Science Ch. 10

Reshaping Earth’s Surface

Biography

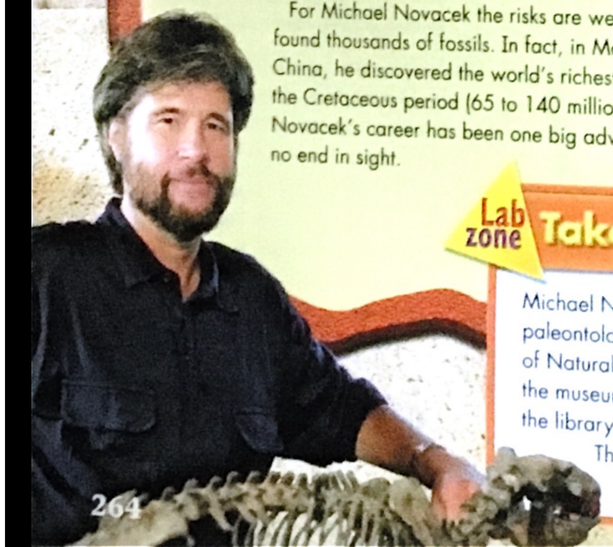
Michael Novacek

Imagine getting dragged over the rocky ground by a spooked horse—or escaping from a cave full of poisonous snakes! It sounds like an episode from a TV reality show. But these are just some of the many adventures of paleontologist Michael Novacek.

Novacek grew up in suburban Los Angeles. As a kid, he liked to turn over rocks to see what critters might be hiding underneath. Today as a world-famous scientist, Novacek is still unlocking secrets hidden beneath rocks—and within them.

Novacek is a paleontologist—a fossil expert. He studies the fossils of dinosaurs and early mammals and the rocks in which the fossils form. Then he can figure out when the animals lived, how they lived, and how they changed through time. Novacek does more than study fossils—he finds them and digs them up. His fossil-hunting expeditions take him all over the world. The expeditions are thrilling, but they can be dangerous too. Besides the bites and stings of animals, Novacek puts up with searing heat and the injuries that come from hiking over rugged landscape.

For Michael Novacek the risks are well worth it. He has found thousands of fossils. In fact, in Mongolia, north of China, he discovered the world's richest site of fossils from the Cretaceous period (65 to 140 million years ago). Novacek's career has been one big adventure, and there's no end in sight.



Lab zone

Take-Home Activity

Michael Novacek is a curator of paleontology at the American Museum of Natural History in New York City. Visit the museum online, either at home or at the library. Explore the museum's exhibits. Then make a poster that highlights one or more exhibits.

