHECK

1. Describe What divides the global ocean into five parts?

TAKE A LOOK

2. Identify What are the five main oceans?

SECTION 1 Earth's Oceans *continued*

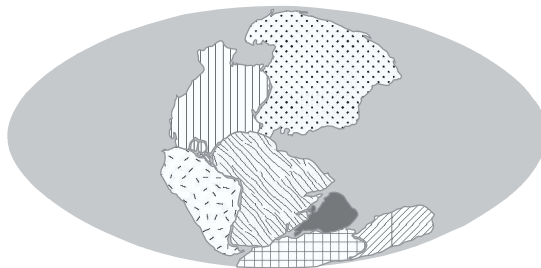
How Did The Oceans Form?

Soon after the Earth formed, it was very different than it is today. There were no oceans. Volcanoes produced large amounts of ash, dust, and gases, including water vapor. These gases began to form the atmosphere. Slowly, Earth cooled. By about 4 billion years ago, the temperature was low enough for the water vapor in the atmosphere to condense. The liquid water fell as rain. The rain filled the basins in Earth's surface, and the first oceans formed. ✓

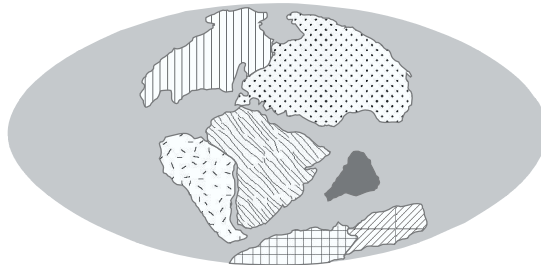
READING CHECK

3. Identify Where did some of the gases that formed Earth's atmosphere come from?

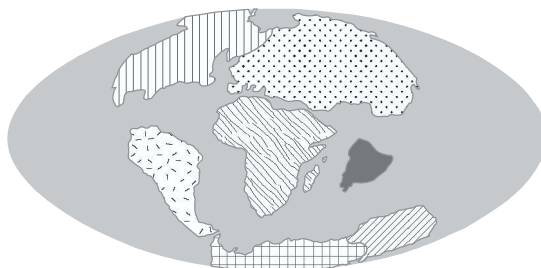
Plate tectonics has caused the shapes and locations of Earth's oceans to change over time.



About 245 million years ago, the continents were joined into one large land mass. The oceans were one large body of water.



By about 180 million years ago, the continents had started to break apart. The North Atlantic Ocean and the Indian Ocean began to form.



By about 65 million years ago, most of the Atlantic Ocean had formed. However, the South Atlantic Ocean was much narrower than it is today.



Today, the continents are still moving slowly, about 1 to 10 cm per year. The Pacific Ocean is getting smaller. However, many of the other oceans are growing.

STANDARDS CHECK

ES 1b Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building result from these plate motions.

Word Help: response
an action brought on by another action; a reaction

Word Help: major
of great importance or large scale

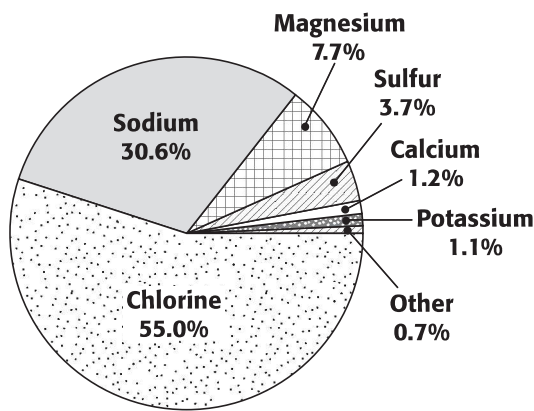
4. Explain Why have the shapes and locations of the oceans changed with time?

SECTION 1 Earth's Oceans *continued*

Why Is Ocean Water Salty?

Ocean water is different from the water that we drink. People cannot use ocean water for drinking because it is salty.

