

Erosion and Deposition by Wind, Ice, and Gravity

ESSENTIAL QUESTION

How do wind, ice, and gravity change Earth's surface?

By the end of this lesson, you should be able to describe erosion and deposition by wind, ice, and gravity as well as identify the landforms that result from these processes.

In this desert, wind has sculpted hills of sand, spreading them out like fingers.

Quick Labs

- Modeling a Glacier
- Modeling a Landslide

Engage Your Brain

1 Predict How do you think wind can erode materials?

2 Infer The dark bands you see in the photo on the right are dirt and rocks frozen in the ice. What do you think will happen to the dirt and rocks when the ice melts?



Active Reading

3 Define In this lesson, you will be learning about how different agents of erosion can abrade rock. Use a dictionary to look up the meaning of the word *abrade*. Record the definition:

Now use the word *abrade* in your own sentence:

As you read this lesson, circle the word *abrade* whenever you come across it. Compare the sentences that include this word with the sentence you wrote above.

Vocabulary Terms

- | | |
|-----------------|-------------|
| • dune | • creep |
| • loess | • rockfall |
| • glacier | • landslide |
| • glacial drift | • mudflow |

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

Gone with the

How can wind shape Earth?

Have you ever been outside and had a gust of wind blow a stack of papers all over the place? If so, you have seen how wind erosion works. In the same way that wind moved your papers, wind moves soil, sand, and rock particles. When wind moves soil, sand, and rock particles, it acts as an agent of erosion.

Abraded Rock

When wind blows sand and other particles against a surface, it can wear down the surface over time. The grinding and wearing down of rock surfaces by other rock or by sand particles is called *abrasion*. Abrasion happens in areas where there are strong winds, loose sand, and soft rocks. The blowing of millions of grains of sand causes a sandblasting effect. The sandblasting effect slowly erodes the rock by stripping away its surface. Over time, the rock can become smooth and polished.

Desert Pavement

The removal of fine sediment by wind is called *deflation*. This process is shown in the diagram below. During deflation, wind removes the top layer of fine sediment or soil. Deflation leaves behind rock fragments that are too heavy to be lifted by the wind. After a while, these rocks may be the only materials left on the surface. The resulting landscape is known as desert pavement. As you can see in the photo below, desert pavement is a surface made up mostly of pebbles and small, broken rocks.



Visualize It!

5 Describe How did the desert pavement in this photo most likely form?

Wind

Dunes

Wind carries sediment in much the same way that rivers do. Just as rivers deposit their loads, winds eventually drop the materials that they are carrying. For example, when wind hits an obstacle, it slows and drops materials on top of the obstacle. As the material builds up, the obstacle gets larger. This obstacle causes the wind to slow more and deposit more material, which forms a mound. Eventually, the original obstacle is buried. Mounds of wind-deposited sand are called **dunes**. Dunes are common in deserts and along the shores of lakes and oceans.

