Chapter 26 The Earth's Oceans

Each day the ocean rises and falls along the coast. At low tide, the ocean pulls back from the coast. What was once underwater is exposed. What do you see in the picture that you would not see at high tide?

Learning Objectives

- Identify how much of the Earth's surface is covered by water.
- Compare surface currents and density currents.
- Identify four features of the ocean floor.
- Explain the causes and movements of waves and tides.
- Identify important ocean resources.
- Explain why the ocean is important to life on Earth.
- LAB ACTIVITY: Discover how temperature affects the movement of water in the ocean.
- ON-THE-JOB SCIENCE: Explore what an underwater photographer does.

Words to Know

oceanography	the study of the ocean
salinity	the measure of how much salt is in something
ocean current	a mass of water that flows like a river through an ocean
density current	a current caused by cold, salty water, which is very dense and sinks below warmer water
mid-ocean ridge	a huge mountain range that runs down the middle of some oceans
continental shelf	the gentle slope from the shore out to sea
continental slope	the steep cliff between the continental shelf and the bottom of the ocean
ocean basin	the bottom of the ocean floor
undertow	the backward movement of ocean water near the shore
seismic sea wave	a giant wave caused by an earthquake on the ocean floor
tide	the rise and fall of the oceans, caused by the sun's and moon's pull of gravity

26·1 Features of the Ocean

Words to Know

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ocean basin	the bottom of the ocean floor

Remember
There are four oceans: the Arctic, the Atlantic, the Indian, and the Pacific. All the oceans are connected.

People usually think of land as making up most of the Earth. Yet 70 percent of the Earth is covered by water. Most of the Earth's organisms live in the ocean. The oceans, also called seas, are frontiers. A frontier is a place that has not been carefully explored. Scientists began only recently to study the oceans. The study of the oceans is called **oceanography.**

What Is Ocean Water Made Of?

If you ever got ocean water in your mouth when you were swimming, you know it contains salt. Ocean water also contains chemical elements such as chlorine, sodium, magnesium, and calcium.

Salinity is a measure of how much salt is in something. The salinity of ocean water is usually between 3.3 percent and 3.7 percent.

Science Fact

The Dead Sea, between Israel and Jordan, is 23 percent salt. Few plants and no fish live in it. The salinity level is too high.

Salts are carried from the land to the oceans. First, weathering and erosion break down rocks containing sodium chloride (table salt) and other salts. This releases the salts into the soil. Then rainwater flows over and through the soil. This dissolves the salts. Rivers carry the salts to the ocean.

✓ **Where does the salt in ocean water come from?**

Ocean Currents

An **ocean current** is a mass of water that flows like a river through an ocean. Most currents are caused by winds that blow steadily in the same direction. These winds push water along with them. The rotation of the Earth also affects the direction of currents. It causes them to move in circular patterns.

The Gulf Stream System

A current of warm water flows through the Atlantic Ocean. This current is 30 miles (48 kilometers) wide. It is a different color than the ocean water around it. It is also warmer because it flows from the Gulf of Mexico, near the equator. This river of water is the Gulf Stream.

The Gulf Stream current sweeps north along the eastern coast of the United States to Newfoundland. There it meets the North Atlantic Current, which moves east across the Atlantic Ocean toward Europe.

Science Fact

Ships in the Atlantic Ocean going from North America to Europe try to stay in the Gulf Stream system. It helps them go faster. They avoid it coming back because it slows them down.

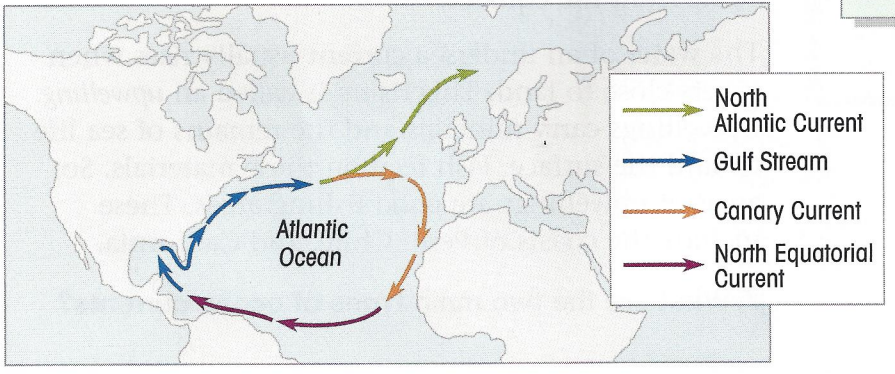


Figure 26-1 *Together the Gulf Stream and the North Atlantic Current make up the Gulf Stream system.*

