



Earth Science

Interactions of Air, Water, and Land

Advanced Level

# Slow Earth- Changing Processes

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# Slow Earth-Changing Processes

How do natural events affect our world?

## CORE CURRICULUM STATEMENTS

**Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.**

Erosion and deposition result from the interaction among air, water, and land.

- interaction between air and water breaks down earth materials
- pieces of earth material may be moved by air, water, wind, and gravity
- pieces of earth material will settle or deposit on land or in the water in different places
- soil is composed of broken-down pieces of living and nonliving earth material

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Earth Science

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# Student Book

*Slow Earth-Changing Processes*

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## Slow Earth-Changing Processes

How do natural events affect our world?

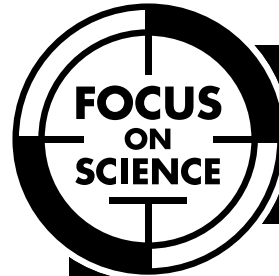
### CORE CURRICULUM STATEMENTS

Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.

Erosion and deposition result from the interaction among air, water, and land.

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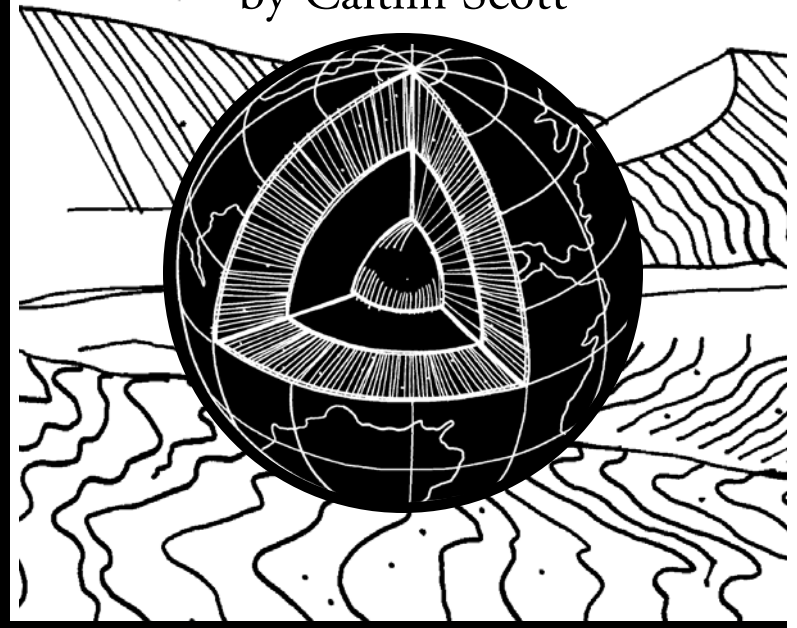


Earth Science

Interactions of Air, Water, and Land

# Slow Earth-Changing Processes

by Caitlin Scott





# Slow Earth-Changing Processes

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## INTRODUCTION

# What Is Earth Made Of?

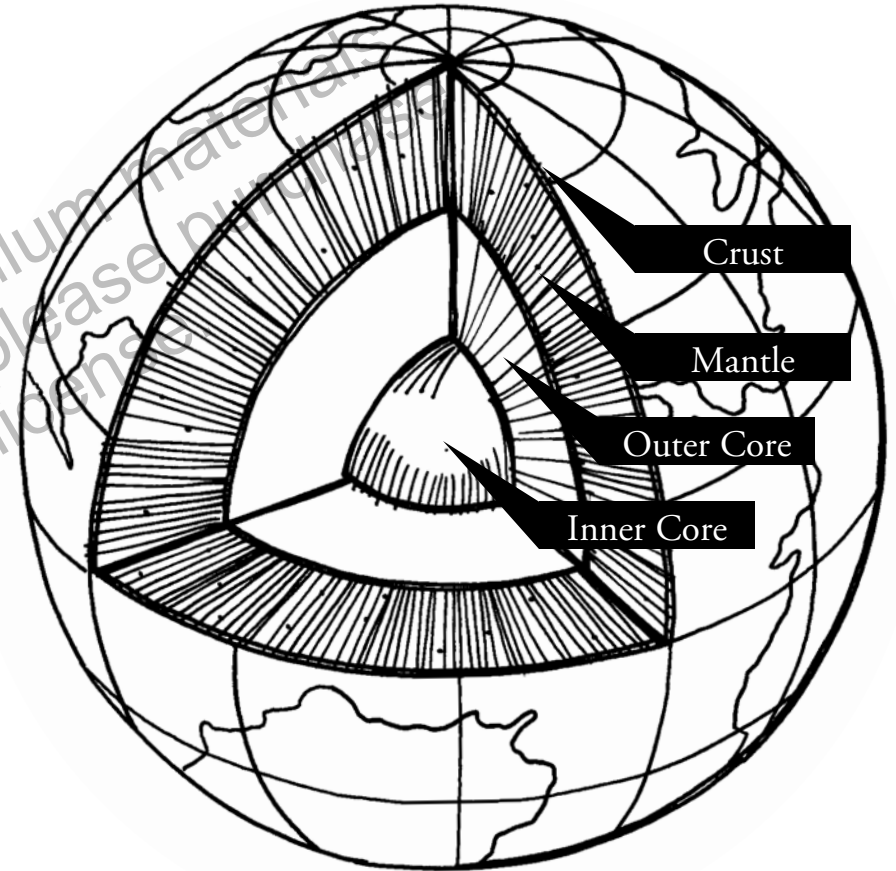
Earth is composed of four different layers. The crust is the layer we walk on and also the layer under the ocean. This layer is the thinnest of the four—about 25 miles thick under the land and about 6.5 miles thick under the ocean. Perhaps because it is so thin, it is lighter than the other layers and breaks easily. Most of the slow changes we observe on Earth occur in the crust.