Most of the salt in the ocean is the same kind of salt we use on our food. This type of salt is called sodium chloride. It is a compound made from the elements sodium, Na, and chlorine, Cl. Ocean water also contains other dissolved solids, including magnesium and calcium. These dissolved solids make the water taste salty.



This graph shows the amounts of different kinds of solids in ocean water.

Math Focus

5. Read a Graph Which two elements make up most of the dissolved solids in sea water?

As rivers and streams flow toward the ocean, they dissolve minerals from rocks and soil. These minerals include halite (sodium chloride) and calcite (calcium carbonate). The rivers carry the dissolved minerals to the ocean. At the same time, liquid water in the oceans evaporates to form water vapor. As the water evaporates, it leaves behind the minerals that were dissolved in it. ✓

What Is Salinity?

Salinity is a measure of the amount of solid material that is dissolved in a certain amount of liquid. It is usually measured as grams of dissolved solids per kilogram. On average, ocean water has 35 g/kg of dissolved solids in it. This means that 1 kg of ocean water has about 35 g of solids dissolved in it. If you evaporated 1 kg of ocean water, 35 g of solids would remain.

READING CHECK

6. Identify Where does most of the salt in the ocean come from?

SECTION 1 Earth's Oceans *continued*

EFFECTS OF LOCATION ON SALINITY

Some parts of the ocean are saltier than others. Most oceans in hot, dry climates have high salinities. In these areas, the hot weather causes water to evaporate quickly. Salt is left behind. For example, the Red Sea in the Middle East is very salty. The climate there is very hot and dry. ✓

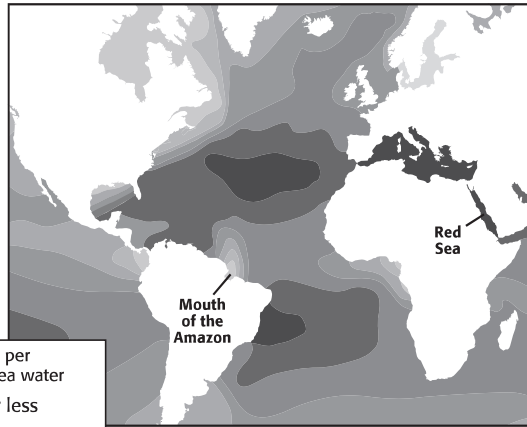
Some parts of the ocean are less salty than others. Along the coastlines, fresh water from streams and rivers runs into the ocean. As fresh water mixes with ocean water, the salinity of the ocean water decreases. For example, the salinity of the ocean waters near the Amazon River is much lower than the salinity in other parts of the ocean.

READING CHECK

7. Explain Why do oceans in hot, dry climates tend to have high salinity?

TAKE A LOOK

8. Infer The Gulf of Mexico is located between Mexico and Florida. Why is the ocean water in the Gulf of Mexico less salty than in other places?



This figure shows the salinity of ocean water in different parts of the world.

EFFECTS OF WATER MOVEMENT ON SALINITY

The movement of water also affects salinity. Slow-moving ocean water tends to have higher salinity than fast-moving water. Parts of the ocean with slow-moving water, such as gulfs, bays, and seas, often have high salinities. Parts of the ocean without currents are likely have higher salinities as well. ✓

READING CHECK

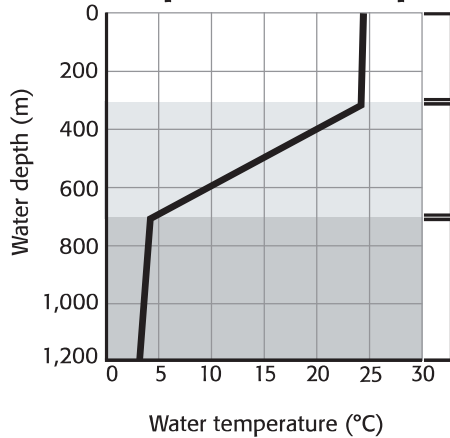
9. Describe How does water movement affect salinity?

What Affects Ocean Temperatures?

The temperature of ocean water decreases as depth increases. However, the temperature change is not uniform. Scientists can divide the water in the ocean into three layers based on how temperature changes. These three layers are the surface zone, the thermocline, and the deep zone.

