

# Erosion by Gravity

## as you read

### What You'll Learn

- Explain the differences between erosion and deposition.
- Compare and contrast slumps, creep, rockfalls, rock slides, and mudflows.
- Explain why building on steep slopes might not be wise.

### Why It's Important

Many natural features throughout the world were shaped by erosion.

### Review Vocabulary

**sediment:** loose materials, such as mineral grains and rock fragments, that have been moved by erosional forces

### New Vocabulary

- erosion
- deposition
- mass movement
- slump
- creep

**Figure 1** The jumbled sediment at the base of a landslide is material that once was located farther uphill.

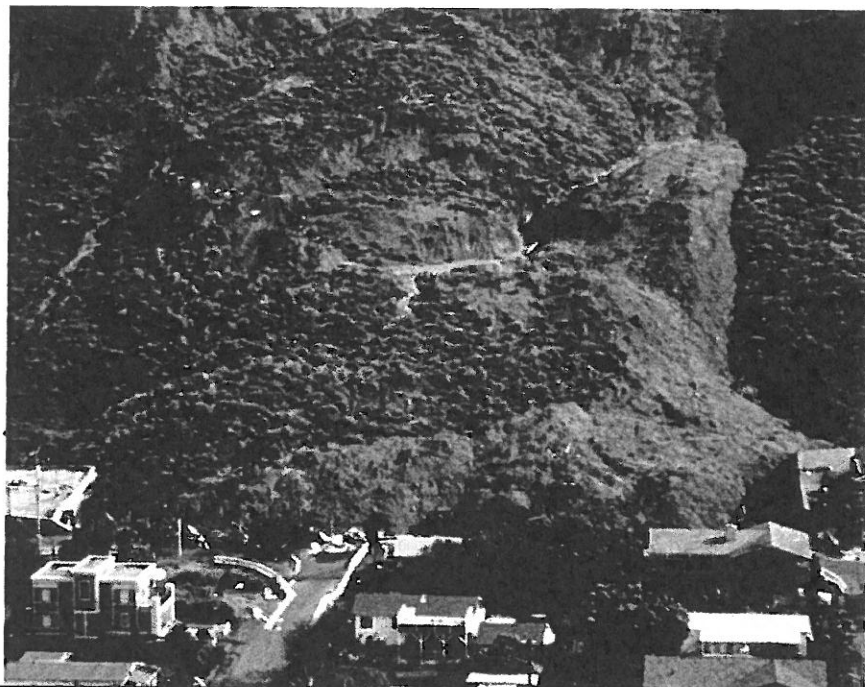
**Define** the force that moves materials toward the center of Earth.

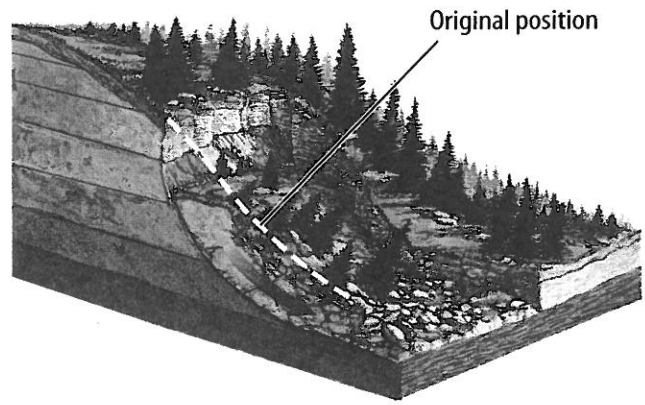
## Erosion and Deposition

Do you live in an area where landslides occur? As **Figure 1** shows, large piles of sediment and rock can move downhill with devastating results. Such events often are triggered by heavy rainfall. The muddy debris at the lower end of the slide comes from material that once was further up the hillside. The displaced soil and rock debris is a product of erosion (ih ROH zhun). **Erosion** is a process that wears away surface materials and moves them from one place to another.

**What wears away sediments?** How were you able to move the pile of sediments in the Launch Lab? If you happened to tilt the pan, you took advantage of an important erosional force—gravity. Gravity is the force of attraction that pulls all objects toward Earth's center. Other causes of erosion, also called agents of erosion, are water, wind, and glaciers.

Water and wind erode materials only when they have enough energy of motion to do work. For example, air can't move much sediment on a calm day, but a strong wind can move dust and even larger particles. Glacial erosion works differently by slowly moving sediment that is trapped in solid ice. As the ice melts, sediment is deposited, or dropped. Sometimes sediment is carried farther by moving meltwater.





**Dropping Sediments** Agents of erosion drop the sediments they are carrying as they lose energy. This is called **deposition**. When sediments are eroded, they are not lost from Earth—they are just relocated.

