

# 2 Water Erosion



🔑 How Does Moving Water Cause Erosion?

🔑 What Land Features Are Formed by Water Erosion and Deposition?

## my planet DiARY

### FIELD TRIP

#### The Great Blue Hole

The boat leaves at 5:30 A.M. But you don't mind the early hour because it's the trip of a lifetime: a visit to the Great Blue Hole of Belize.

The Great Blue Hole is actually the remains of a cave formed by erosion. Several factors, including rising sea levels, caused the roof of the cave to collapse. This resulted in a natural depression called a sinkhole.

The Great Blue Hole is more than 300 meters wide and 125 meters deep. It's possibly the deepest and most massive sinkhole in the world. If you want to explore it, you have to scuba dive through the roof. It's an impressive example of what nature can accomplish over time!

Read the story. Then answer the question.

How was the Great Blue Hole formed?

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▶ PLANET DIARY Go to Planet Diary to learn more about water erosion.

**Lab zone** Do the Inquiry Warm-Up *How Does Moving Water Wear Away Rocks?*

### How Does Moving Water Cause Erosion?

Erosion by water begins with a splash of rain. Some rainfall sinks into the ground. Some evaporates or is taken up by plants. The rest of the water runs off over the land surface. 🚗 **Moving water is the major agent of the erosion that has shaped Earth's land surface.**

### Vocabulary

- runoff • rill • gully • stream • tributary
- flood plain • meander • oxbow lake • delta
- alluvial fan • groundwater • stalactite
- stalagmite • karst topography

### Skills

- 🔍 Reading: Identify Supporting Evidence
- 🔺 Inquiry: Develop Hypotheses

### Runoff

As water moves over the land, it carries particles with it. This moving water is called **runoff**. When runoff flows in a thin layer over the land, it may cause a type of erosion called sheet erosion. The amount of runoff in an area depends on five main factors. The first factor is the amount of rain an area gets. A second factor is vegetation. Grasses, shrubs, and trees reduce runoff by absorbing water and holding soil in place. A third factor is the type of soil. Some types of soils absorb more water than others. A fourth factor is the shape of the land. Steeply sloped land has more runoff than flatter land. Finally, a fifth factor is how people use land. For example, a paved parking lot absorbs no water. All the rain that falls on it becomes runoff. Runoff also increases when farmers cut down crops, since this removes vegetation from the land.

Generally, more runoff means more erosion. In contrast, factors that reduce runoff will reduce erosion. Even though deserts have little rainfall they often have high runoff and erosion because they have few plants and thin soil. In wet areas, runoff and erosion may be low because there are more plants to help protect the soil.

✎ **Identify Supporting Evidence** As you read the paragraph on the left, number each of the factors that affect runoff.

Factor	Example

FIGURE 1 **Factors Affecting Runoff**  
 ✎ **Complete the task below.**  
 1. **List** Record the five main factors affecting runoff.  
 2. **Identify** Using a specific location, such as a park, identify an example for each factor.  
 3. **Communicate** Explain to a partner what the runoff would be like at your location.

**Stream Formation** Because of gravity, runoff and the material it contains flow downhill. As this water moves across the land, it runs together to form rills, gullies, and streams.

**Rills and Gullies** As runoff travels, it forms tiny grooves in the soil called **rills**. When many rills flow into one another, they grow larger, forming a gully. A **gully** is a large groove, or channel, in the soil that carries runoff after a rainstorm. As water flows through gullies, it moves soil and rocks with it, thus enlarging the gullies through erosion. Gullies only contain water during a rainstorm and for a short time after it rains.

**Streams and Rivers** Gullies join together to form a larger channel called a stream. A **stream** is a channel along which water is continually flowing down a slope. Unlike gullies, streams rarely dry up. Small streams are also called creeks or brooks. As streams flow together, they form larger and larger bodies of flowing water. A large stream is often called a river.

**Tributaries** A stream grows into a larger stream or river by receiving water from tributaries. A **tributary** is a stream or river that flows into a larger river. For example, the Missouri and Ohio rivers are tributaries of the Mississippi River. A drainage basin, or watershed, is the area from which a river and its tributaries collect their water.