Density Currents

Currents that are formed by winds are all surface currents. They flow near the surface of the oceans. Another kind of current is an undersea current. This current flows below the surface current. An undersea current is caused by a difference in the densities of ocean water.

A **density current** is caused by cold, salty water sinking below warmer water. Cold water is denser than warm water. Salt water is denser than fresh water. Water that is cold and salty is very dense and sinks. Warmer, less salty water rises.

Huge undersea currents occur between the North and South poles and the equator. Water near the poles is much saltier and colder than water near the equator. This dense water sinks and moves along the ocean bottom toward the equator. In warmer places, such as near the equator, the water rises. It takes the place of warm surface water that flows toward the poles.

Science Fact

When ocean water near the poles freezes, the salt in the water does not freeze. The salt stays in the water. This makes water near the poles saltier than water near the equator.

Because of this process, every current has a countercurrent. A countercurrent flows either above or below the main current in the opposite direction. For example, the Gulf Stream has a colder undersea countercurrent flowing beneath its warmer surface. The undersea currents flowing from the poles have warmer surface currents flowing above them that come from the equator.

The water of an undersea current usually rises when it gets close to land. This rising is called an *upwelling*. Upwellings carry minerals and the remains of sea life toward the surface. Fish feed on these materials. So, areas of upwellings are good fishing areas. These include the coasts of Peru, Chile, and California.

✓ **What are the two main types of ocean currents?**

The Ocean Floor

There are many of the same formations on the ocean floor as there are on land.

A **mid-ocean ridge** is a huge mountain range that runs down the middle of some oceans. Scientists think that new crust is made in these underwater mountain ranges. Hot magma pushes up through openings in the ridges. The magma then cools and hardens into rock on either side of the ridge. This causes *sea floor spreading*, which is the slow but steady pushing of the sea floor crust away from the ridge. Most underwater earthquakes occur along the mid-ocean ridge.

Remember
According to the theory of plate tectonics, the Earth's crust is broken into several major plates. These plates all float on the mantle. Landmasses and oceans ride on top of the plates.

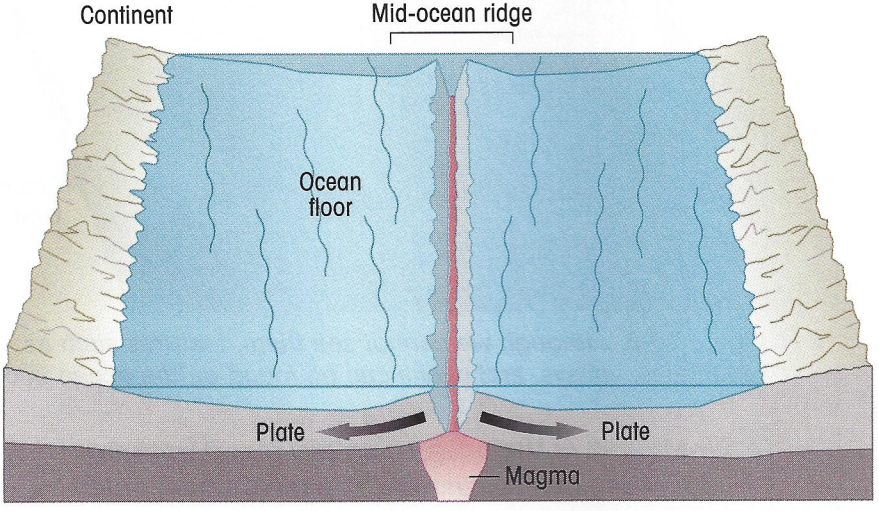


Figure 26-2 *As ocean plates move apart, magma rises to fill the space between them. This forms a mid-ocean ridge.*

Even though the ocean floor is spreading, this does not mean that the Earth's surface is getting bigger. Remember the theory of plate tectonics. Sometimes one plate slips under another plate. The lower plate melts, and the magma returns to the mantle. This happens in oceans as well as on land. Deep trenches form in the ocean where one plate slips under another plate.

