

## CHAPTER 11 The Flow of Fresh Water

## SECTION

## 3

## Water Underground

**BEFORE YOU READ**

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

- What is a water table?
- What is an aquifer?
- What is the difference between a spring and a well?

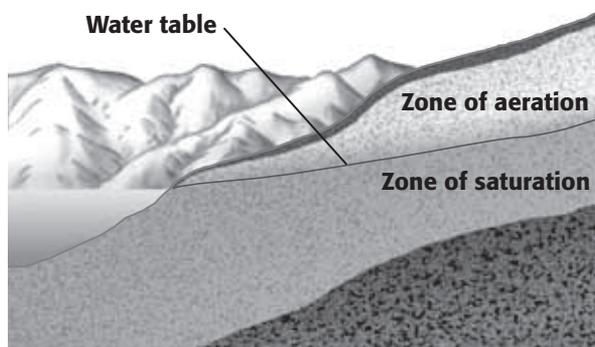
**National Science  
Education Standards**  
ES 1c

**Where Is Fresh Water Found?**

Some of the Earth's fresh water is found in streams and lakes. However, a large amount of water is also found underground. Rainwater and water from streams move through the soil and into the spaces between rocks underground. This underground area is divided into two zones. The *zone of aeration* is the area that rainwater passes through. The spaces between particles in the zone of aeration contain both water and air.

The *zone of saturation* is the area where water collects. The spaces between particles in the zone of saturation are filled with only water. The water found inside underground rocks is called *groundwater*. ✓

The zone of aeration and the zone of saturation meet at a boundary called the **water table**. The depth of the water table is not the same all the time or in all places. The water table can move closer to the surface during wet seasons and farther from the surface during dry seasons. In wet regions, the water table may be just below the surface. In dry regions, the water table may be hundreds of meters below the surface.



The water table is the boundary between the zone of aeration and the zone of saturation.

**STUDY TIP**

**Summarize** As you read, underline the important ideas in this section. When you are finished reading, write a one- or two-paragraph summary of the section, using the underlined ideas.

**READING CHECK**

**1. Define** What is groundwater?

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**TAKE A LOOK**

**2. Infer** If a region receives a lot of rainfall, will the water table in the region probably rise or fall?

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**SECTION 3** Water Underground *continued*

### How Can Water Pass Through Rock?

A layer of rock or sediment that stores groundwater is called an **aquifer**. Most aquifers are made of sedimentary rock. There can be many *pores*, or open spaces, between the particles in an aquifer. The more open spaces there are, the more water the aquifer can hold. The fraction of a rock's volume that is taken up by pores is called the rock's **porosity**. ✓

**READING CHECK**

**3. Define** What is porosity?

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### Critical Thinking

**4. Apply Concepts** Shale has a very high porosity. However, shale does not form many aquifers, because water cannot move through it easily. Explain why this might be the case.

(Hint: What is permeability?)

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Imagine filling a jar with large pebbles. The pebbles cannot fill all of the space in the jar, so there will be many open spaces. In other words, the jar has a high porosity. Now, imagine pouring sand over the pebbles in the jar. The sand can fill the spaces between the pebbles, leaving little open space in the jar. The jar has a low porosity.

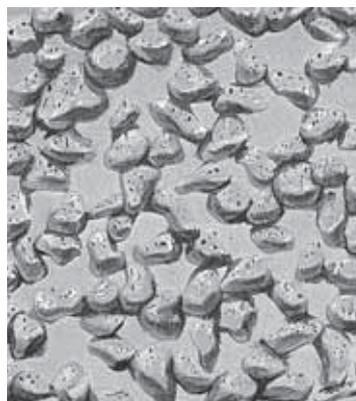
Like the jar, the sizes of the particles in a rock affect the rock's porosity. Rocks made of the same-sized particles tend to have high porosity, like the jar of pebbles. Rocks made of different-sized particles tend to have low porosity, like the jar with sand and pebbles.

If the open spaces in the rock layer are connected, water can move through the rock. A rock's ability to let water pass through is called **permeability**. Rock that water can not flow through is called *impermeable*.

The size of rock particles also affects permeability. Rock made of large particles tends to have a high permeability. This is because the large particles produce less friction on the water moving through them. *Friction* is a force that slows down moving objects. Rock particles produce friction on water when the water touches the rock particles.