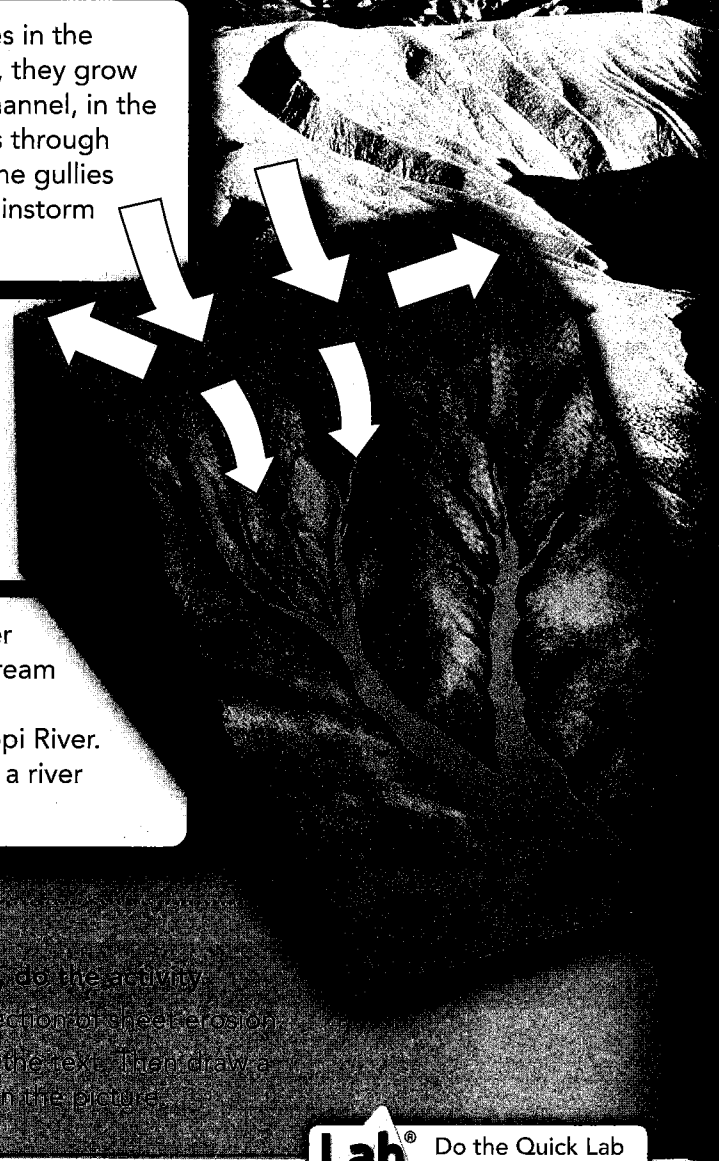


FIGURE 2 Stream Formation

- Relate Text and Visuals** After you read, do the activity.
1. Shade in the arrows that indicate the direction of sheet erosion.
  2. Circle the terms *rills*, *gully*, and *stream* in the text. Then draw a line from the word to examples of them in the picture.

**Lab zone** Do the Quick Lab *Raindrops Falling.*

**Assess Your Understanding**

**1a. Review** How does runoff affect the rate of erosion?  
\_\_\_\_\_  
\_\_\_\_\_

**b. Sequence** Put these in order of size from smallest to biggest: creek, rill, gully, river.  
\_\_\_\_\_  
\_\_\_\_\_

**got it?** .....

I get it! Now I know what runoff does: \_\_\_\_\_  
\_\_\_\_\_

I need extra help with \_\_\_\_\_  
\_\_\_\_\_

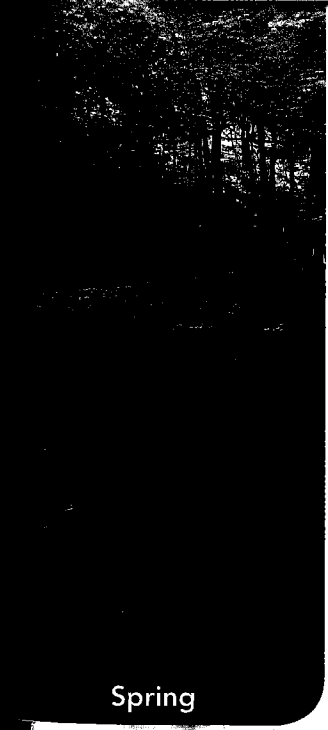
### What Land Features Are Formed by Water Erosion and Deposition?