The edges of the continents drop gradually to the bottom of the ocean. The gentle slope from the shore is called the **continental shelf.** The ocean floor drops off at the edge of the continental shelf. This steep cliff between the continental shelf and the bottom of the ocean is the **continental slope.** The continental slope leads to the **ocean basin,** the bottom of the ocean floor. Mid-ocean ridges and ocean trenches are found in the ocean basin.

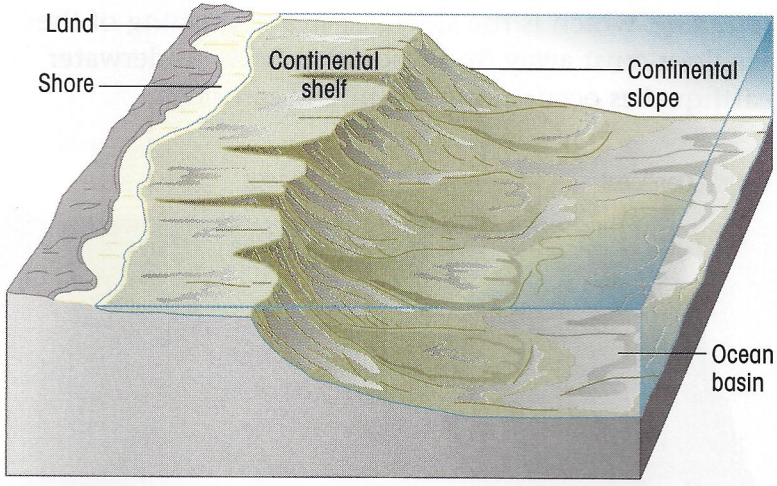


Figure 26-3 *Although we cannot see them, features such as mountains, valleys, and plains can be found on the ocean floor.*

✓ **What parts of the ocean floor are found from the coast to a mid-ocean ridge? Name them in order.**

Lesson Review

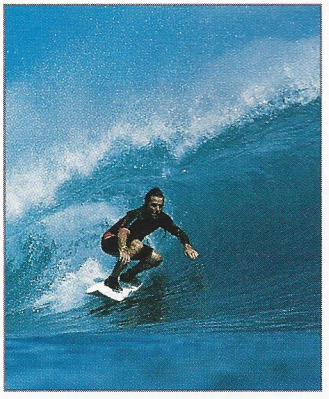
1. What substance makes up 3.3 percent to 3.7 percent of ocean water?
2. What is the Gulf Stream?
3. What happens during sea-floor spreading?
4. **CRITICAL THINKING** Why is most of the ocean still not explored?

26-2 Waves and Tides

Words to Know

undertow	the backward movement of ocean water near the shore
seismic sea wave	a giant wave caused by an earthquake on the ocean floor
tide	the rise and fall of the oceans, caused by the sun's and moon's pull of gravity

Wind and Waves



Surfers can ride waves for fun.

Local winds cause most ocean waves. Underwater earthquakes and volcanoes can cause waves, too.

If you watch a bird resting on the ocean surface, you will see it rise and fall with the waves. The water under the bird seems to move forward, but the bird does not. This is because it is the wave's *energy* that moves forward. The water itself only moves up and down.

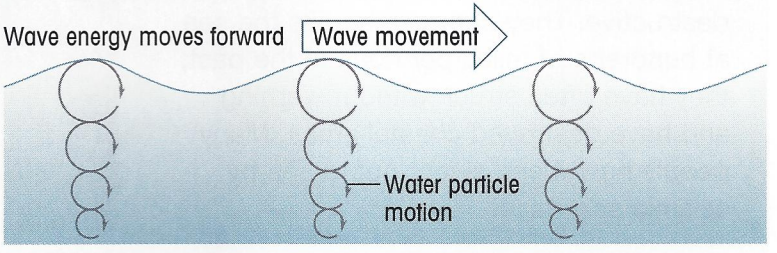


Figure 26-4 *The energy in waves moves forward. The water itself only moves in circles.*

You have probably seen waves, called *breakers*, hit the shore. These form because the lower part of the wave "drags" on the shallow bottom near the shore. So, the wave top spills forward, or breaks. After a wave breaks, water returns to the ocean under the breakers. The backward movement of this water near the shore is called **undertow.**

✓ **What causes most ocean waves?**

Seismic Sea Waves

Science Fact

Many people call seismic sea waves "tidal waves." However, they do not have anything to do with tides.