Below the crust is the mantle, which is about 1,800 miles thick. Instead of cracking easily like the crust, the mantle flows like a thick liquid.

Below the mantle is the outer core, which is made of liquid rock called magma. The inner core is solid. Iron in the inner core gives Earth its **magnetic** charge.

**magnetic:** able to attract metal

## Layers of Earth



*The planet Earth is made up of four layers.*

# What Causes Changes on Earth?

Earth is constantly changing. Most of these changes occur slowly and take place on the crust, which is thinner and more **brittle** than the other layers. These slow changes can be caused by weathering, **erosion**, deposition, and mountain building.

## Weathering

Weathering is the breakdown of rocks and minerals. This happens when wind, water, ice, gravity, or human actions wear away the crust.

### Wind

Have you ever seen a dirt devil or a dust storm? In a dust storm, the wind might blow dust across a road or field. Sometimes this dust forms a rotating funnel, which people call a dirt devil. Wind carrying dirt away is a type of erosion. On a beach, wind erosion can move sand several miles.

**brittle:** easily broken

**erosion:** the process of slowly wearing away; a type of weathering

---

## Water

Like wind, water can also change the surface of Earth. Water can transport soil and rocks to other places. Most of the time this happens very slowly.

For example, rain on a rocky cliff can wear down the rock over thousands of years, or a river can slowly carve out the riverbanks. This creates twists and turns in the river. Sometimes these twists break off and create small ponds or lakes called oxbows beside the river.

Flooding can carry soil and rocks away more quickly. This can be quite dangerous. Plants may be uprooted and animals may be carried away by the flood waters. Sometimes houses and people get caught in the flood waters, too.

Waves on a lake or ocean also cause Earth to wear away. Crashing waves break down beaches, rocks, and cliffs over time. The shoreline is constantly changing.



---

## Ice

Ice doesn't move dirt and rocks in quite the same way as water and wind do. You might not think ice could cause changes to Earth, but it can. Like wind and water, ice changes Earth slowly.

Water freezes at 0 degrees Celsius or 32 degrees Fahrenheit. When water freezes, it **expands** rapidly. Have you ever left a soda can in the freezer by accident? If so, you know that the soda can swells, pushing out the top and bottom of the can. It almost looks as if the soda is about to break out of the aluminum can.

The same thing happens when water freezes inside the ground or inside a crack in a rock. The ice expands and breaks Earth's crust apart. Sometimes ice can even break a rock apart.

– Recall –

*Describe ways that wind, water, and ice reshape Earth's surface.*

**expands:** gets bigger

---

## Gravity

What happens when you drop something? It falls to the ground. That's gravity—a force that pulls things back to Earth's surface. Without gravity, we would all float away into space. Like Earth, all planets have gravity.

Gravity causes huge mountains to change. It is not strong enough to tear a mountain down in a day, but gravity slowly helps pull down mountains over millions and millions of years.

Gravity frequently plays a part in other types of erosion as well. For example, when ice breaks apart Earth's crust, gravity makes the broken parts roll downhill. When river water carves into a hillside, gravity eventually makes that hillside collapse.

– Transfer –

*Explain why erosion is a slow Earth-changing process. What might be some fast Earth-changing processes?*

---

## Physical Weathering

You've learned that weathering is the breakdown of rocks and minerals. This breakdown can be caused by physical and chemical processes.