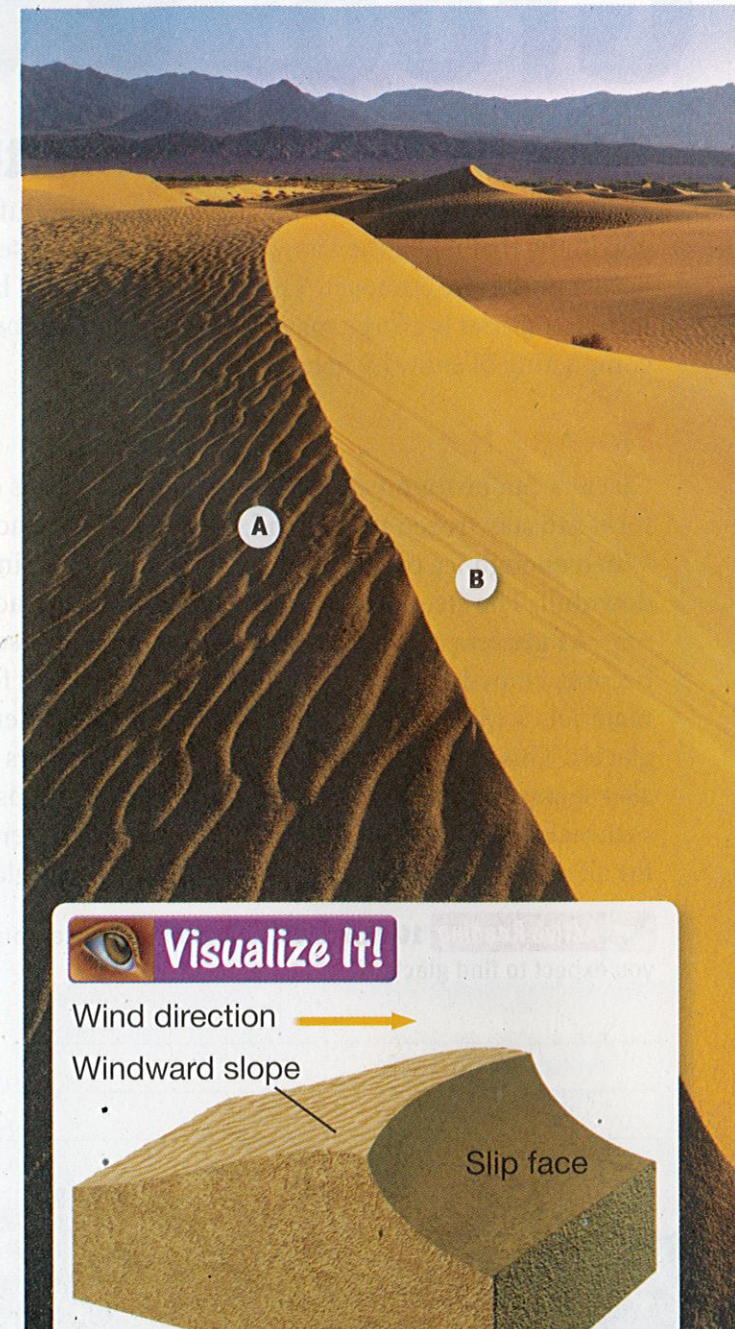
Generally, dunes move in the same direction the wind is blowing. Usually, a dune's gently sloped side faces the wind. Wind constantly moves material up this side of the dune. As sand moves over the crest of the dune, the sand slides down the slip face and makes a steep slope.

Loess

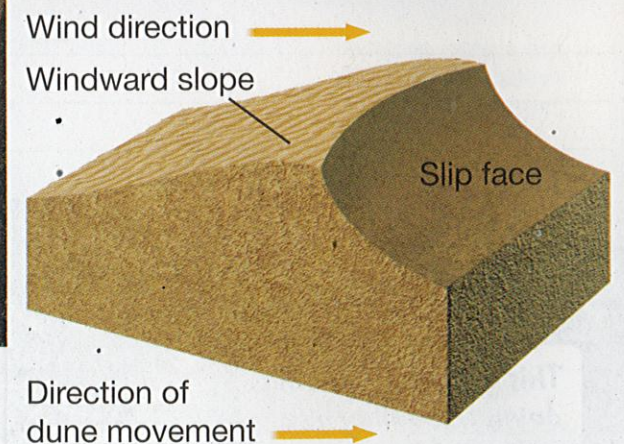
Wind can carry extremely fine material long distances. Thick deposits of this windblown, fine-grained sediment are known as **loess** (LOH-uhs). Loess can feel like the talcum powder a person may use after a shower. Because wind carries fine-grained material much higher and farther than it carries sand, loess deposits are sometimes found far away from their source. Loess deposits can build up over thousands and even millions of years. Loess is a valuable resource because it forms good soil for growing crops.

Inquiry

6 Infer Why do you think loess can be carried further than sand?



Visualize It!



7 Determine Look at the photo above the illustration. Which direction does the wind blow across the photographed dune: from left to right or right to left?

8 Identify Which side of the dune in the photograph is the slip face: A or B?

Groovy Glaciers

What kinds of ice shape Earth?

Have you ever made a snowball from a scoop of fluffy snow? If so, you know that when the snow is pressed against itself, it becomes harder and more compact. The same idea explains how a glacier forms. A **glacier** is a large mass of moving ice that forms by the compacting of snow by natural forces.

Flowing Ice

Glaciers can be found anywhere on land where it is cold enough for ice to stay frozen year round. Gravity causes glaciers to move. When enough ice builds up on a slope, the ice begins to move downhill. The steeper the slope is, the faster the glacier moves.

As glaciers move, they pick up materials. These materials become embedded in the ice. As the glacier moves forward, the materials scratch and abrade the rock and soil underneath the glacier. This abrasion causes more erosion. Glaciers are also agents of deposition. As a glacier melts, it drops the materials that it carried. **Glacial drift** is the general term for all of the materials carried and deposited by a glacier.