Walking in the woods in summer, you can hear the racing water of a river before you see the river itself. When you reach the river's banks, you see water rushing by. Sand and pebbles tumble along the river bottom. As it swirls downstream, the water also carries twigs, leaves, and bits of soil. In sheltered pools, insects skim the water's calm surface. Beneath the surface, a rainbow trout swims in the clear water. As the seasons change, so does the river. In winter, the surface of the river may freeze. But during spring, it may flood. Throughout the year, the river continues to erode Earth's surface.

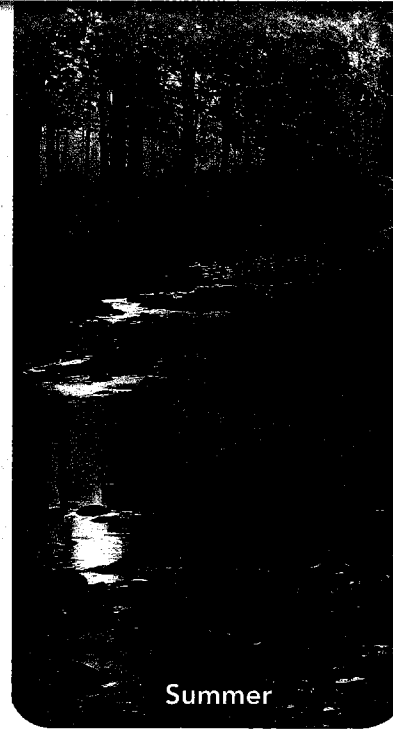
FIGURE 3

#### River Erosion

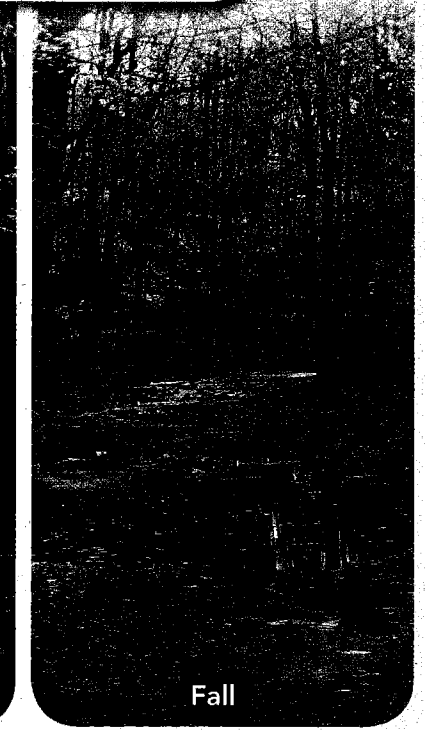
**Interpret Photos** How does a river's ability to erode change with the seasons? (*Hint: Look at how the amount of water changes during each season.*)