Physical weathering, also known as mechanical weathering, is the breakdown of large pieces of earth material into smaller ones through forces such as changes in heat, water movement, ice formation, and pressure.

For example, water can seep into cracks in rock. When the water freezes, it expands and causes stress, or pressure, in the crack. As the stress increases, the crevice widens and breaks the rock or mineral apart.

Plants can physically weather rocks and minerals in a similar way. Plant roots grow into cracks and slowly wedge the rock apart as they grow larger.

– Explain –  
*How do plant growth and  
freezing water cause weathering?*

---

## Chemical Weathering

Physical weathering does not change the material that is being broken down. Chemical weathering does change the material.

Chemical weathering is the process by which earth materials are **decomposed**, dissolved, or loosened by chemical processes, which leads to a breakdown of the material. The internal structure of the material is altered by the addition or removal of chemical elements.

For example, when oxygen is added to material with iron, the iron forms rust. The surface of the iron has changed from a solid, hard surface to a loose, crumbly surface. The properties of the material have changed. It is not iron anymore. It is now rust or iron oxide.

Both physical and chemical weathering lead to erosion and the deposition of rocks and minerals.

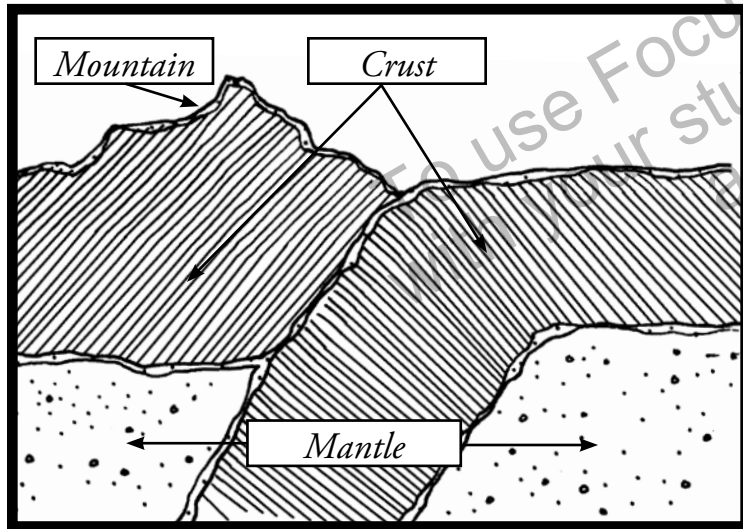
**decompose:** to break down into separate, basic parts

---

## Mountain Building

When the Earth's crust cracks, large pieces break off and start to float and move on the liquid mantle. When two large pieces of crust run into each other, the pieces fold up like an accordion or a paper fan, causing ridges and mountains to form.

This is how the Adirondack Mountains in upstate New York formed. These mountains are extremely old because this slow-change process takes millions of years.



*These two pieces of crust ran into each other. One piece pushed up, creating a mountain.*

---

## Erosion and Deposition

Erosion is the process by which soil and weathered rock particles, such as gravel, sand, silt, and clay, are transported, or moved, from one place to another. It is often a slow process. Erosion occurs on sandy beaches, on the banks of rivers, and even on mountain tops.

What happens to all that eroded dirt and rock when it is deposited someplace else? It doesn't disappear. The eroded material creates new landforms. This process is called deposition.

– Brainstorm –  
*Think of all the ways erosion changes Earth.  
Talk about it with a friend.*

---

## CHAPTER 2

# Landforms Caused by Slow Changes

**Natural** erosion and deposition are happening constantly everywhere on Earth. The dirt and rock of Earth's crust are gradually being worn away and then deposited to form different landforms.