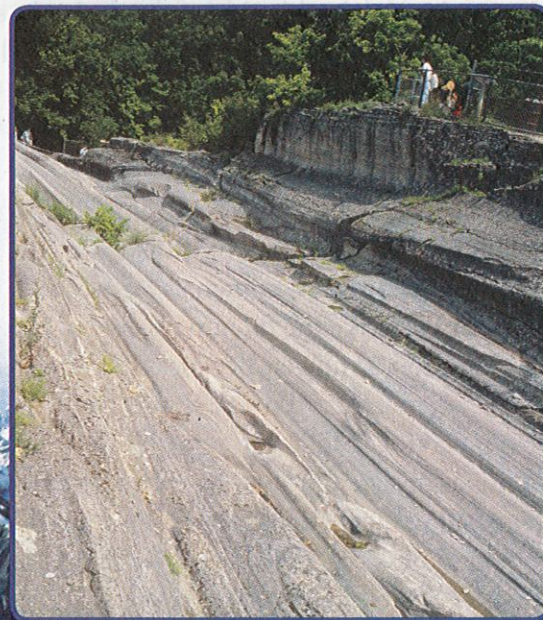
Active Reading 10 Infer Where in North America would you expect to find glaciers?

This glacier is moving down the valley like a river of ice.

Think Outside the Book

9 Apply Find out whether glaciers have ever covered your state. If so, what landforms did they leave behind?

As a glacier flowed over this rock, it scratched out these grooves.



Alpine Glaciers

An alpine glacier is a glacier that forms in a mountainous area. Alpine glaciers flow down the sides of mountains and create rugged landscapes. Glaciers may form in valleys originally created by stream erosion. The flow of water in a stream forms a V-shaped valley. As a glacier slowly flows through a V-shaped valley, it scrapes away the valley floor and walls. The glacier widens and straightens the valley into a broad U-shape. An alpine glacier can also carve out bowl-shaped depressions, called *cirques* (surks), at the head of a valley. A sharp ridge called an *arête* (uh•RAYT) forms between two cirques that are next to each other. When three or more arêtes join, they form a sharp peak called a *horn*.

Visualize It!

11 Summarize Use the illustration below to write a description for each of the following landforms.

Landforms made by alpine glaciers	Description
Arête	
Cirque	
Horn	
U-shaped valley	

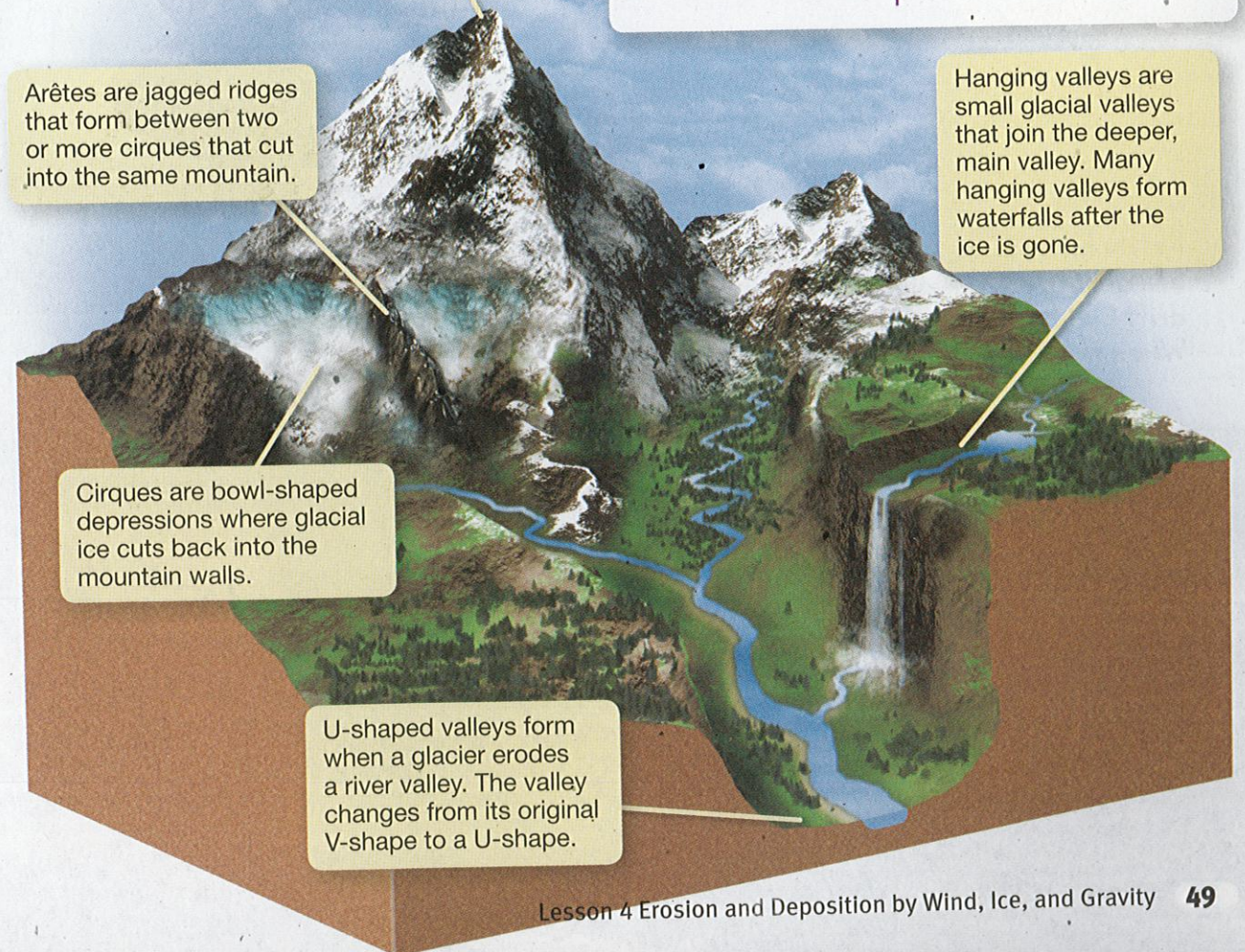
Horns are sharp, pyramid-shaped peaks that form when several arêtes join at the top of a mountain.