Spring



Summer




Fall

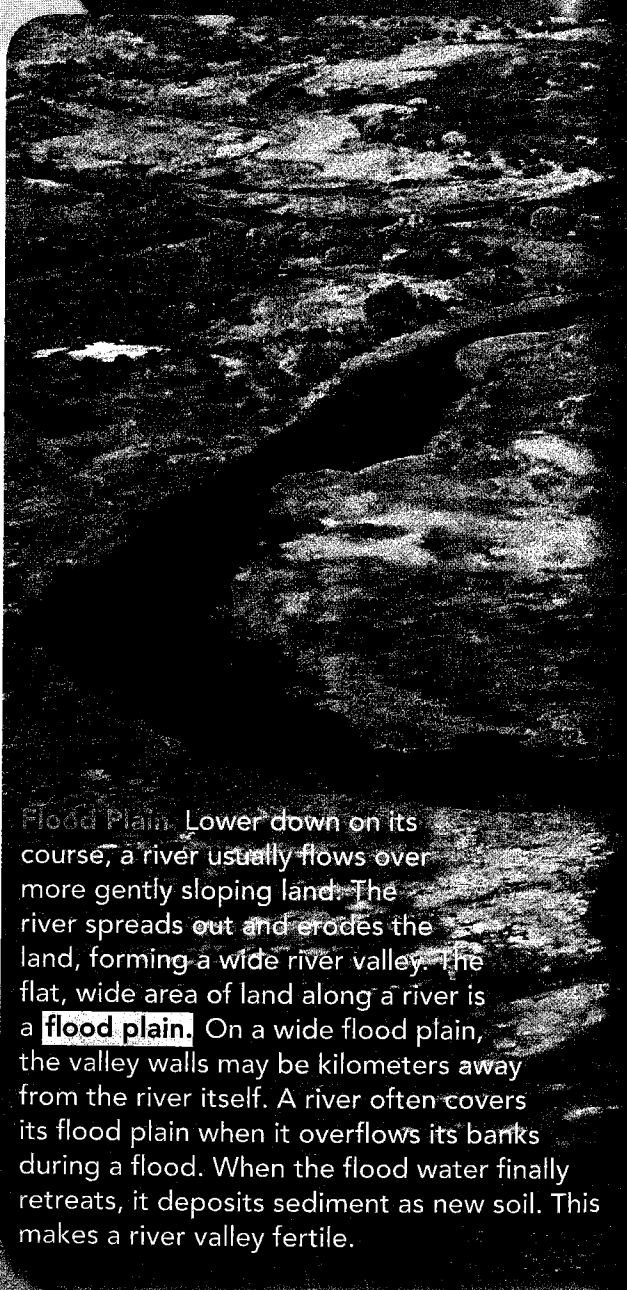
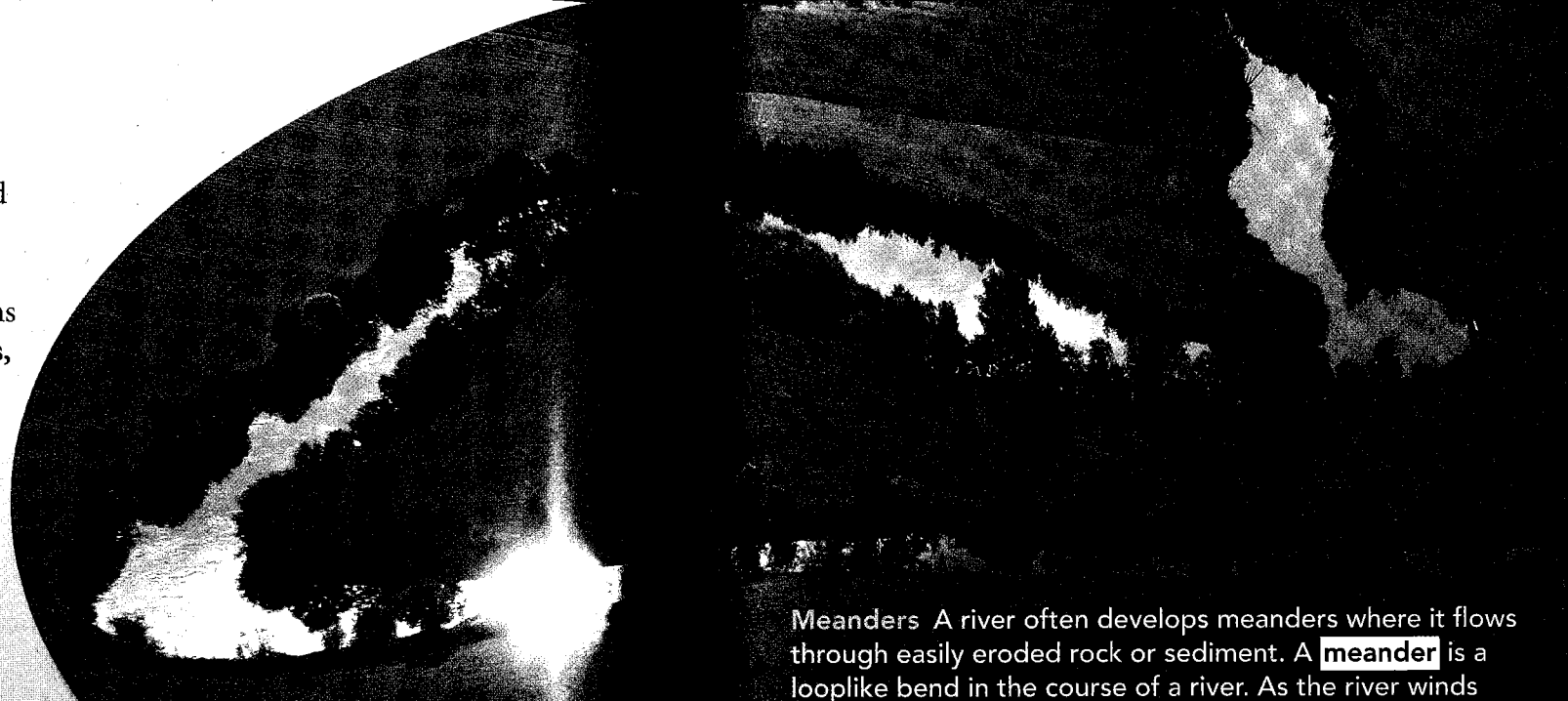