## Sand Dunes

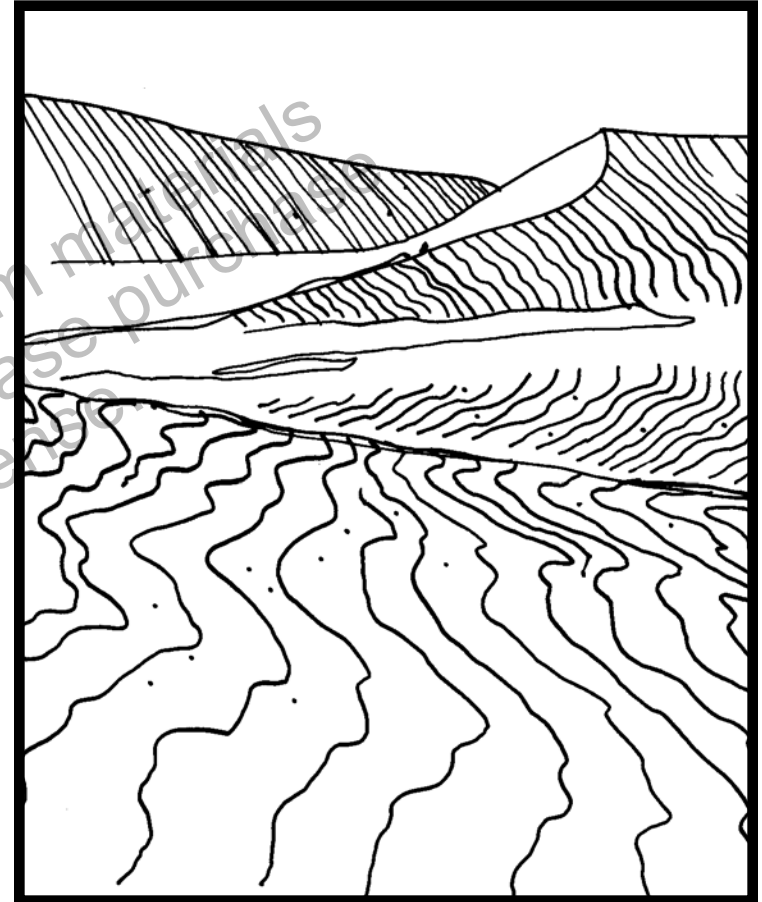
Sand dunes are a land feature created by deposition. Dunes form mostly on beaches and deserts, but they can occur anywhere with very sandy soil. To create a sand dune, the wind blows on the sand and transports it. Eventually, the sand is deposited and piles up, forming hills. These hills can be a few feet high or more than one hundred feet high.

Sand slowly migrates from place to place, transported on the wind. That's why a beach never looks exactly the same two summers in a row.

**natural:** not made by humans

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## Sand Dunes



*If you look closely at a sand dune, you can often see a pattern on the surface of the dune. This shows how the wind is slowly moving the sand.*

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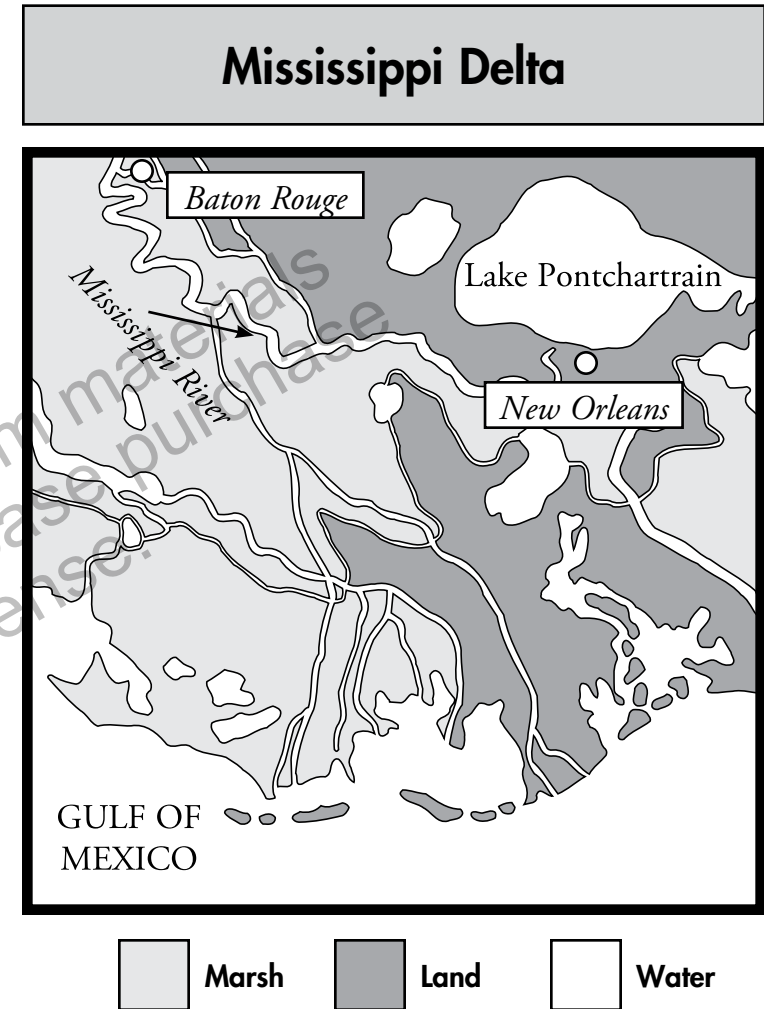
## Deltas

Deltas are also a land feature created by deposition. Deltas are areas of sand and soil deposited at the mouth of a river.