Arêtes are jagged ridges that form between two or more cirques that cut into the same mountain.

Cirques are bowl-shaped depressions where glacial ice cuts back into the mountain walls.

U-shaped valleys form when a glacier erodes a river valley. The valley changes from its original V-shape to a U-shape.

Hanging valleys are small glacial valleys that join the deeper, main valley. Many hanging valleys form waterfalls after the ice is gone.



Continental Glaciers

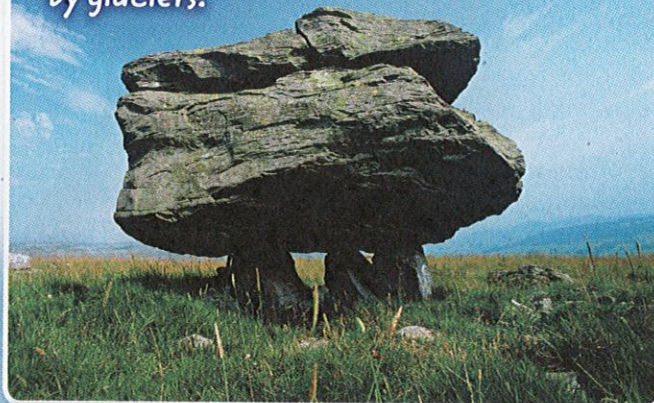
Continental glaciers are thick sheets of ice that may spread over large areas, including across entire continents. These glaciers are huge, continuous masses of ice. Continental glaciers create very different landforms than alpine glaciers do. Alpine glaciers form sharp and rugged features, whereas continental glaciers flatten and smooth the landscape. Continental glaciers erode and remove features that existed before the ice appeared. These glaciers smooth and round exposed rock surfaces in a way similar to the way that bulldozers can flatten landscapes.

Erosion and deposition by continental glaciers result in specific, recognizable landforms. Some of the landforms are shown below. Similar landforms can be found in the northern United States, which was once covered by continental glaciers.

Visualize It!

12 Compare What does the formation of erratics and kettle lakes have in common?

Erratics are large boulders that were transported and deposited by glaciers.



Kettle lakes form when chunks of ice are deposited by a glacier and glacial drift builds up around the ice blocks. When the ice melts, a lake forms.