Winter

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**Water Erosion** Many rivers begin on steep mountain slopes. Near their source, these rivers can be fast-flowing and generally follow a straight, narrow course. The steep slopes along the river erode rapidly, resulting in a deep, V-shaped valley. As a river flows from the mountains to the sea, it forms many features.  **Through erosion, a river creates valleys, waterfalls, flood plains, meanders, and oxbow lakes.**

**Waterfalls** Waterfalls may occur where a river meets an area of rock that is very hard and erodes slowly. The river flows over this rock and then flows over softer rock downstream. Softer rock wears away faster than harder rock. Eventually a waterfall develops where the softer rock was removed. Areas of rough water called rapids also occur where a river tumbles over hard rock.



**Flood Plain.** Lower down on its course, a river usually flows over more gently sloping land. The river spreads out and erodes the land, forming a wide river valley. The flat, wide area of land along a river is a **flood plain**. On a wide flood plain, the valley walls may be kilometers away from the river itself. A river often covers its flood plain when it overflows its banks during a flood. When the flood water finally retreats, it deposits sediment as new soil. This makes a river valley fertile.

**Meanders** A river often develops meanders where it flows through easily eroded rock or sediment. A **meander** is a looplike bend in the course of a river. As the river winds from side to side, it tends to erode the outer bank and deposit sediment on the inner bank of a bend. Over time, a meander becomes more curved.

Because of the sediment a river carries, it can erode a very wide flood plain. Along this part of a river's course, its channel may be deep and wide. The southern stretch of the Mississippi River meanders on a wide, gently sloping flood plain.

**Oxbow Lakes** Sometimes a meandering river forms a feature called an oxbow lake. As the photo below shows, an **oxbow lake** is a meander that has been cut off from the river. An oxbow lake may form when a river floods. During the flood, high water finds a straighter route downstream. As the flood waters fall, sediments dam up the ends of a meander, forming an oxbow lake.