SECTION 1 Earth's Oceans *continued*

Ocean Temperature and Depth



Surface zone The surface zone is the warm, top layer of ocean water. It extends to about 300 m below the surface. Sunlight heats the top 100 m of the surface zone. Convection currents mix the heated water with the cooler water below.

Thermocline The thermocline is the layer of water below the surface zone. It extends to between 700 m and 1,000 m below the surface. In the thermocline, temperature decreases quickly as depth increases.

Deep zone The deep zone is the deepest layer of the ocean. The temperature in the deep zone is only about 2°C.

TAKE A LOOK

10. Identify How does warm water mix with cool water in the surface zone?

SURFACE ZONE

The *surface zone* is the top layer of ocean water. It is heated by energy from the sun. As the ocean water is heated, it becomes less dense and rises above denser, cooler water. Convection currents form as the water moves. These currents can move heat within the surface zone to a depth of 100 m to 300 m. Therefore, the water temperature within the surface zone is fairly uniform.

THERMOCLINE

The *thermocline* is the layer of the ocean just beneath the surface zone. Within the thermocline, the temperature of the water decreases a lot as depth increases. This is because the sun cannot heat the water below the surface zone. In addition, the warm water of the surface zone cannot mix easily with the water below.

The depth of the thermocline is different in different places. It can extend from 100 m to almost 1,000 m below the surface of the ocean.

DEEP ZONE

The *deep zone* is the layer below the thermocline. In the deep zone, the temperature of the water is about 2°C. This very cold water is very dense. It moves slowly across the ocean floor and forms the deep ocean currents.

Critical Thinking

11. Predict Consequences What would happen to the water temperature in the surface zone if convection currents did not form there? Explain your answer.

SECTION 1 Earth's Oceans *continued*

CHANGES IN SURFACE TEMPERATURE

The temperature of water at the surface of the ocean is different in different places. Surface water along the equator is warmer than at the poles. This is because more sunlight reaches the equator than the poles. Surface water at the equator can be up to 30°C. In the polar oceans, water at the surface can be as cold as -1.9°C. ✓

The temperature of water at the surface of the ocean can also change during different times of year. Many areas receive more sunlight in the summer than in the winter. In these areas, the surface water in the oceans is warmer in the summer.

READING CHECK

12. Explain Why is surface water warmer at the equator than at the poles?

How Does Water Move on Earth?

Imagine that you could see Earth from outer space. You would see green and brown landmasses, blue oceans, and white clouds. These parts are involved in the water cycle, which is shown below. The **water cycle** is the movement of water between the atmosphere, the ocean, and the land. The ocean is important to the water cycle because it holds nearly all of the Earth's water. ✓

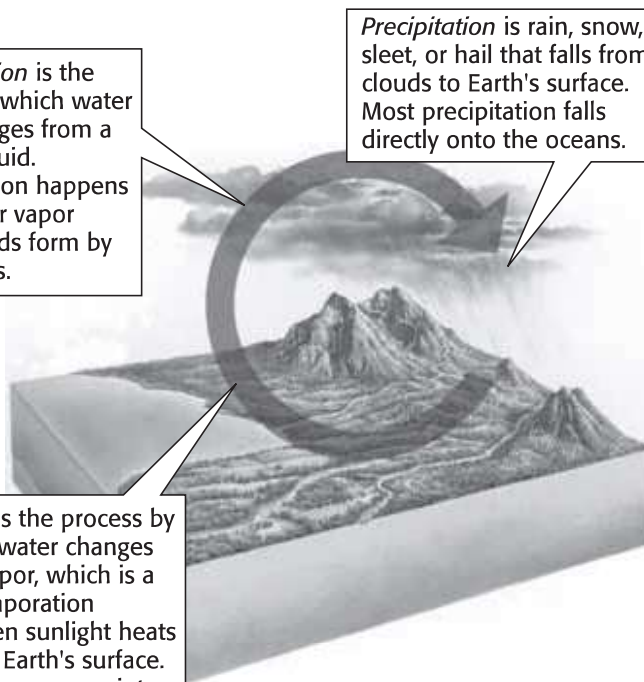
READING CHECK

13. Define What is the water cycle?

Condensation is the process by which water vapor changes from a gas to a liquid. Condensation happens when water vapor cools. Clouds form by this process.