Once in a while, a giant wave reaches the shore. Scientists call this giant wave a **seismic sea wave.** It is caused by an earthquake on the ocean floor. The word *seismic* means "having to do with earthquakes."

Ships at sea often do not notice seismic sea waves passing. In deep water, the waves are only about 1 or 2 yards (1 or 2 meters) high. However, as they reach the shore, these waves can be over 100 feet (30 meters) high. Seismic sea waves can travel more than 350 miles (560 kilometers) per hour and do a lot of damage when they crash into the shoreline.

✓ **What causes a seismic sea wave?**

A Closer Look

SEISMIC SEA WAVES

Seismic sea waves, or tsunamis, do not happen often. However, they can be destructive. They can race across the sea at hundreds of miles per hour. In the past, they have often struck without warning and have destroyed coastal areas. Many people have been swept out to sea by seismic sea waves.

A seismic sea wave almost 50 feet (15 meters) high hit Japan in 1993. It did great damage.

Today, the Tsunami Warning Center in Hawaii can save many people from harmful seismic sea waves. The center keeps track of earthquakes in the Pacific Ocean basin. That is where most seismic sea waves happen. The center also tracks the height and movement of waves. If a seismic sea wave forms, the center knows within an hour. It then warns coastal communities that a wave is on the way.

CRITICAL THINKING Why is it helpful to know a seismic sea wave is coming?

Tides

Ocean waters rise and fall on the shoreline twice a day. This rise and fall of the oceans is called a **tide.** Tides are caused by the sun's and moon's pull of gravity on the Earth.

The sun's and moon's gravity actually pulls the water back and forth as the Earth spins on its axis. The sun is much farther away from the Earth than the moon is. Therefore, the sun's pull on the Earth is not as strong as that of the moon's pull on the Earth.

During *high tide,* the water is as high as it gets on the shore. During *low tide,* the water is as low as it gets on the shore.

Twice a month the sun and moon lie in a straight line with the Earth. The combined gravity of both of these bodies makes their pull especially strong. So, high tides are very high. Low tides are very low. These tides are called *spring tides.*

Twice a month, the sun and moon form a right angle with the Earth. At these times, the sun's pull works against the moon's pull. That means the tides are neither very high nor very low. These are called *neap tides.*