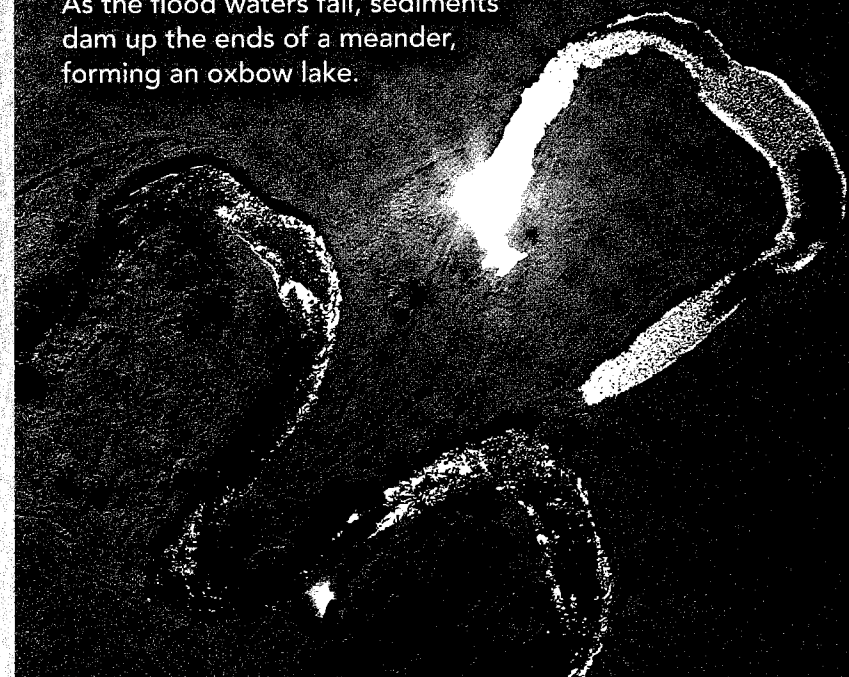

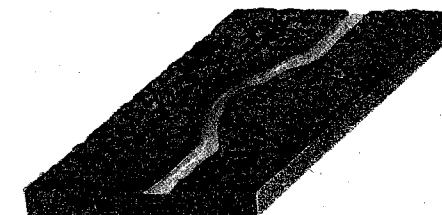


FIGURE 5 .....

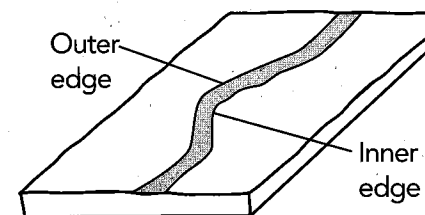
**Oxbow Lakes**

A meander may gradually form an oxbow lake.

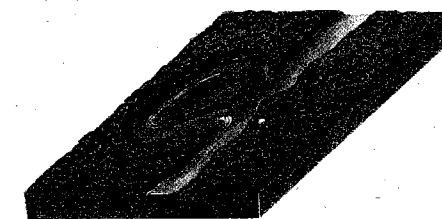
 **Make Models** Draw steps 2 and 4 to show how an oxbow lake forms and describe the last step.



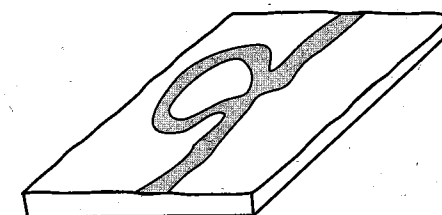
1 A small obstacle creates a slight bend in the river.



2 As water erodes the outer edge, the bend becomes bigger, forming a meander. Deposition occurs along the inner edge.



3 Gradually, the meander becomes more curved. The river breaks through and takes a new course.



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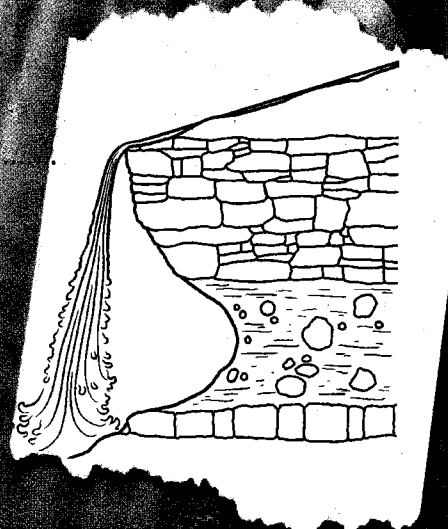



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FIGURE 4 .....