## Mass Movement

The greater an object's mass is, the greater its gravitational force is. Earth has such a great mass that gravity is a major force of erosion and deposition. Rocks and other materials, especially on steep slopes, are pulled toward the center of Earth by gravity.

A **mass movement** is any type of erosion that happens as gravity moves materials downslope. Some mass movements are so slow that you hardly notice they're happening. Others happen quickly—possibly causing catastrophes. Common types of mass movement include slump, creep, rockfalls, rock slides, and mudflows. Landslides are mass movements that can be one of these types or a combination of these types of mass movement.

**Reading Check** *What is a mass movement?*

**Slump** When a mass of material slips down along a curved surface, the mass movement is called **slump**. Often, when a slope becomes too steep, the base material no longer can support the rock and sediment above it. The soil and rock slip downslope as one large mass or break into several sections.

Sometimes a slump happens when water moves to the base of a slipping mass of sediment. This water weakens the slipping mass and can cause movement of material downhill. Or, if a strong rock layer lies on top of a weaker layer—commonly clay—the clay can weaken further under the weight of the rock. The clay no longer can support the strong rock on the hillside. As shown in **Figure 2**, a curved scar is left where the slumped materials originally rested.

**Figure 2** Slump occurs when material slips downslope as one large mass.

**Infer** *What might have caused this slump to happen?*



### Modeling Slump

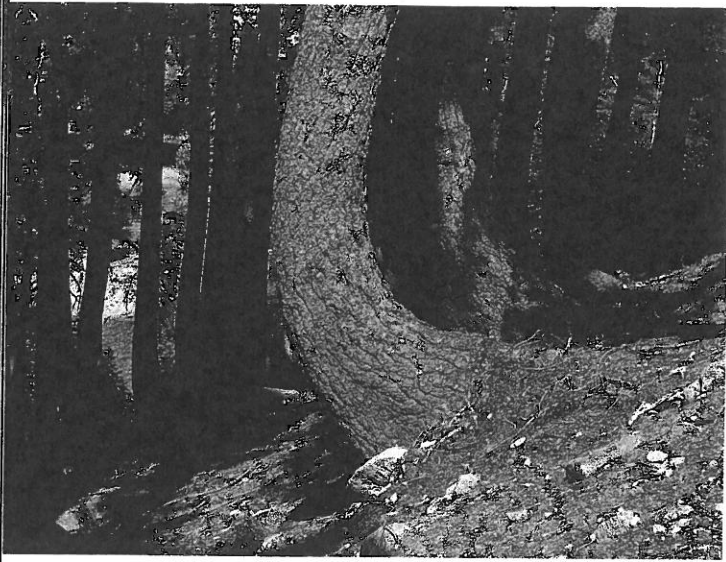
**Procedure** 

**WARNING:** *Do not pour lab materials down the drain.*

1. Place one end of a **baking pan** on **two bricks** and position the other end over a sink with a sealed drain.
2. Fill the bottom half of the pan with **gelatin powder** and the top half of the pan with **aquarium gravel**. Place a large, **flat rock** on the gravel.
3. Using a **watering can**, sprinkle water on the materials in the pan for several minutes. Record your observations in your **Science Journal**.

### Analysis

1. What happened to the different sediments in the pan?
2. Explain how your experiment models slump.



**Figure 3** Over time, creep has caused these tree trunks to lean downhill. The trees then curved back toward the Sun.

**Creep** The next time you travel, look along the roadway or trail for slopes where trees and fence posts lean downhill. Leaning trees and human-built structures show another mass movement called creep. **Creep** occurs when sediments slowly shift their positions downhill, as **Figure 3** illustrates. Creep is common in areas of frequent freezing and thawing.

**Rockfalls and Rock Slides** Signs along mountainous roadways warn of another type of mass movement called rockfalls. Rockfalls happen when blocks of rock break loose from a steep slope and tumble through the air. As they fall, these rocks crash into other rocks and

