KEY CONCEPT

# 4.1 The oceans are a connected system.

### Sunshine State STANDARDS

**SC.D.1.3.3:** The student knows how conditions that exist in one system influence the conditions that exist in other systems.

### BEFORE, you learned

- Most water on Earth is salt water
- The ocean plays an important role in the water cycle

### NOW, you will learn

- What ocean water contains
- What the ocean floor looks like
- How people explore the ocean

### FCAT VOCABULARY

**density** p. 116

### VOCABULARY

**salinity** p. 116
**continental shelf** p. 120
**sonar** p. 122

### EXPLORE Density

***Why do liquids form layers?***

#### PROCEDURE

1. Insert the straw into one of the solutions. Cover the top of the straw with your finger and then remove the straw from the solution. The liquid should stay in the straw.
2. Using this technique, try to layer the three liquids in your straw so that you can see three distinct layers.
3. Experiment with the order in which you place the liquids into the straw. Between trials, empty the contents of the straw into the waste cup.

#### MATERIALS

- 3 solutions—A, B, and C—provided by your teacher
- clear straw
- waste cup


#### WHAT DO YOU THINK?

Did it matter in what order you layered the liquids? If so, can you explain why?

## Ocean water covers much of Earth.

As land animals, we naturally think of our planet as a rocky and solid place. We even named our planet Earth, which means "land" or "soil." But look at a globe and you will see that oceans cover most of Earth. In fact, 71 percent of Earth is covered in seawater.

Looking at a map of the world, you can see the seven continents spread over our planet. These landmasses divide Earth's global ocean into connected sections. Different sections of the ocean have different names, such as Atlantic, Indian, and Pacific. However, all the sections are connected.

**OUTLINE**

Remember to start an outline for this section.

I. Main idea
  A. Supporting idea
    1. Detail
    2. Detail
  B. Supporting idea


The global ocean is one connected body of water, divided into sections by the continents.

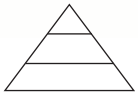
How did Earth become covered by an ocean? Scientists have several theories. The most commonly accepted explanation has to do with how Earth formed. Earth formed about 4.6 billion years ago as a ball of molten rock. Heavier materials sank to the core, and lighter materials floated toward the surface—the same way oil and vinegar in salad dressing separate into layers. Water vapor, a very light substance, rose to the cooler surface. By about 4 billion years ago, Earth had cooled enough for the water vapor to become liquid. At that time, the vapor condensed—just as water vapor condenses into droplets on a cool glass of lemonade—forming liquid water that became the ocean.

## Ocean water contains salts and gases.

Despite its name, the salt water that fills the ocean is much more than just salt and water. Ocean water contains many different dissolved substances. Sodium chloride, which is the same compound as ordinary table salt, is the most plentiful of these substances. The ocean also contains other dissolved solids, as well as dissolved molecules of the same gases found in the atmosphere. In fact, the ocean contains all 92 elements that occur in nature, although most are in very tiny amounts.

### Salts

**VOCABULARY**
Add word triangles for *salinity* and *density* to your notebook.



One taste will convince you that ocean water is salty. Every 1000 grams of seawater contains an average of 35 grams of salt. **Salinity** (suh-LIHN-ih-tee) is a measure of the amount of dissolved salt contained in water. The ocean contains many different kinds of salts. However, sodium chloride accounts for most of the ocean's salinity.

The elements that make up salts are found in rocks and minerals. Over time, rain and rivers wash some of these elements into the sea. The elements that make up salts also enter the ocean when underwater volcanoes erupt. Natural processes also remove salt from the ocean. Because salt is added as well as removed, the ocean's overall salinity does not change much over time. The ocean's salinity has stayed constant for the past 1.5 billion years.

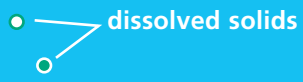
Water that contains dissolved solids, such as salts, is heavier than the same amount of water with no dissolved solids. In other words, salt water has a greater density than fresh water. **Density** is a measure of the amount of matter packed into a given volume.

The higher water's salt content, the greater its density. The denser the water, the more easily things float in it. As you can see in the photograph on page 117, the Dead Sea is so salty (and dense) that people can float easily on the surface.