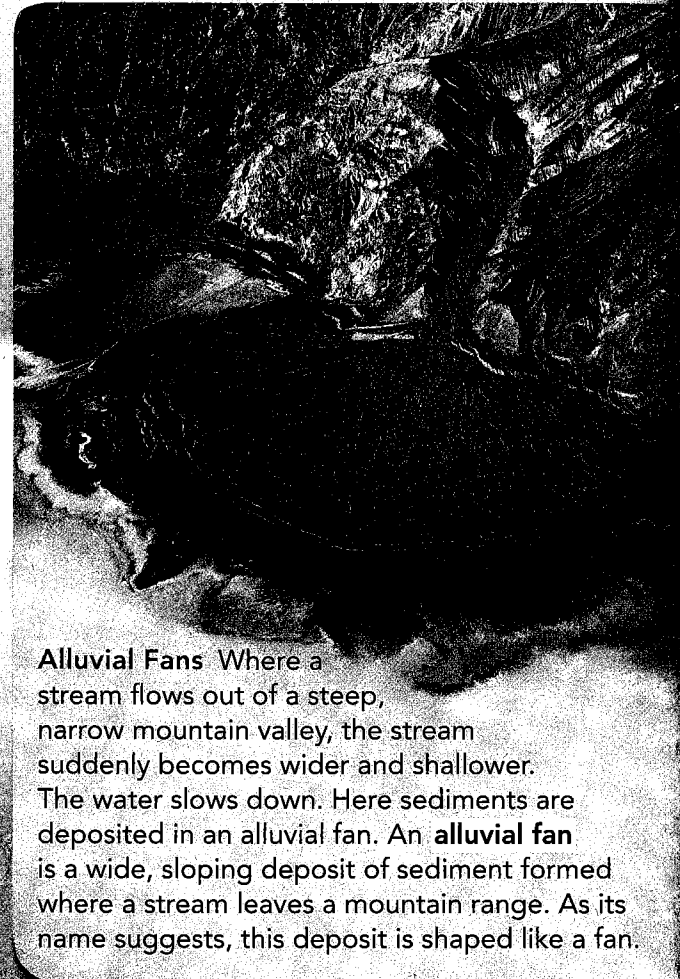
**Waterfalls**

 **Apply Concepts** Where do you think the layers of hard and soft rock are located? Label the areas on the diagram to show your answer.




**Water Deposition** As water moves, it carries sediment with it. Any time moving water slows down, it drops, or deposits, some of the sediment. In this way, soil can be added to a river's flood plain. As the water slows down, large stones quit rolling and sliding. Fine particles fall to the river's bed as the river flows even more slowly.  **Deposition** creates landforms such as alluvial fans and deltas.

A river ends its journey when it flows into a still body of water, such as an ocean or a lake. Because the river water is no longer flowing downhill, the water slows down. At this point, the sediment in the water drops to the bottom. Sediment deposited where a river flows into an ocean or lake builds up a landform called a **delta**. Deltas can be a variety of shapes. Some are arc-shaped, others are triangle-shaped. The delta of the Mississippi River, shown here, is an example of a type of delta called a "bird's foot" delta.



**Alluvial Fans** Where a stream flows out of a steep, narrow mountain valley, the stream suddenly becomes wider and shallower. The water slows down. Here sediments are deposited in an alluvial fan. An **alluvial fan** is a wide, sloping deposit of sediment formed where a stream leaves a mountain range. As its name suggests, this deposit is shaped like a fan.

**FIGURE 6** .....  
**Deposits by Rivers**  
 **Interpret Photos** Use the pictures above to describe the difference between an alluvial fan and a delta.

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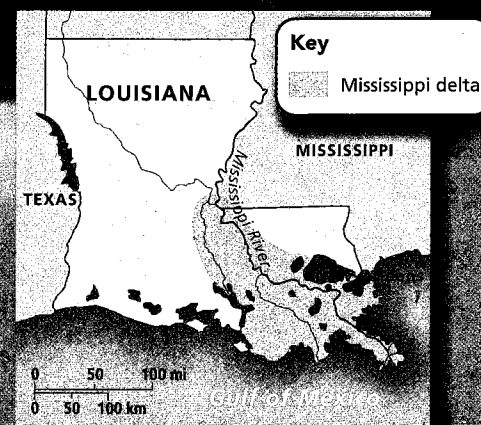
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## Rolling Through the Hills



What processes shape the surface of the land?

**FIGURE 7** .....  
**REAL-WORLD INQUIRY** You're a tour guide in the area pictured below, and your tour group wants to learn more about some of the features they are seeing.

 **Relate Evidence and Explanation** Identify the two missing features on the image below. Then summarize what you would say about them to your tour group.

**Waterfalls and Rapids**  
 Waterfalls and rapids are common where the river passes over harder rock.

**V-Shaped Valley** Near its source, the river flows through a deep, V-shaped valley. As the river flows, it cuts the valley deeper.