The large particles touch the water in only a few places. They produce little friction on the water, so they have a high permeability.



The small particles touch the water in many places. They produce a lot of friction on the water, so they have a low permeability.

### TAKE A LOOK

**5. Explain** Why do small particles produce more friction on the water than large particles?

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**SECTION 3** Water Underground *continued***RECHARGE ZONES**

Like rivers, aquifers depend on precipitation to keep their water level constant. Precipitation that falls onto land can flow through the ground and into an aquifer. The ground surface where water enters an aquifer is called the aquifer's **recharge zone**. Recharge zones are found where the soil and rock above an aquifer are permeable. ✓

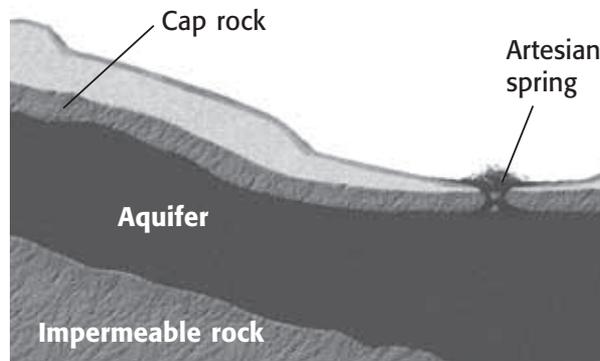
Some aquifers are small, but many cover large underground areas. Many cities and farms depend on aquifers for fresh water.

People's actions can affect the amount and quality of water in an aquifer. If people build roads or buildings in a recharge zone, less water can enter the aquifer. If people dump chemicals in a recharge zone, the chemicals can enter the aquifer and pollute the water in it.

**What Is a Spring?**

Like all water, groundwater tends to move downhill. Remember that the water table can be at different depths in different places. Groundwater tends to move to follow the slope of the water table. When the water table meets the Earth's surface, water flows out and forms a *spring*. Springs are important sources of drinking water. ✓

In some places, an aquifer is found between two layers of impermeable rock. This is called an *artesian formation*. The top layer of impermeable rock is called the *cap rock*. If the water in the aquifer flows through a crack in the cap rock, it forms an **artesian spring**.



The water from most springs is cool. However, rock far below Earth's surface can be very hot. Therefore, water that flows through deep aquifers may be very hot. When this water reaches the surface, it can form a *hot spring*.

**READING CHECK**

**6. Identify** Where does the water in aquifers come from?

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**READING CHECK**

**7. Describe** How does a spring form?

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**TAKE A LOOK**

**8. Explain** What causes an artesian spring to form?

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**SECTION 3** Water Underground *continued*

### How Do People Get Water Out of the Ground?

When people need a supply of water, they often dig a well. A *well* is a hole dug by people that is deeper than the water table. If the well does not reach below the water table, the well will not produce water. In addition, too many wells may remove water from an aquifer more quickly than the aquifer can refill. Then, the water table can drop and all the wells can go dry.

#### TAKE A LOOK

**9. Identify** Two people drilled wells to try to get water out of the ground. The white bars in the figure show where the two people drilled their wells. Which of the wells will probably produce water? Explain your answer.

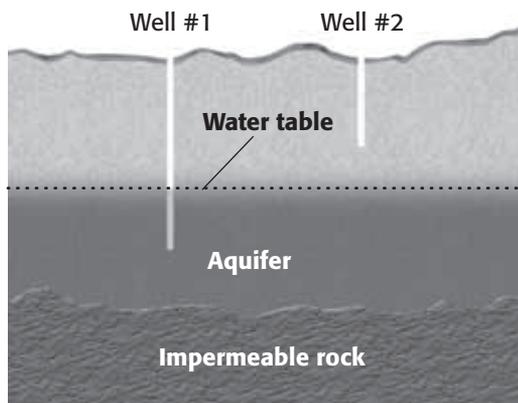
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### How Can Groundwater Cause Weathering?

Remember that streams can cause physical weathering when particles in the stream hit other particles and cause them to break. Groundwater can also cause weathering. However, instead of physical weathering, groundwater causes chemical weathering by dissolving rock.