## Salinity and Density

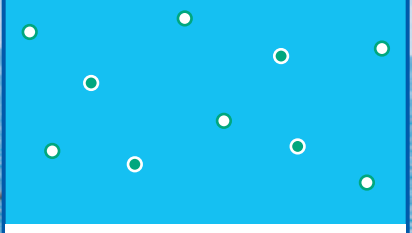
### Salt water has a greater density than fresh water.

**Fresh Water**



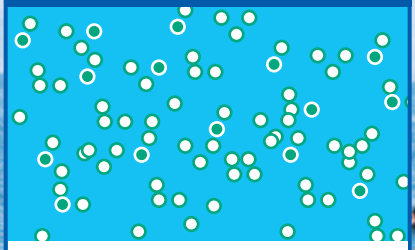

Fresh water has fewer dissolved solids than salt water, so it is less dense than salt water.

**Ocean Water**



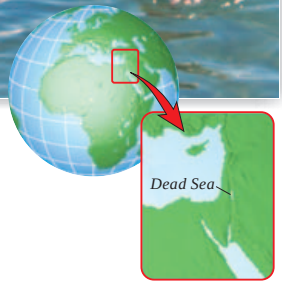
Ocean water is more dense than fresh water because it has more dissolved solids.

**Dead Sea Water**



The Dead Sea is about ten times saltier than the ocean, so Dead Sea water is more dense than ocean water.

Located between Israel and Jordan, the Dead Sea is actually a salty lake and not part of the ocean. Its high salinity, and therefore high density, allows people to float more easily in it than in fresh water or in the ocean.




Some parts of the ocean are saltier than others. When water evaporates from the ocean, the salts are left behind, causing the remaining water to become even saltier. Ocean water is especially salty in places where water evaporates quickly, such as in shallow areas and warm climates. Salinity is also higher in very cold areas, where the ocean water freezes. When ice forms on the ocean, the salt is left in the water below.

Salinity is lower in areas where the ocean is diluted by fresh water. For example, seawater has lower salinity in places where rivers empty into the ocean. Similarly, the ocean's salinity is lower in areas where a lot of rain falls.

**CHECK YOUR READING** How are salinity and density related?

# INVESTIGATE Density

## How does dense water move?

**SKILL FOCUS**
Predicting

**MATERIALS**
- 2 baby food jars
- blue and red food coloring
- tap water
- 10 percent salt solution
- index cards
- large pan or bucket

**TIME**
30 minutes

### PROCEDURE

1. Read the instructions below and predict what will happen in steps 3 and 4 before you begin. Record your predictions.
2. Fill one jar with tap water and color it blue. Fill another jar with salt water and color it red. Place an index card over the top of the jar of red salt water.
3. With your hand over the index card, turn the jar over and place it on top of the jar with the blue tap water. Pull out the index card and observe the water movement, if any.
4. Repeat steps 2 and 3, but with the blue tap water on the top.

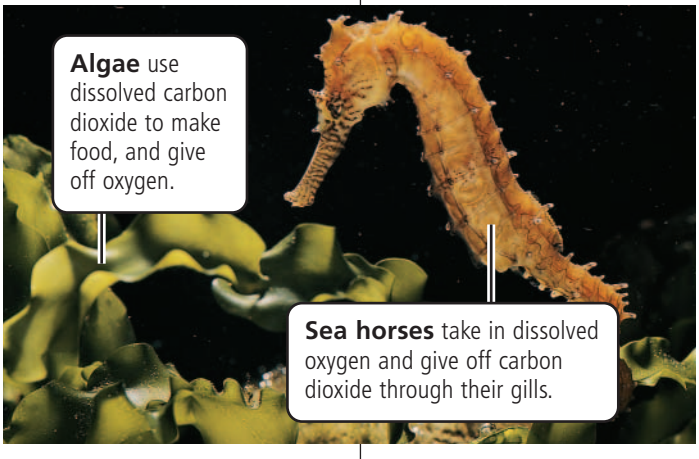
### WHAT DO YOU THINK?

- Describe any ways in which your observations differed from your predictions. On what did you base your predictions?
- Explain why the water moved, if it did, in each of the two setups.