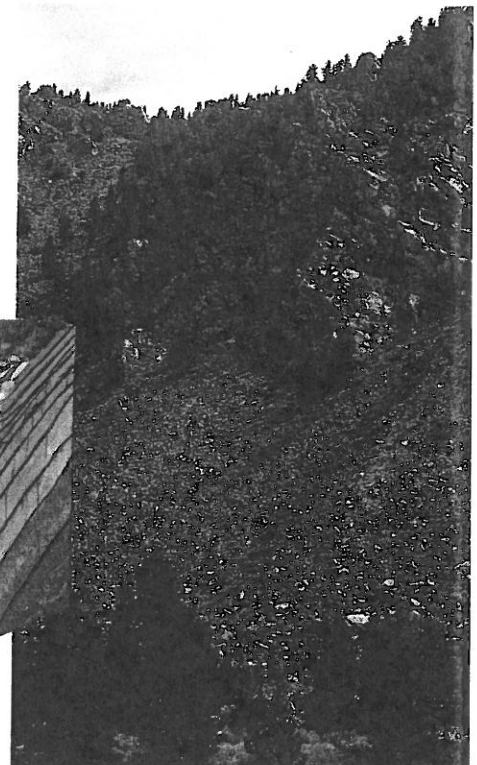
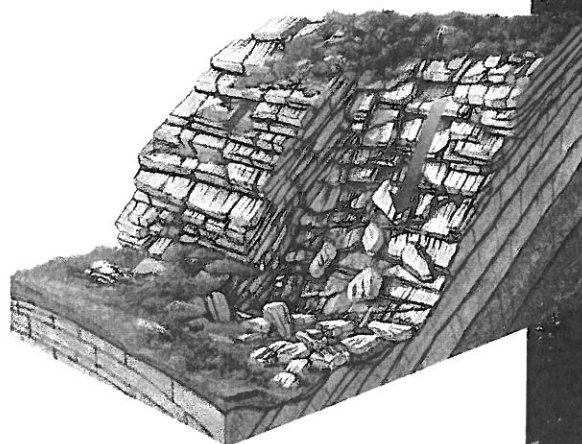
knock them loose. More and more rocks break loose and tumble to the bottom. The fall of a single, large rock down a steep slope can cause serious damage to structures at the bottom. During the winter, when ice freezes in the cracks of rocks, the cracks expand and extend. In the spring, the pieces of rock break loose and fall down the mountainside, as shown in **Figure 4**.

Rock slides occur when layers of rock—usually steep layers—slip downslope suddenly. Rock slides, like rockfalls, are fast and can be destructive in populated areas. They commonly occur in mountainous areas or in areas with steep cliffs, also as shown in **Figure 5**. Rock slides happen most often after heavy rains or during earthquakes, but they can happen on any rocky slope at any time without warning.

**Figure 4** Rockfalls, such as this one, occur as material free falls through the air.



**Figure 5** Rock slides are common in regions where layers of rock are steep.



**Mudflows** What would happen if you took a long trip and forgot to turn off the sprinkler in your hillside garden before you left? If the soil is usually dry, the sprinkler water could change your yard into a muddy mass of material much like chocolate pudding. Part of your garden might slide downhill. You would have made a mudflow, a thick mixture of sediments and water flowing down a slope. The mudflow in **Figure 6** caused a lot of destruction.

Mudflows usually occur in areas that have thick layers of loose sediments. They often happen after vegetation has been removed by fire. When heavy rains fall on these areas, water mixes with sediment, causing it to become thick and pasty. Gravity causes this mass to flow downhill. When a mudflow finally reaches the bottom of a slope, it loses its energy of motion and deposits all the sediment and everything else it has been carrying. These deposits often form a mass that spreads out in a fan shape. Why might mudflows cause more damage than floodwaters?

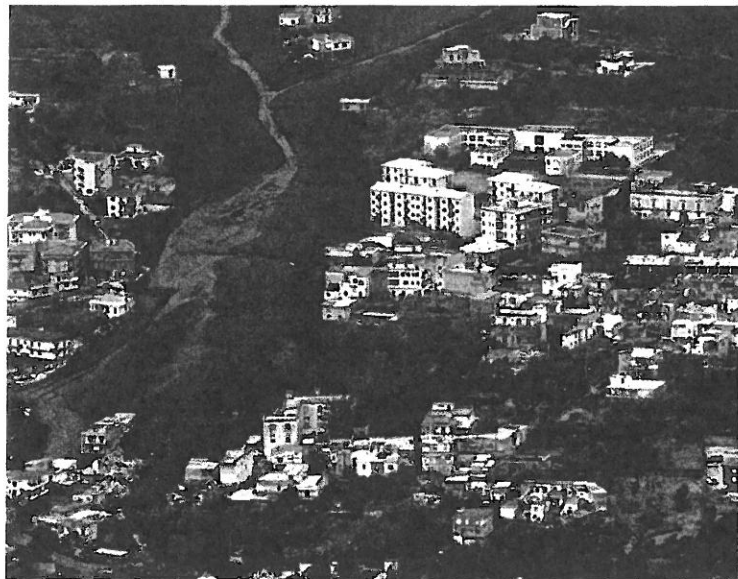
**Reading Check** *What conditions are favorable for triggering mudflows?*

Mudflows, rock slides, rockfalls, creep, and slump are similar in some ways. They all are most likely to occur on steep slopes, and they all depend on gravity to make them happen. Also, all types of mass movement occur more often after a heavy rain. The water adds mass and creates fluid pressure between grains and layers of sediment. This makes the sediment expand—possibly weakening it.