Why It Matters

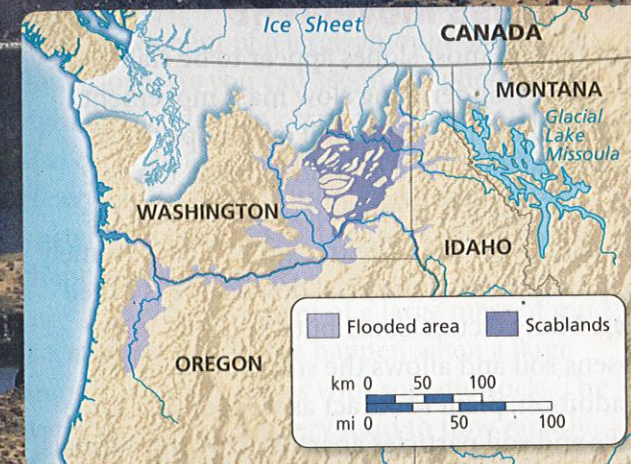
Melting the Ice

A CHANGING
WORLD

What would you do if an Ice Age glacial dam broke and let loose millions of gallons of water? Get out of the way and get ready for some erosion!

A Crack in the Ice

During the last Ice Age, a huge ice dam held back Glacial Lake Missoula, a 320-km-long body of water. Then one day, the dam burst. Water roared out, emptying the lake in less than 48 hours!



Large-Scale Landforms

The erosion caused by the roaring water carved out a landscape of huge waterfalls, deep canyons, and three-story-high ripple marks. Many of these features are in an area called the Scablands.



History Repeats Itself

Lake Missoula eventually reformed behind another ice dam. The breaking of the dam and the floods repeated about 40 more times, ripping away topsoil and exposing and cracking the bedrock.

Extend

13 Relate Where have you seen ripple marks before and how do they compare to the ripple marks shown in the photo on this page?

14 Explain How do you think the three-story-high ripple marks shown here were formed?

15 Model Use sand, pebbles, and other materials to model how a severe flood can alter the landscape. Photograph or illustrate the results of your investigation. Present your results in the form of an animation, slide show, or illustrated report.

Inquiry

Slippery Slopes

How can gravity shape Earth?

Although you can't see it, the force of gravity, like water, wind, and ice, is an agent of erosion and deposition. Gravity not only influences the movement of water and ice, but it also causes rocks and soil to move downslope. This shifting of materials is called *mass movement*. Mass movement plays a major role in shaping Earth's surface.

Slow Mass Movement

Even though most slopes appear to be stable, they are actually undergoing slow mass movement. In fact, all the rocks and soil on a slope travel slowly downhill. The ground beneath the tree shown on the left is moving so slowly that the tree trunk curved as the tree grew. The extremely slow movement of material downslope is called **creep**. Many factors contribute to creep. Water loosens soil and allows the soil to move freely. In addition, plant roots act as wedges that force rocks and soil particles apart. Burrowing animals, such as gophers and groundhogs, also loosen rock and soil particles, making it easier for the particles to be pulled downward.

Visualize It!

16 Analyze As the soil on this hill shifts, how is the tree changing so that it continues to grow upright?

The shape of this tree trunk indicates that creep has occurred along the slope.

Rapid Mass Movement

The most destructive mass movements happen suddenly and rapidly. Rapid mass movement can be very dangerous and can destroy everything in its path. Rapid mass movement tends to happen on steep slopes because materials are more likely to fall down a steep slope than a shallow slope.

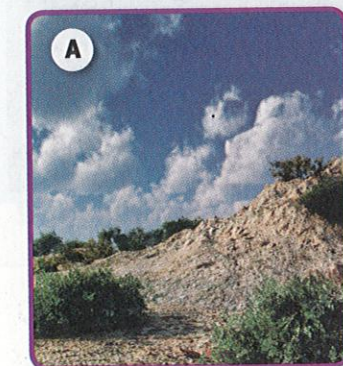
While traveling along a mountain road, you may have noticed signs along the road that warn of falling rocks. A **rockfall** happens when loose rocks fall down a steep slope. Steep slopes are common in mountainous areas. Gravity causes loosened and exposed rocks to fall down steep slopes. The rocks in a rockfall can range in size from small fragments to large boulders.

Another kind of rapid mass movement is a landslide. A **landslide** is the sudden and rapid movement of a large amount of material downslope. As you can see in the photo on the right, landslides can carry away plants. They can also carry away animals, vehicles, and buildings. Heavy rains, deforestation, construction on unstable slopes, and earthquakes increase the chances of a landslide.

A rapid movement of a large mass of mud is a **mudflow**. Mudflows happen when a large amount of water mixes with soil and rock. The water causes the slippery mud to flow rapidly downslope. Mudflows happen in mountainous regions after deforestation has occurred or when a long dry season is followed by heavy rains. Volcanic eruptions or heavy rains on volcanic ash can produce some of the most dangerous mudflows. Mudflows of volcanic origin are called lahars. Lahars can travel at speeds greater than 80 km/h and can be as thick as wet cement.