**CHALLENGE** How do you think water in the ocean might be layered?

## Oxygen and Other Gases

Fish, like other animals, need oxygen to live. Oxygen and other gases dissolve in water, just as sugar dissolves in tea. The ocean contains the same gases as the air, including oxygen, nitrogen, and carbon dioxide. Dissolved gases are essential to ocean life.



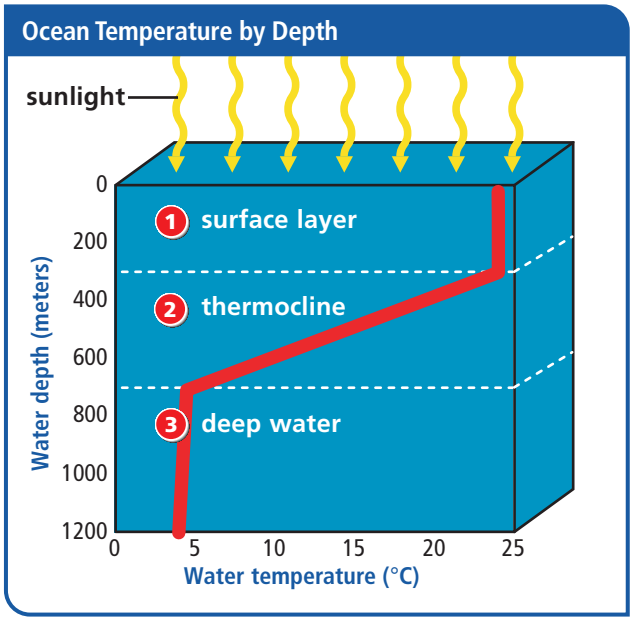

You know that when you breathe, you use oxygen and exhale carbon dioxide. Ocean animals also take in oxygen and give off carbon dioxide. Oxygen and carbon dioxide get mixed into the ocean from the air above the ocean surface. Oxygen is also added to the ocean by plants and algae that live near the surface. Plants and algae use sunlight to convert carbon dioxide and water into food, and release oxygen into the water. Besides being used by plants to make food, carbon dioxide is a building block of ocean animals' shells.

CHECK YOUR READING Where does the oxygen in the ocean come from? Name two sources.

## Ocean temperatures vary.

Oceanographers—people who study the ocean—divide ocean water into three layers on the basis of temperature.

1. **The surface layer,** heated by the Sun and mixed by winds and waves, is the warmest layer. Warm water is less dense than cold water, so the heated water stays at the surface.
2. **The thermocline** (THUR-muh-KLYN) lies below the surface layer. The temperature of the water in the thermocline drops fast with depth.
3. **The deep water** is cold all year. Almost anywhere on the globe—even in the tropics—the temperature of the water at the ocean's bottom is around 0°C–3°C (32°F–37°F), at or barely above freezing.