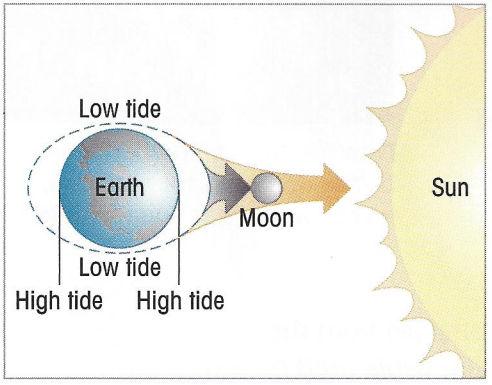


Figure 26-5 *Spring tides are very high and very low tides.*

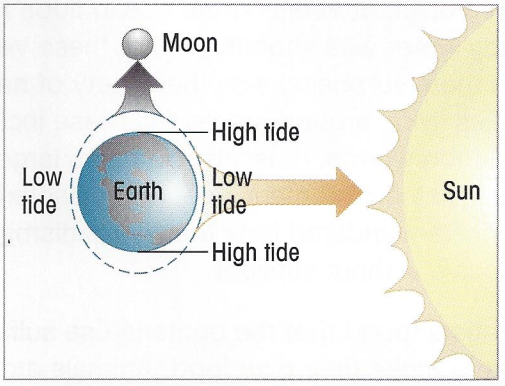


Figure 26-6 *Neap tides are neither very high nor very low.*

✓ **What causes tides?**

Lesson Review

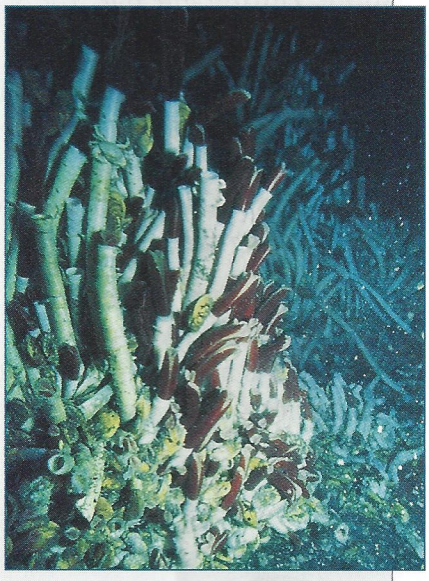
1. Why do breakers form?
2. How do seismic sea waves cause damage?
3. What is the difference between a spring tide and a neap tide?
4. **CRITICAL THINKING** Why would an undertow be dangerous for swimmers?

On the Cutting Edge

EXPLORING THE OCEAN FLOOR

The ocean floor is totally dark and freezing cold. People cannot live in the high water pressure at the bottom of the ocean. For many years, it remained unexplored. Then scientists invented underwater research vessels called *submersibles*. These vessels can withstand great pressure. They have equipment for exploring the ocean floor, such as cameras, water testers, thermometers, and sonar.

In 1977, scientists using a submersible came upon cracks, or *vents*, in the ocean floor. Hot, cloudy water was shooting out of these vents. Even more surprising was the variety of new species living around the vents. These included giant tube worms, mussels, clams as large as dinner plates, and many species of bacteria. Scientists wondered how these organisms could live without sunlight.



New life forms, such as these 6-foot (2 meter) tube worms, were found near ocean vents.

Scientists found that the bacteria use sulfur chemicals from the vents to make their own food. Animals around the vents feed on the bacteria. The vents are a source of life on the cold, dark ocean floor.

CRITICAL THINKING Some fish live near the ocean floor far from vents. How do you think they get their food?

26-3 Ocean Resources

People use some ocean resources for food.

The ocean is full of riches. For thousands of years, people have fished the oceans for food. Ocean algae, such as seaweed, is used in cosmetics and ice cream. Algae are also used in some paints, dyes, and papers.

The ocean floor is also rich in oil, natural gas, and important metals. Salt and chlorine are both taken from the sea. In some places, people remove the salt from the ocean to make drinking water. The tides in the seas may one day be a source of energy.

Ocean Resources	
Foods	Fish, seaweed, shellfish
Energy	Natural gas, oil
Minerals	Cobalt, copper, manganese, nickel
Medicines	Blood thinners from algae; muscle relaxers from sea snails
Jewelry	Coral, pearl, shell

Remember
Algae are plantlike protists. A protist is a one-celled organism.

Ocean algae make about 90 percent of the food produced by living organisms on Earth. They are the first step in many food chains. Many organisms would not have food if it were not for algae. Algae also produce up to 90 percent of all the oxygen in the air we breathe.

✓ **What are three ocean resources?**

Lesson Review

1. What is the importance of algae to life on Earth?
2. What metals are found in the ocean?
3. **CRITICAL THINKING** Why would people in some places need to remove salt from ocean water to make drinking water?

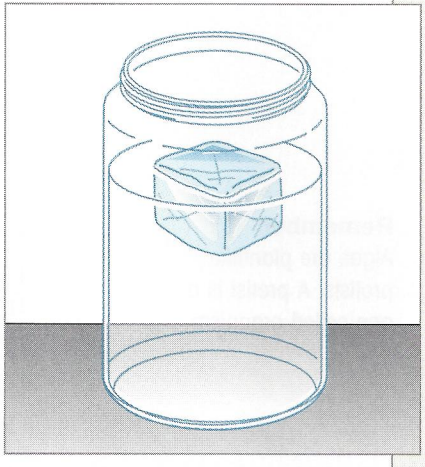
LAB ACTIVITY
Making a Cold-Water Current

BACKGROUND
Cold water is dense. It sinks. Warm water is not as dense. It rises. These differences in temperatures help create density currents in the ocean.