To create deltas, the water in rivers slowly erodes the banks of that river. Dirt and rocks from the banks are carried downstream. Some dirt and rock is deposited further down the river, but some is carried all the way to the ocean by strong river currents. Much of this rock and dirt that goes all the way to the ocean is deposited where the river flow slows as it meets the ocean, creating a delta.

Deltas are marshy grasslands, often with rich soil that is very good for farming. But building houses on a delta can be tricky because the land in a delta is new and low. This low lying land is easily flooded by the river or by ocean storms.

– Recall –  
*What are the landforms that are  
produced through deposition?*



*The city of New Orleans was built on the Mississippi Delta and has flooded many times.*

## Glacial Moraines

Glaciers are enormous slabs of ice that have built up over millions of years. As glaciers melt, they slide over Earth and erode Earth's crust. The Finger Lakes in Western New York were carved out by glaciers and later filled in with water when the glacier melted.

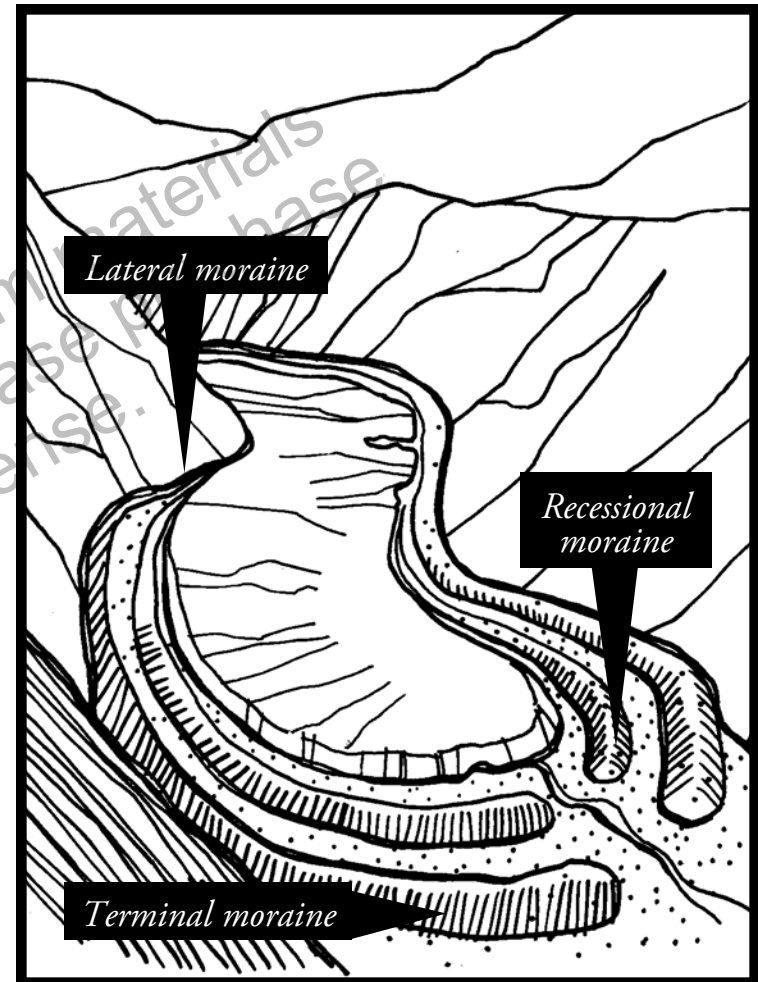
As a glacier moves, it pushes a huge pile of rock and dirt in front of it, called the glacial **till**. When the glacier stops moving, it melts and starts moving backwards. As the glacier retreats, the rock and dirt from the glacial till is left behind. This big pile of rocks and dirt is called the glacial moraine.

Many glaciers moved over the land of North America during the ice age, about 25,000 years ago. Scientists know how these glaciers moved because the glaciers left glacial moraines behind them.

Glaciers are still moving today. Most are melting and moving backwards because Earth is warming.

**till:** deposits of rock and dirt

## Glacial Moraine



*This is a glacial moraine. How did these mounds get to this land? They were left behind by a glacier.*

---

## CHAPTER 3

# Wangari Maathai

Wangari Maathai was born in Nyeri, Kenya in 1940. She went to school to study biology. Afterward, Wangari decided to help people in Kenya. She noticed that many, many trees were being cut down all over the country, but very few trees were being replanted.

Without trees, the land eroded rapidly. The rain and wind carried the good, rich topsoil away. Soon, many small animals couldn't find enough to eat. Eventually, people began to have trouble farming and finding enough firewood to cook with and heat their homes.