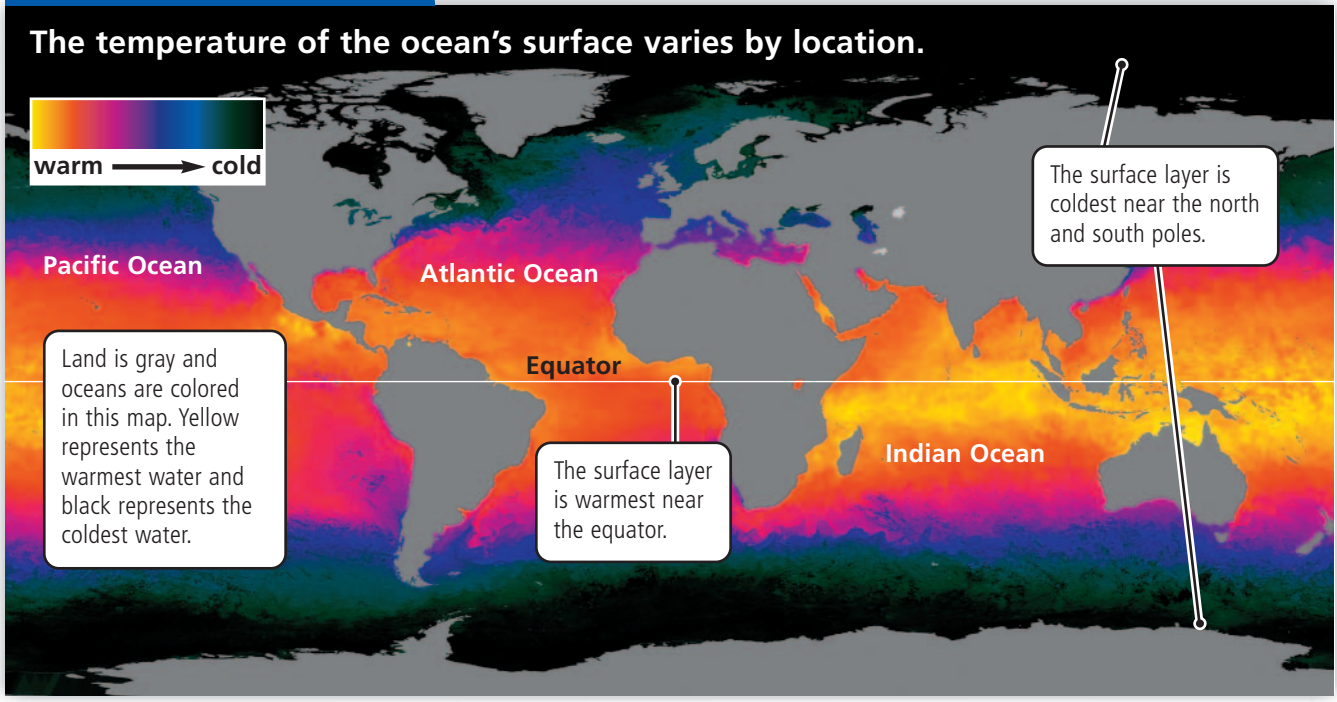



The temperature of the water at the surface of the ocean varies by location and season. As you can see in the map of satellite data below, the surface layer is warmer near the equator than near the poles. Over much of Earth, the surface layer is warmer in the summer and cooler in the winter.

**CHECK YOUR READING** Why doesn't the warm water at the ocean's surface sink to the bottom?

### Surface Temperature

**The temperature of the ocean's surface varies by location.**



## The ocean floor has many features.

People have sailed the ocean for thousands of years. However, the landscape of most of the ocean floor remained a mystery until the 1950s. Since then, exploration and improvements in mapping techniques have revealed many spectacular features on the ocean floor, including the tallest mountains and deepest canyons on Earth.