PURPOSE
You will use differences in water temperature to create a current.

MATERIALS
large wide-mouth glass jar, ice cube tray, water, blue food coloring, eyedropper, spoon, freezer, paper, pencil

WHAT TO DO
1. Fill the jar with water. Stir in several drops of blue food coloring.
2. Fill the ice cube tray with the blue water. Put the tray in the freezer for a few hours.
3. Fill the glass jar with clear water. Let it stand for an hour to reach room temperature.
4. Remove the blue ice from the tray. Float one of the ice cubes on the surface of the water in the jar.
5. Observe what happens in the jar. On a sheet of paper, sketch what you see.



DRAW CONCLUSIONS
- What happens to the frozen blue water? Explain why this happens.
- What happens in the jar that is similar to what happens with density currents in the ocean?

ON-THE-JOB SCIENCE
Underwater Photographer

You have probably seen photos of underwater shipwrecks, coral reefs, and strange sea life. Underwater photographers take these photos.

Susan is an underwater photographer. She became one because it combined two things that she loves: taking photographs and scuba diving.

After high school, Susan earned a diving certificate. The algebra and physics she took in high school were helpful. Knowing how to swim helped, too. Diving school taught her how to use and repair diving equipment. She learned how to dive safely and how to handle medical emergencies underwater. She also studied oceanography and underwater photography in college.

Susan enjoys being a diving photographer. She travels a lot. She spends a lot of time in beautiful underwater environments. Susan also enjoys seeing her photographs in magazines and newspapers.

Susan takes a picture of a fish called a grouper.

Animal	Deepest It Goes
Human scuba diver	500 feet
Sperm whale	3,700 feet
Northern elephant seal	5,000 feet
Octopus	16,000 feet

In one of Susan's textbooks, she found the chart shown to the right. Answer these questions about the chart.

1. Which animal can go the deepest in the ocean?
2. Which animals could avoid Susan by diving below her?

Critical Thinking

Why do you think so many sea creatures can dive deeper than people?

Chapter 26 Review

Summary

Water covers 70 percent of the Earth's surface. Water moves in currents, waves, and tides.

Lesson 26.1

Ocean currents flow through the ocean like rivers. Wind drives surface currents. There are also undersea currents called density currents. The ocean floor has mountain ranges, volcanoes, and deep trenches.

Lesson 26.2

Winds cause most ocean waves. Underwater earthquakes cause seismic sea waves. The tide is the regular rise and fall of ocean water near the coast. The pull of gravity of the moon and sun causes tides.

Lesson 26.3

The ocean contains resources such as algae, fish, oil, and minerals. Algae also produce most of the oxygen in the Earth's atmosphere.

Vocabulary Review

continental shelf
salinity
ocean current
density current
mid-ocean ridge
ocean basin
seismic sea wave
tide

Match each definition with a term from the list.

1. Mountain range that runs down the middle of an ocean
2. Ocean movement caused by the pull of gravity
3. The bottom of the ocean floor
4. The measure of how much salt is in something
5. A current caused by cold, salty water that sinks below warmer water
6. Water that flows like a river through an ocean
7. A giant wave caused by an underwater earthquake
8. The gentle slope from the shore out to sea

Chapter Quiz

Write your answers on a separate sheet of paper.

1. How much of the Earth's surface is covered by water?
2. What causes surface ocean currents?
3. What causes undersea ocean currents?
4. How does temperature affect ocean currents?
5. Where do most underwater earthquakes occur?
6. What is the difference between the continental shelf, continental slope, and ocean basin?
7. What causes most waves?
8. What causes tides?
9. What is the difference between high tide and low tide?
10. What are three important ocean resources, and how do we use them?

Test Tip
To prepare for a test, practice writing each of the important vocabulary words in a sentence.

Research Project

Do research to find out about seaweeds. Make a poster that shows and compares a few different kinds of seaweeds. On your poster, include a chart that lists some of the uses for seaweeds. Be sure to include seaweed products, such as algin, agar, and carrageenin, which are added to certain foods. Write a brief report to go with your poster.