**Tributary** The river receives water and sediment from a tributary—a smaller river or stream that flows into it.

**Oxbow Lake** An oxbow lake is a meander cut off from the river by deposition of sediment.

**Flood Plain** A flood plain forms where the river's power of erosion widens its valley rather than deepening it.

**Valley Widening** As the river approaches sea level, it meanders more and develops a wider valley and broader flood plain.

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**did you know?**

The Schellenberg Ice cave in Germany is a limestone cave with ice formations. Cold air is trapped in the lower areas of the cave so the temperature stays near freezing. This keeps the ice formations from melting.



**Groundwater Erosion** When rain falls and snow melts, not all of the water evaporates or becomes runoff. Some water soaks into the ground. There it fills the openings in the soil and trickles into cracks and spaces in layers of rock. **Groundwater** is the term geologists use for this underground water. Like running water on the surface, groundwater affects the shape of the land.

**Groundwater can cause erosion through a process of chemical weathering.** Rainwater is naturally acidic. In the atmosphere, water combines with carbon dioxide to form a weak acid called carbonic acid. Carbonic acid can break down limestone. Groundwater containing carbonic acid flows into any cracks in the limestone. Then some of the limestone dissolves and is carried away in a solution of water. This process gradually hollows out pockets in the rock. Over time, these pockets develop into large holes underground, called caves or caverns.

**Cave Formations** The action of carbonic acid on limestone can also result in deposition. Inside limestone caves, deposits called stalactites and stalagmites often form. Water containing carbonic acid and calcium from limestone drips from a cave's roof. Carbon dioxide escapes from the solution, leaving behind a deposit of calcite. A deposit that hangs like an icicle from the roof of a cave is known as a **stalactite** (stuh LAK tyt). Slow dripping builds up a cone-shaped **stalagmite** (stuh LAK tyt) from the cave floor.

FIGURE 8

**Groundwater Erosion and Deposition**

**Explain** How do erosion and deposition shape caves? Take notes as you read. Then discuss with a classmate.

**Process of Erosion**

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**Process of Deposition**

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**Karst Topography** In rainy regions where there is a layer of limestone near the surface, groundwater erosion can significantly change the shape of the land. Streams are rare, because water easily sinks down into the weathered limestone. Deep valleys and caverns are common. If the roof of a cave collapses because of the erosion of the underlying limestone, the result is a depression called a sinkhole. This type of landscape is called **karst topography** after a region in Eastern Europe.



This sinkhole is in Russia's Perm region.

**apply it!**

Study the map and answer the questions below.

1 Name three states in which you can find karst topography.

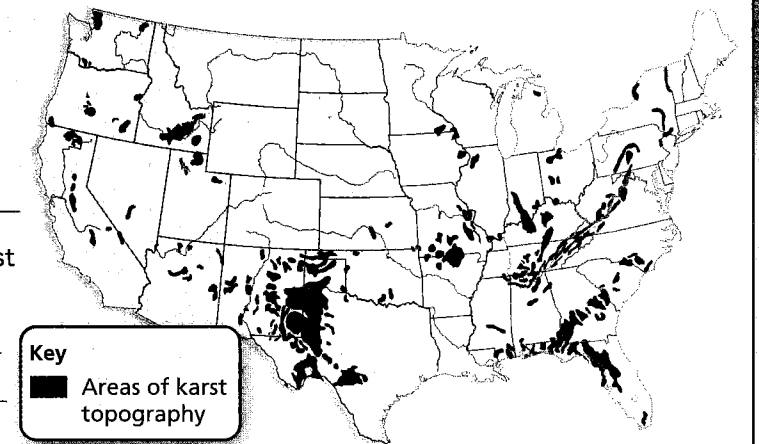
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2 **Develop Hypotheses** Why do you think karst topography occurs in these areas?

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**Lab zone** Do the Quick Lab Erosion Cube.

**Assess Your Understanding**

2a. **List** Name two features of water erosion.

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\_\_\_\_\_

b. **CHALLENGE** What is carbonic acid and how does it affect rock?

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\_\_\_\_\_

c. **ANSWER THE BIG QUESTION** What processes shape the surface of the land?

\_\_\_\_\_

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\_\_\_\_\_

**got it?**

I get it! Now I know that features of erosion and deposition include \_\_\_\_\_

I need extra help with \_\_\_\_\_