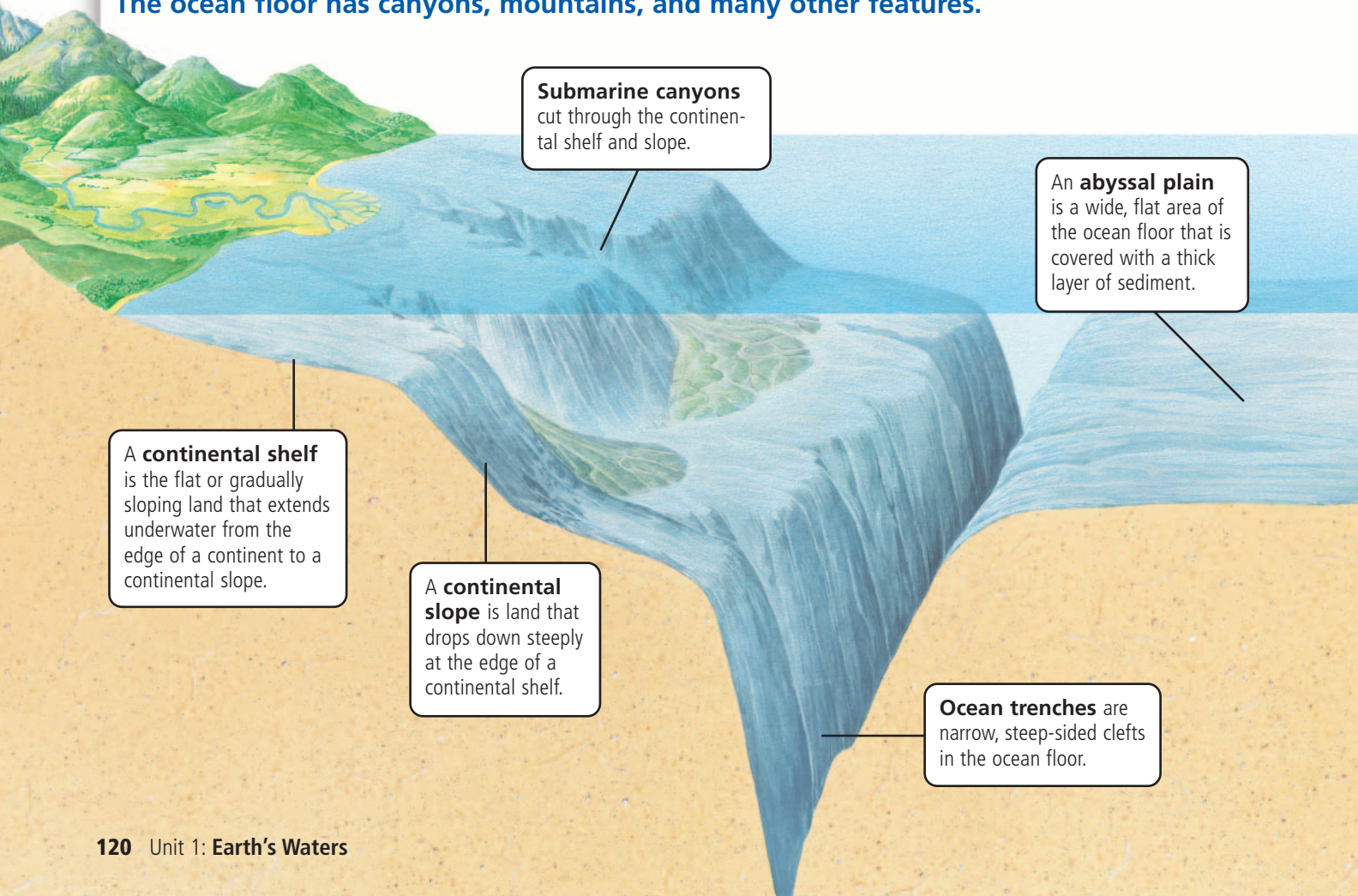
**READING TiP**

*Abyss* means "a very deep place." Abyssal plains are on the deep-ocean floor.

A **continental shelf** is the flat or gently sloping land that lies submerged around the edges of a continent and that extends from the shoreline out to a continental slope. Huge submarine canyons, some similar in size to the Grand Canyon, slice through continental shelves and slopes. Farther out, ocean trenches cut deep into the ocean floor. With a bottom over 11,000 meters (36,000 ft) below sea level, the Mariana Trench is the deepest place in the world. Flat abyssal (uh-BIHS-uhl) plains cover huge portions of the deep-ocean floor. Seamounts are undersea mountains. Tall volcanoes that poke above the surface are volcanic islands. Mid-ocean ridges, the world's longest mountain range, run throughout Earth's ocean like the seams on a baseball.

### The Ocean Floor

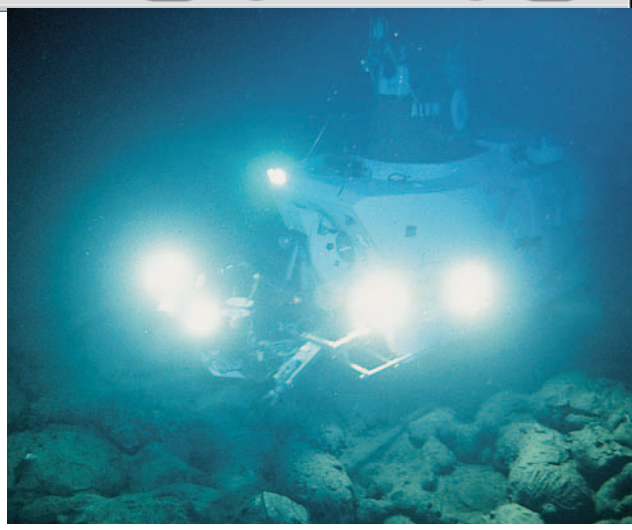
**The ocean floor has canyons, mountains, and many other features.**