To help solve these problems, Wangari formed the Green Belt Movement. She got Kenyan women to plant trees. The people cutting down the trees didn't like this, but Wangari stuck with it.



*Through Green Belt, Kenyan women have planted more than 20 million trees and much of the land has been restored. As a result of her work, Wangari won the Nobel Prize in 2004.*

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## Glossary

**brittle**—easily broken

**decompose**—to break down into separate, basic parts

**erosion**—the process of slowly wearing away; a type of weathering

**expands**—gets bigger

**magnetic**—able to attract metal

**natural**—not made by humans

**till**—deposits of rock and dirt

---

## To Find Out More . . .

Want to learn more about how Earth changes?

### Try these books

*Erosion* by Joelle Riley. Lerner Publications, 2006.

*Land Preservation* by Christine Peterson. Children's Press, 2004.

### Access these Web sites

U.S. Environmental Protection Agency  
Land Revitalization Initiative  
<http://www.epa.gov/oswer/landrevitalization/lrso.htm>

The Nature Conservancy  
<http://www.nature.org/>

### Write for more information

U.S. Environmental Protection Agency  
Office of Solid Waste and Emergency  
Response (5103-T)  
1200 Pennsylvania Avenue, N.W.  
Washington, D.C. 20460

The Nature Conservancy  
4245 North Fairfax Drive, Suite 100  
Arlington, VA 22203-1606



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# Assessments

*Slow Earth-Changing Processes*

Print pages 20–22 of this PDF for the assessments.

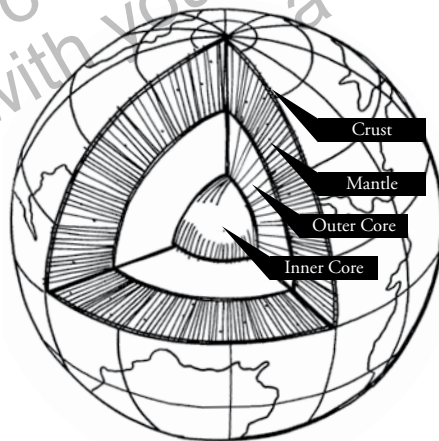
# Check Understanding

Shade the circle next to the correct answer or write your answer on the lines provided.

1. A delta is an example of a land feature formed by a slow process. How does a delta form?
  - Ⓐ Wind blows sand and deposits it in a pile.
  - Ⓑ A river deposits dirt and rock where it meets the ocean.
  - Ⓒ Water seeps into a crack in a rock, then freezes and expands.
  - Ⓓ Waves on a lake or ocean break down beaches, rocks, and cliffs.
2. The picture below shows the four layers of the Earth.

Where do most of Earth's slow changes occur?

- Ⓐ crust
- Ⓑ mantle
- Ⓒ outer core
- Ⓓ inner core



3. What was the cause of rapid land erosion in Kenya?

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Explain how Wangari Maathai solved this problem.

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# Check Understanding

Shade the circle next to the correct answer or write your answer on the lines provided.

4. Identify **two** ways that pressure causes physical weathering.

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_

Explain how these pressures cause the weathering.

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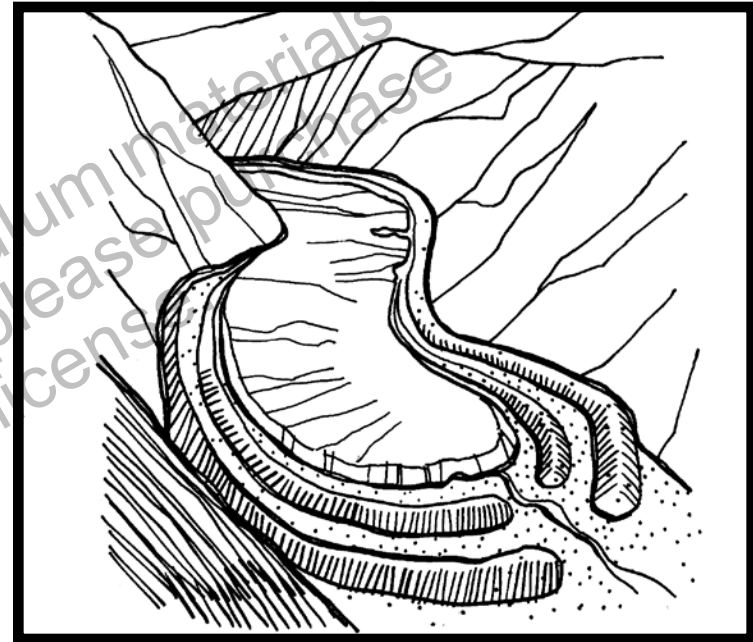
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5. The diagram below shows an area of land that changed after many years.