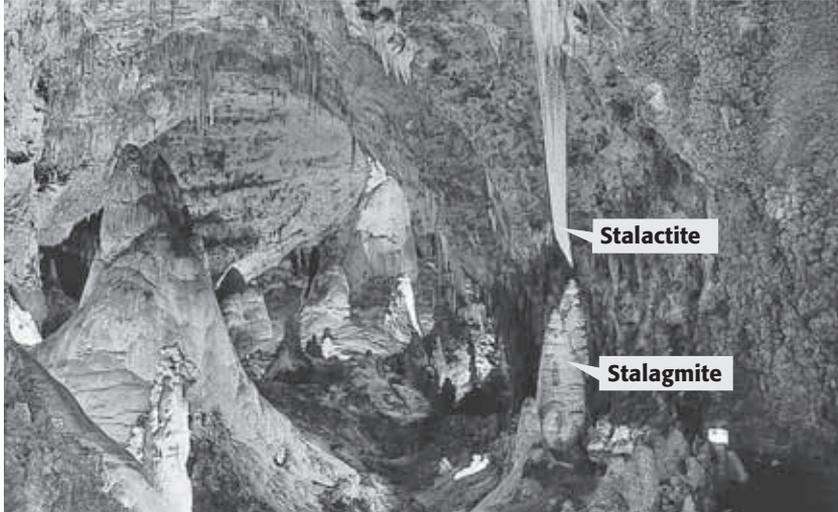
Many minerals, such as calcite, can dissolve in water. When groundwater flows through rock that contains these minerals, the minerals can dissolve. Rocks that contain a lot of these minerals, such as limestone, can weather faster than other rocks. In addition, some groundwater contains weak acids. These acids can dissolve the rock more quickly than pure water can.

Weathering by groundwater can form large caves. In fact, most of the caves in the world have formed because of weathering by groundwater. The caves form slowly over thousands of years as groundwater dissolves limestone. The figure on the next page shows how large some of these caves can become.

#### Say It

**Investigate** Learn more about an area that has large underground caves. What kind of rock did the caves form in? How did the caves form? Share your findings with a small group.

**SECTION 3** Water Underground *continued*



This cave in New Mexico formed when groundwater dissolved huge volumes of limestone.

**TAKE A LOOK**

**10. Identify** Name one kind of rock that can be dissolved by groundwater.

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**What Structures Can Groundwater Form?**

Many caves show signs of deposition as well as weathering. Water flowing through caves can have many minerals dissolved in it. If the water drips from a crack in the cave’s ceiling, it can deposit these minerals. These deposits form icicle-shaped structures that hang from the ceilings. They are called *stalactites*.

Water that falls to the cave floor can build cone-shaped structures called *stalagmites*. Sometimes, a stalactite and a stalagmite join together to form a *dripstone column*.

Sometimes, the roof of a cave can collapse. This forms a circular *depression*, or pit, on the Earth’s surface called a *sinkhole*. Sinkholes can damage buildings, roads, and other structures on the surface. Streams can “disappear” into sinkholes and flow through the cave underground. In areas where the water table is high, lakes can form inside sinkholes.

*Critical Thinking*

**11. Compare** How is a stalactite different from a stalagmite?

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This sinkhole formed in Florida when a cave collapsed.

**TAKE A LOOK**

**12. Identify Relationships** How are caves and sinkholes related?

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# Section 3 Review

## SECTION VOCABULARY

<p><b>aquifer</b> a body of rock or sediment that stores groundwater and allows the flow of groundwater</p> <p><b>artesian spring</b> a spring whose water flows from a crack in the cap rock over an aquifer</p> <p><b>permeability</b> the ability of a rock or sediment to let fluids pass through its open spaces, or pores</p>	<p><b>porosity</b> the percentage of the total volume of a rock or sediment that consists of open spaces</p> <p><b>recharge zone</b> an area in which water travels downward to become part of an aquifer</p> <p><b>water table</b> the upper surface of underground water; the upper boundary of the zone of saturation</p>
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1. **Explain** Why is it important to know where the water table is located?

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2. **Describe** How does particle size affect the porosity of an aquifer?

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3. **Infer** How could building new roads affect the recharge zone of an aquifer?

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4. **Compare** What is the difference between a spring and a well?

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5. **List** What are two features that are formed by underground weathering?

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6. **Describe** How does a dripstone column form?

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