## Ocean Exploration

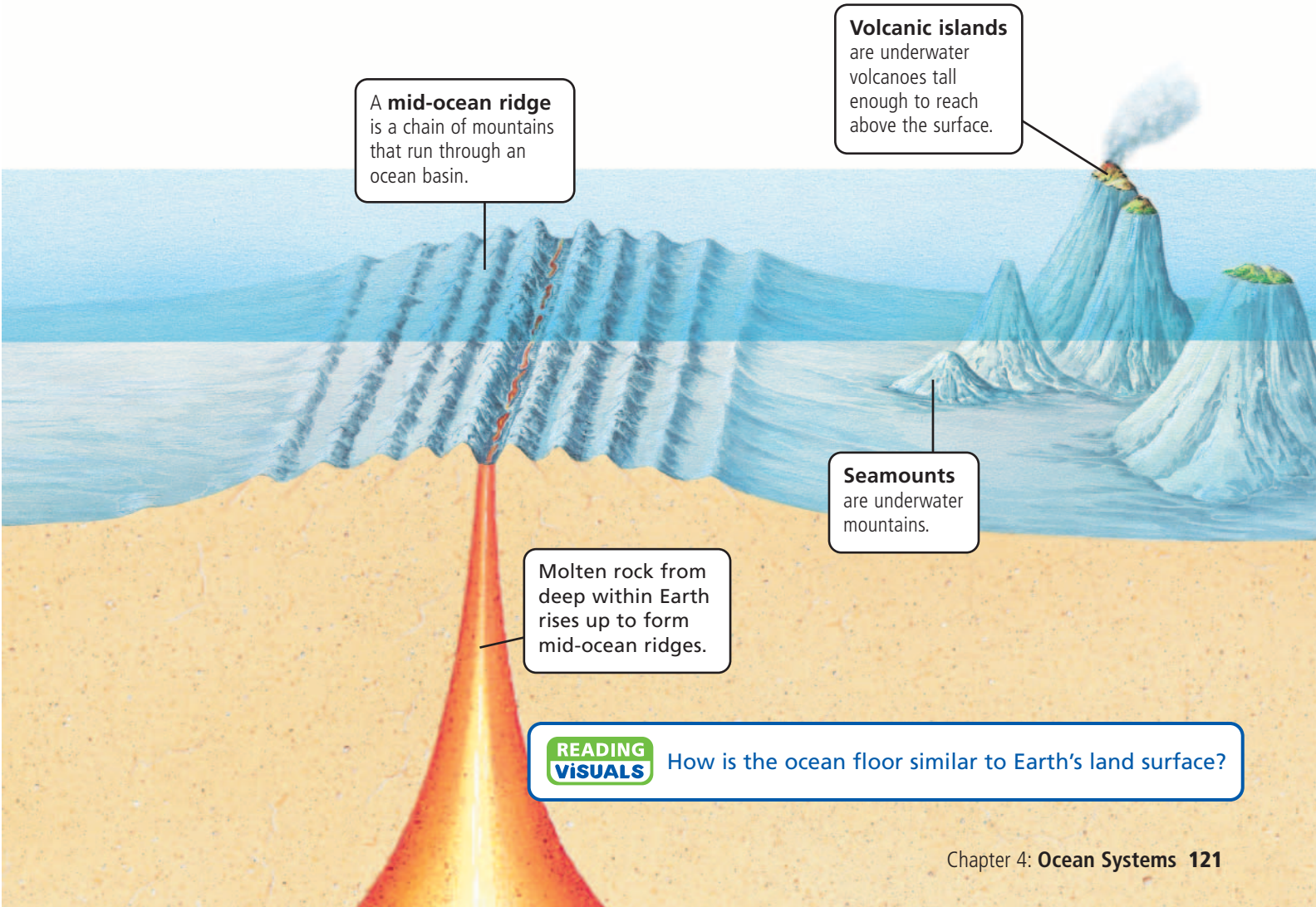
Because the majority of Earth's surface is underwater, until recently it remained largely unexplored. If your ears have ever hurt when you dived to the bottom of a pool, you have felt the effects of water pressure. That pressure is multiplied hundreds of times deep in the ocean. The deeper down you go, the more crushing the weight of the water.