Which caused the land area to change?

- (A) gravity
- (B) air
- (C) ice
- (D) wind

# Assessment Scoring Guidelines

1. Answer B is correct.
2. Answer A is correct.
3. Lack of trees  
Wangari Maathai got Kenyan women to plant millions of new trees.
4. Ice  
Water freezes inside the ground, expanding and putting pressure on Earth's crust until it cracks.  
  
Plant roots  
Roots grow into cracks in Earth's crust, wedging the rock apart as they grow larger.
5. Answer C is correct.

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# English Language Arts Activities

*Slow Earth-Changing Processes*

Print pages 24–28 of this PDF for the reading activities.

# Summarize

## TRY THE SKILL

**Summarizing means retelling what you have read, often in a slightly shorter version. Summarizing helps you understand the most important points about what you read.**

**Read this passage from *Slow Earth-Changing Processes* and try summarizing it in one or two sentences.**

Earth is composed of four different layers. The crust is the layer we walk on and also the layer under the ocean. This layer is the thinnest of the four—about 25 miles thick under the land and about 6.5 miles thick under the ocean.

Below the crust is the mantle, which is about 1,800 miles thick. Instead of cracking easily like the crust, the mantle flows like a thick liquid.

Below the mantle is the outer core, which is made of liquid. The inner core is solid. Iron in the inner core gives Earth its magnetic charge.

**Is this a good summary?**

The Earth is composed of four layers—the thin crust, the thicker mantle, the liquid outer core, and the iron inner core.

**Yes! This is the main point of the passage.**

**Read this passage.**

Earth is constantly changing, but these changes occur slowly. Most take place on the crust of the Earth, which is thin and brittle. These changes include:

**Weathering**—when wind, water, ice, gravity, or human activities wear away parts of the crust.

**Erosion and Deposition**—when weathered material is carried away to create land structures such as dunes, deltas, and glacial moraines.

**Mountain Building**—when two layers of crust press together and fold back on themselves.

**Summarize the passage in one or two sentences.**

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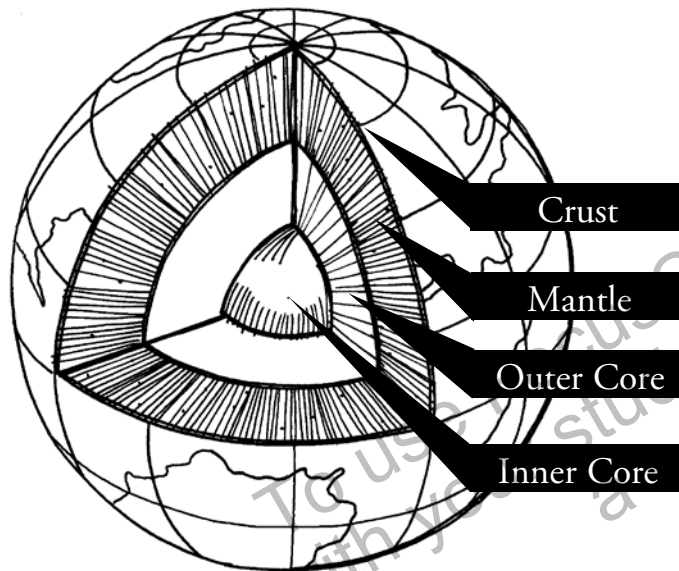
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# Interpret Graphics

## TRY THE SKILL

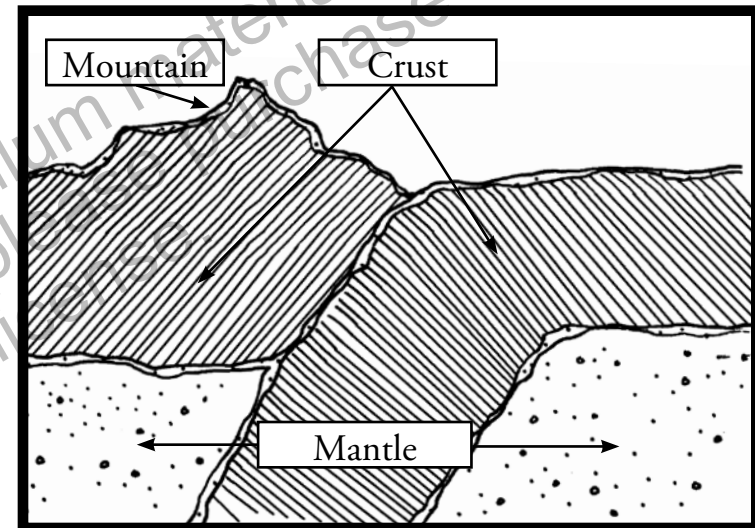
Graphics can give you information quickly and help you understand how something works. Look at this graphic showing the layers of the Earth.