Precipitation is rain, snow, sleet, or hail that falls from clouds to Earth's surface. Most precipitation falls directly onto the oceans.

Evaporation is the process by which liquid water changes into water vapor, which is a gas. Most evaporation happens when sunlight heats water on the Earth's surface. The water vapor moves into the atmosphere.



TAKE A LOOK

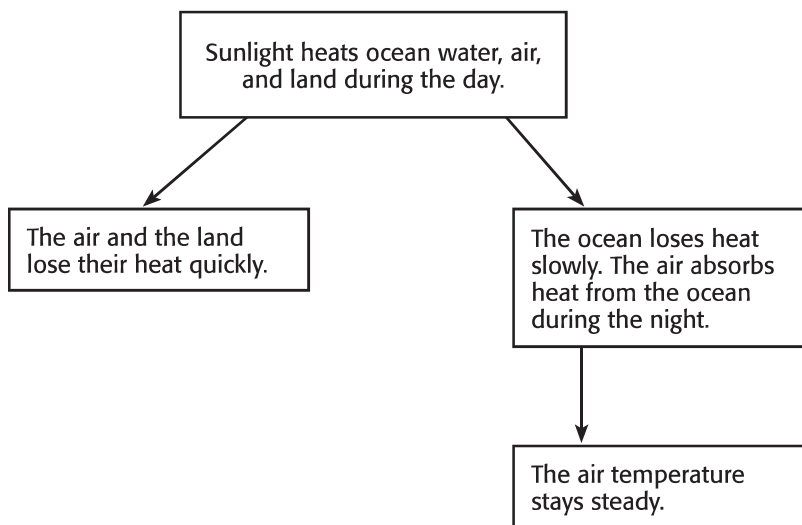
14. Identify Where does most precipitation fall?

SECTION 1 Earth's Oceans *continued*

How Do the Oceans Affect Air Temperatures?

You may know that many living things depend on the oceans for food and shelter. However, the oceans also help to keep the rest of the planet suitable for living things. This is because the oceans absorb and hold energy from sunlight. This helps to keep temperatures in the atmosphere from changing too much.

The ocean absorbs and releases heat much more slowly than the land does. Air can absorb heat from the oceans. Therefore, the oceans help to keep air temperatures steady, as shown below.



If there were no oceans on Earth, the air temperature could vary from above 100°C to below -100°C in a single day! Such large temperature changes could cause a lot of severe weather. Life as we know it could not exist in these conditions.

The ocean can also affect the climate of different areas. Remember that ocean water at the equator is warmer than ocean water at the poles. Currents in the ocean move the ocean water from place to place. This helps to distribute heat throughout the Earth. ✓

The warm water from the equator can flow past land at high latitudes. The air absorbs heat from the warm ocean water. As a result, the land can have milder temperatures than other areas at the same latitude. For example, the islands of the United Kingdom are at about the same latitude as parts of Canada. However, a warm ocean current flows past the United Kingdom. As a result, its climate is much warmer than much of Canada's.

STANDARDS CHECK

ES 1j Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

Word Help: major
of great importance or large scale

15. Explain How do the oceans affect air temperatures?

READING CHECK

16. Identify What helps to distribute the heat in ocean water?

Section 1 Review

NSES ES 1b, 1f, 1g, 1h, 1j, 2a

SECTION VOCABULARY

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

water cycle the continuous movement of water between the atmosphere, the land, and the oceans

1. Explain Why do scientists call the ocean water on Earth the global ocean?

2. Identify What are two factors that can affect salinity?

3. Identify Relationships Why do most oceans in hot, dry climates have high salinities?

4. Explain Why does the temperature in the thermocline decrease quickly with depth?

5. Explain In the space below, make a drawing of the water cycle. Explain what is happening in each part of your drawing.