Despite the pressure, darkness, lack of air, chilling cold, and other obstacles to ocean exploration, scientists have developed tools that help them discover what lies beneath the surface. Scuba equipment allows a diver to spend about an hour underwater, breathing air carried in a tank on his or her back. Scuba divers can safely reach depths as great as 40 meters (130 ft). To go even deeper, people use small submarines, such as the one pictured here. Robots equipped with cameras offer views of areas too deep or difficult for humans to reach.



Small submarines carry researchers to depths as great as 6500 meters (21,300 ft).

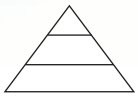
**CHECK YOUR READING** What is one obstacle to ocean exploration?



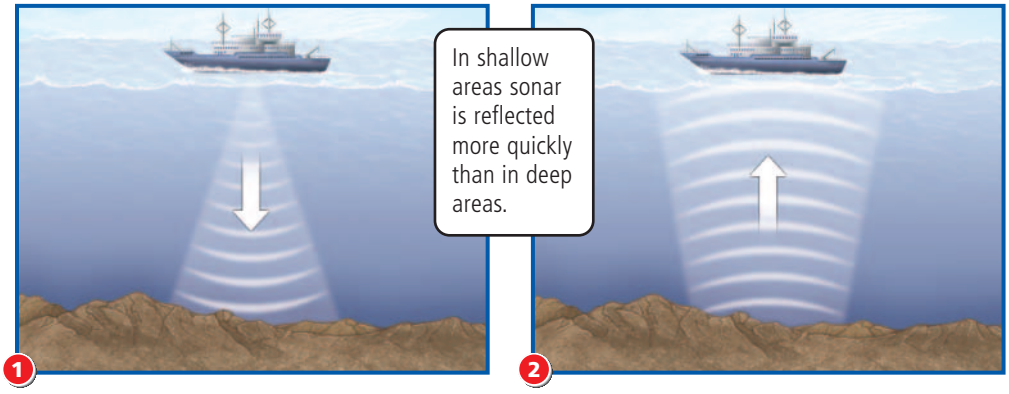

**READING VISUALS** How is the ocean floor similar to Earth's land surface?

## Mapping the Ocean Floor

**VOCABULARY** Add a word triangle for *sonar* to your notebook.



Today's detailed maps of the ocean floor would amaze early scientists and sailors, who tested sea-floor depths by dropping weighted lines overboard. Now sailors find depths with **sonar,** a system that uses sound waves to measure distances and locate objects. Ships aim sound waves at the ocean's bottom and measure the time it takes to receive the echo. A fast echo means the bottom is shallow; a slow echo means the bottom is deep.




1 To measure sea-floor depth, ships aim sound waves at the ocean floor.

2 The time it takes for the echo to return depends on the depth of the ocean floor.

**FLORIDA Content Preview**

Sound waves are used a great deal to explore the ocean. You'll learn more about how sound waves work in grade 8.

Sonar can provide detailed images of small areas of the ocean floor. For mapping large areas, satellite imaging is much more efficient. Satellites can detect tiny bumps and dips in the ocean's height. These small surface differences reveal the shape of the ocean floor. For example, water levels are slightly higher over seamounts and lower over trenches. Because of its vast size and the challenges of exploring it, the ocean still holds many secrets. Exploration continues to bring new discoveries of geological formations and events.

**CHECK YOUR READING** What are two methods used in mapping the ocean floor?

## 4.1 Review

### KEY CONCEPTS

1. What substances are contained in ocean water?
2. Describe or draw five features of the ocean-floor landscape.
3. Describe three kinds of technology or equipment used to explore the ocean.

### CRITICAL THINKING

4. **Predict** A shallow pan and a deep bowl hold equal amounts of salt water. If you left both containers in the sun for a day and then measured the salinity of the water in each, which would be saltier? Why?
5. **Analyze** Where in the ocean do you think water pressure is greatest? Explain why.

### CHALLENGE

6. **Synthesize** If you wanted to design a submarine to obtain the most information possible during a research voyage, what features would you include and why? First think about what types of information you would like to collect.