What does this graphic show you about the layers of Earth? Here is some information you get from the graphic.

- The crust is on the surface of Earth. It's very thin.
- The mantle is under the crust. It's thicker.
- The outer core is under the mantle.
- The inner core is under the outer core.

Study this graphic from *Slow Earth-Changing Processes*. What does it tell you about mountain building? Write about it.



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# Steps In a Process

## TRY THE SKILL

Understanding the steps in a process can help you understand and remember what you read.

Read this passage from *Slow Earth-Changing Processes* and try to identify the steps in the process.

Deltas are a land feature created by deposition. To create deltas, the water in rivers slowly erodes the banks of that river. Dirt and rocks from the banks are carried down stream. Some dirt and rock is deposited further down the river, but some is carried all the way to the ocean by strong river currents. This rock and dirt that goes all the way to the ocean is deposited where the river meets the ocean, creating a delta.

How do deltas form? A graphic organizer can help you identify the steps.

Step 1 First, the water in a river slowly erodes the river banks.	Step 3 Next, some dirt and rocks are carried all the way to the ocean by strong river currents.
Step 2 Then, dirt and rocks from the banks are carried down stream.	Step 4 Finally, rock and dirt that goes all the way to the ocean is deposited where the river meets the ocean, creating a delta.

Read this passage from *Slow Earth-Changing Processes* and try to identify the steps in the process. Use the graphic organizer to help you.

As a glacier moves, it pushes a huge pile of rock and dirt in front of it, called the glacial till. When the glacier stops moving, it melts and starts moving backwards. As the glacier retreats, the rock and dirt from the glacial till is left behind. This big pile of rocks and dirt is called the glacial moraine.


# Cause and Effect

## TRY THE SKILL

A cause is why something happens. An effect tells what happens. Sometimes the cause is stated first, but sometimes the effect is first. Words such *as if*, *because*, *as*, and *when* are often used to state cause and effect.

Read this sentence from *Slow Earth-Changing Processes*.

For example, when ice breaks apart Earth's crust, gravity makes the broken parts roll downhill.

**Which part of the sentence is the effect?**

Gravity makes the broken parts roll downhill.

**This phrase tells *what* happens.**

**Which part of the sentence is the cause?**

When ice breaks apart the Earth's crust

**This phrase tells *why* the parts break apart. Notice that the phrase *For example* is not needed to show cause and effect.**

Read these sentences. Then underline the cause and circle the effect.

1. When Earth's crust cracks, large pieces break off and start to float and move on the more liquid mantle.
2. As the glacier retreats, the rock and dirt from the glacial till is left behind.
3. The deforested land erodes quickly because the trees are not there to help hold the land in place.
4. If a farmer plants crops in the same place too many times, plants use up the nutrients in the soil.
5. Natural erosion occurs when Earth is worn away.
6. When river water carves into a hillside, gravity eventually makes that hillside collapse.
7. These mountains are extremely old because this slow-change process takes millions of years.
8. Perhaps because it is so thin, it is light and breaks easily.

# Answer Key

## Summarize

Answers will vary but might include:

The Earth is slowly and constantly changing due to weathering, mountain building, erosion and deposition.

## Interpret Graphics

Answers will vary but might include:

- The crust floats on the mantle.
- As the two pieces of crust press against each other, the land folds.
- These folds become mountains.

## Steps in a Process

**Step 1:** First, as a glacier moves, it pushes a huge pile of rock and dirt in front of it, called the glacial till.

**Step 2:** Then, when the glacier stops moving, it melts and starts moving backwards.

**Step 3:** Finally, as the glacier retreats, the rock and dirt from the glacial till is left behind. This big pile of rocks and dirt is called the glacial moraine.

## Cause and Effect

1. When the Earth's crust cracks (large pieces break off and start to float and move on the more liquid mantle).
2. As the glacier retreats, (the rock and dirt from the glacial till is left behind).
3. The deforested land erodes quickly because the trees are not there to help hold the land in place.
4. If a farmer plants crops in the same place too many times, (plants use up the nutrients in the soil).
5. Natural erosion occurs when the Earth is worn away.
6. When river water carves into a hillside, (gravity eventually makes that hillside collapse).
7. These mountains are extremely old because this slow-change process takes millions of years.
8. Perhaps because it is so thin, (it is light and breaks easily).