## Consequences of Erosion

People like to have a great view and live in scenic areas away from noise and traffic. To live this way, they might build or move into houses and apartments on the sides of hills and mountains. When you consider gravity as an agent of erosion, do you think steep slopes are safe places to live?

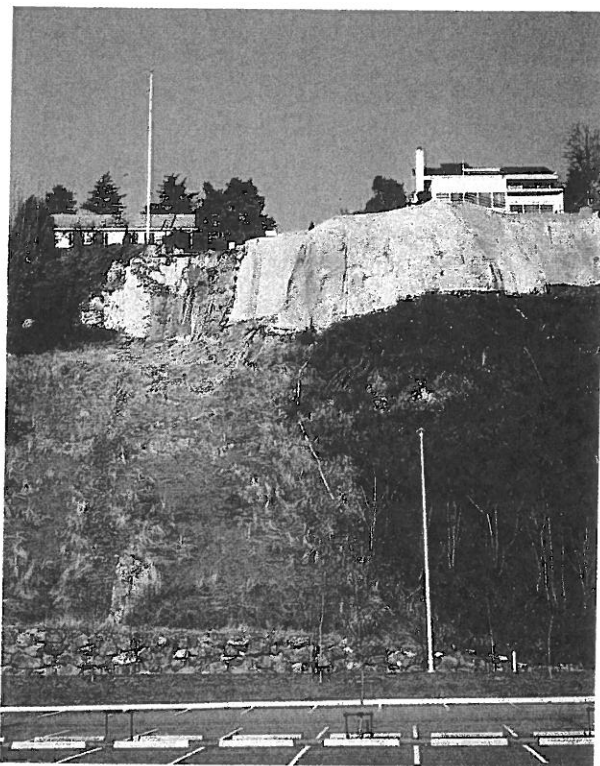
**Building on Steep Slopes** When people build homes on steep slopes, they constantly must battle naturally occurring erosion. Sometimes builders or residents make a slope steeper or remove vegetation. This speeds up the erosion process and creates additional problems. Some steep slopes are prone to slumps because of weak sediment layers underneath.



**Figure 6** Mudflows, such as these in the town of Sarno, Italy, have enough energy to move almost anything in their paths. **Explain** how mudflows differ from slumps, creep, and rock slides.



**Driving Force** The force that drives most types of erosion is gravity. Water at an elevation has potential, or stored energy. When water drops in elevation this energy changes to kinetic energy, or energy of motion. Water may then become a powerful agent of erosion. Find out how water has shaped the region in which you live.



**Figure 7** Some slopes are stabilized by building walls made from concrete or stone.

**Making Steep Slopes Safe** Plants can be beautiful or weedlike—but they all have root structures that hold soil in place. One of the best ways to reduce erosion is to plant vegetation. Deep tree roots and fibrous grass roots bind soil together, reducing the risk of mass movement. Plants also absorb large amounts of water. Drainage pipes or tiles inserted into slopes can prevent water from building up, too. These materials help increase the stability of a slope by allowing excess water to flow out of a hillside more easily.

Walls made of concrete or boulders also can reduce erosion by holding soil in place, as shown in **Figure 7**. However, preventing mass movements on a slope is difficult because rain or earthquakes can weaken all types of Earth materials, eventually causing them to move downhill.

**Reading Check** *What can be done to slow erosion on steep slopes?*

People who live in areas with erosion problems spend a lot of time and money trying to preserve their land. Sometimes they're successful in slowing down erosion, but they never can eliminate erosion and the danger of mass movement. Eventually, gravity wins. Sediment moves from place to place, constantly reducing elevation and changing the shape of the land.

## section 1 review

### Summary

#### Erosion and Deposition

- Gravity is the force that pulls all objects toward Earth's center.
- Water and wind erode materials only when they have enough energy of motion to do work.
- Agents of erosion drop sediment as they lose energy.

#### Mass Movement

- The greater an object's mass is, the greater its gravitational force is.
- Gravity is a major force of erosion and deposition.
- Common types of mass movement include slump, creep, rockfalls, rock slides, and mudflows.

### Self Check

1. Define the term *erosion* and name the forces that cause it.
2. Explain how deposition changes the surface of Earth.
3. Describe the characteristics that all types of mass movements have in common.
4. Describe ways to help slow erosion on steep slopes.
5. **Think Critically** When people build houses and roads, they often pile up dirt or cut into the sides of hills. Predict how this might affect sediment on a slope. Explain how to control the effects of such activities.

### Applying Skills

6. **Compare and Contrast** What are the similarities and differences between rock falls and rock slides?