17 Identify List five events that can trigger a mass movement.

This landslide in California was caused by heavy rains.



Visualize It!

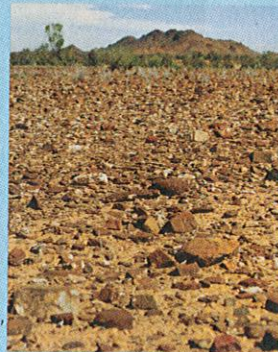
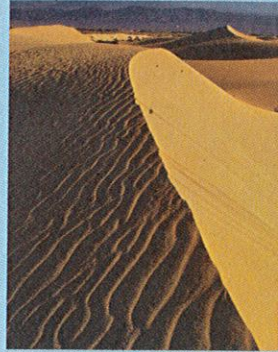
18 Infer On which slope, A or B, would a landslide be more likely to occur? Explain.

Visual Summary

To complete this summary, fill in the blanks with the correct word or phrase. Then, use the key below to check your answers. You can use this page to review the main concepts of the lesson.

Erosion and Deposition by Wind, Ice, and Gravity

Wind forms dunes and desert pavement.



19 Wind forms dunes through:

20 Wind forms desert pavement through:

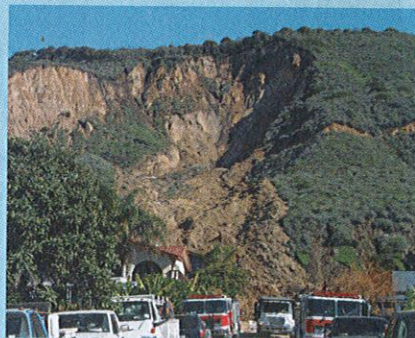
Ice erodes and deposits rock.



21 Alpine glaciers make landforms such as:

22 Continental glaciers make landforms such as:

Gravity pulls materials downward.



23 Type of slow mass movement:

24 Three major types of rapid mass movement:

Answers: 19 deposition; 20 erosion, deflation; 21 arêtes, cirques, horns, hanging and U-shaped valleys; 22 kettle lakes, erratics; 23 creep; 24 rock fall, landslide, mudflow

25 Summarize Describe the role that gravity plays in almost all examples of erosion and deposition.

Lesson Review

Lesson 4

Vocabulary

Use a term from the section to complete each sentence below.

- When an obstacle causes wind to slow down and deposit materials, the materials pile up and eventually form a _____.
- Large masses of flowing ice called _____ are typically found near Earth's poles and in other cold regions.
- Very fine sediments called _____ can be carried by wind over long distances.
- As glaciers retreat, they leave behind deposits of _____.

Key Concepts

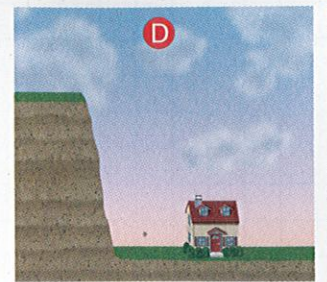
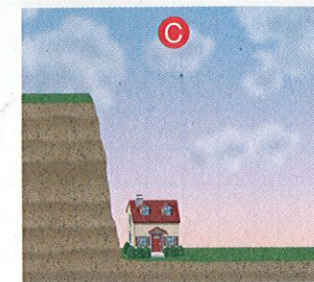
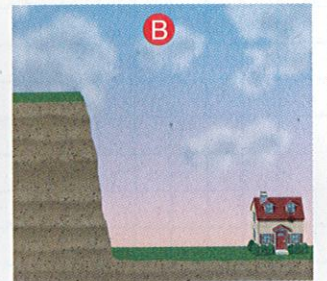
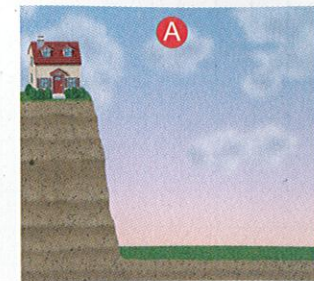
5 Explain How can glaciers cause deposition?

6 Compare Compare and contrast how wind and glaciers abrade rock.

7 Distinguish What is the difference between creep and a landslide?

Critical Thinking

Use the diagram to answer the question below.



8 Synthesize Which of the four locations would be the best and worst places to build a house? Rank the four locations and explain your reasoning.

9 Integrate Wind erosion occurs at a faster rate in deserts than in places with a thick layer of vegetation covering the ground. Why do you think this is the case?