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Web Games

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Chapter 10

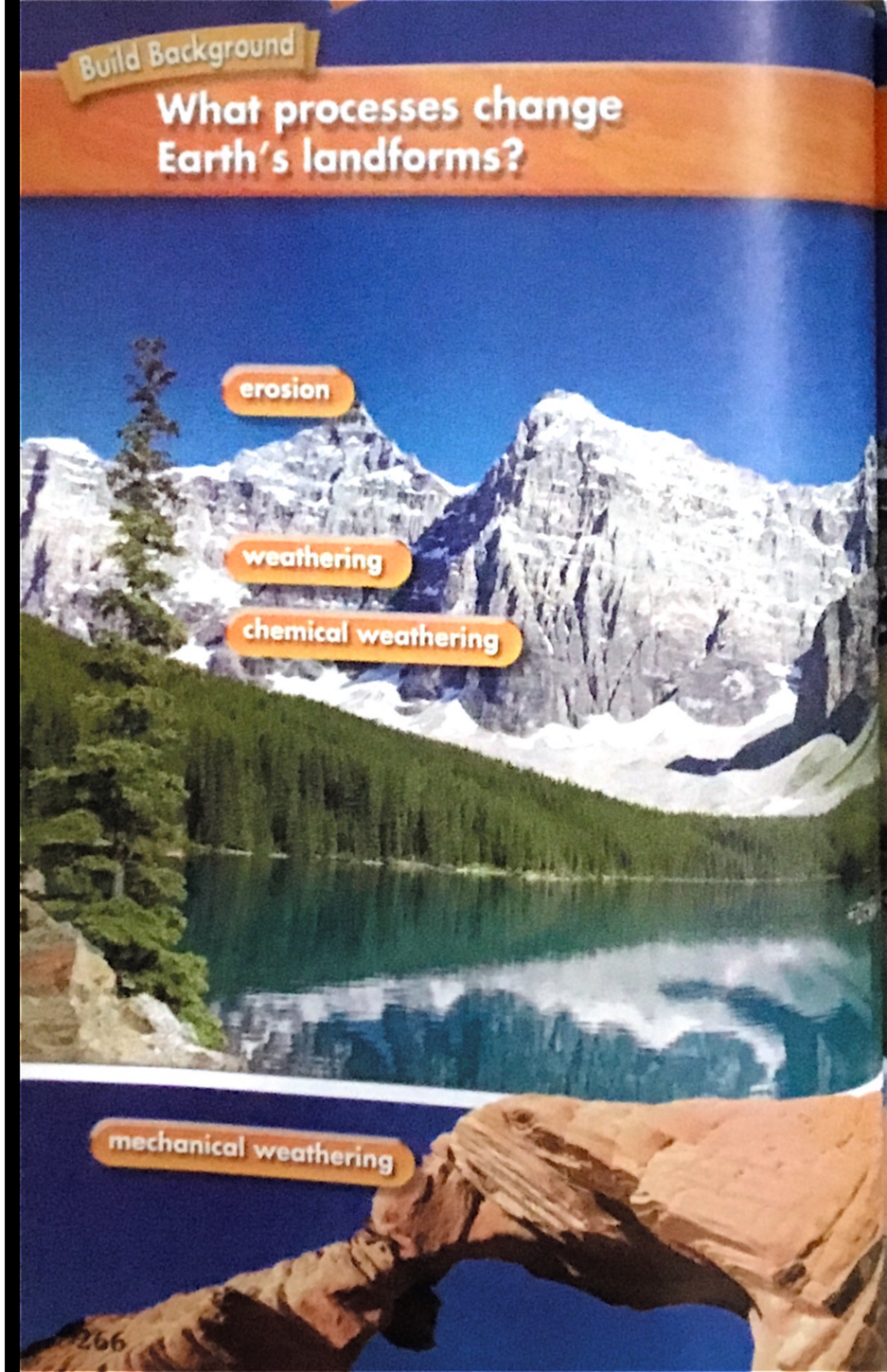
Reshaping Earth's Surface

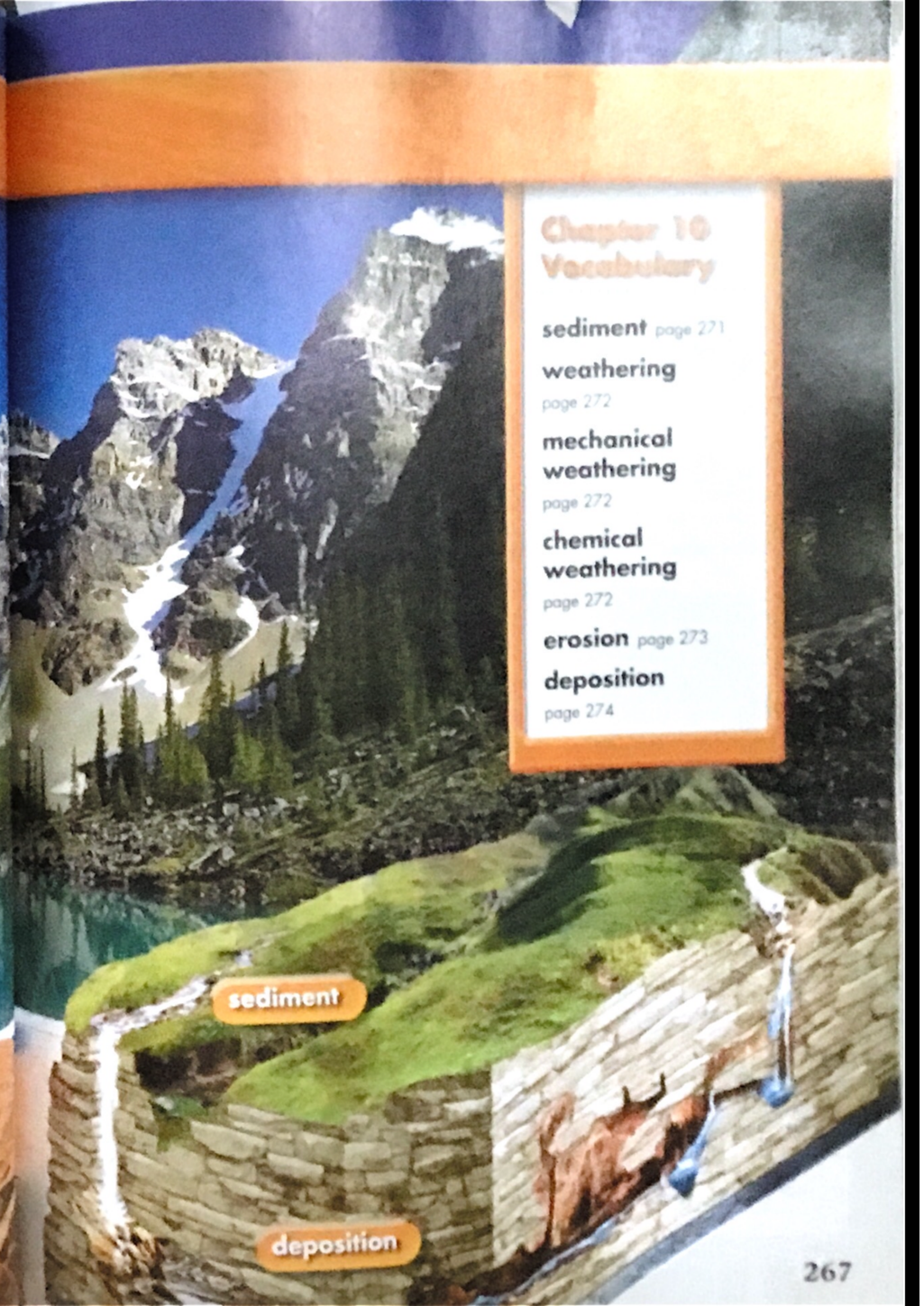
You Will Discover

- how Earth's surface is changed by mechanical weathering and chemical weathering.
- how Earth's surface has changed throughout Earth's history.
- how river systems form and change.
- how waves and wind erosion change coastlines.

Build Background

What processes change Earth's landforms?



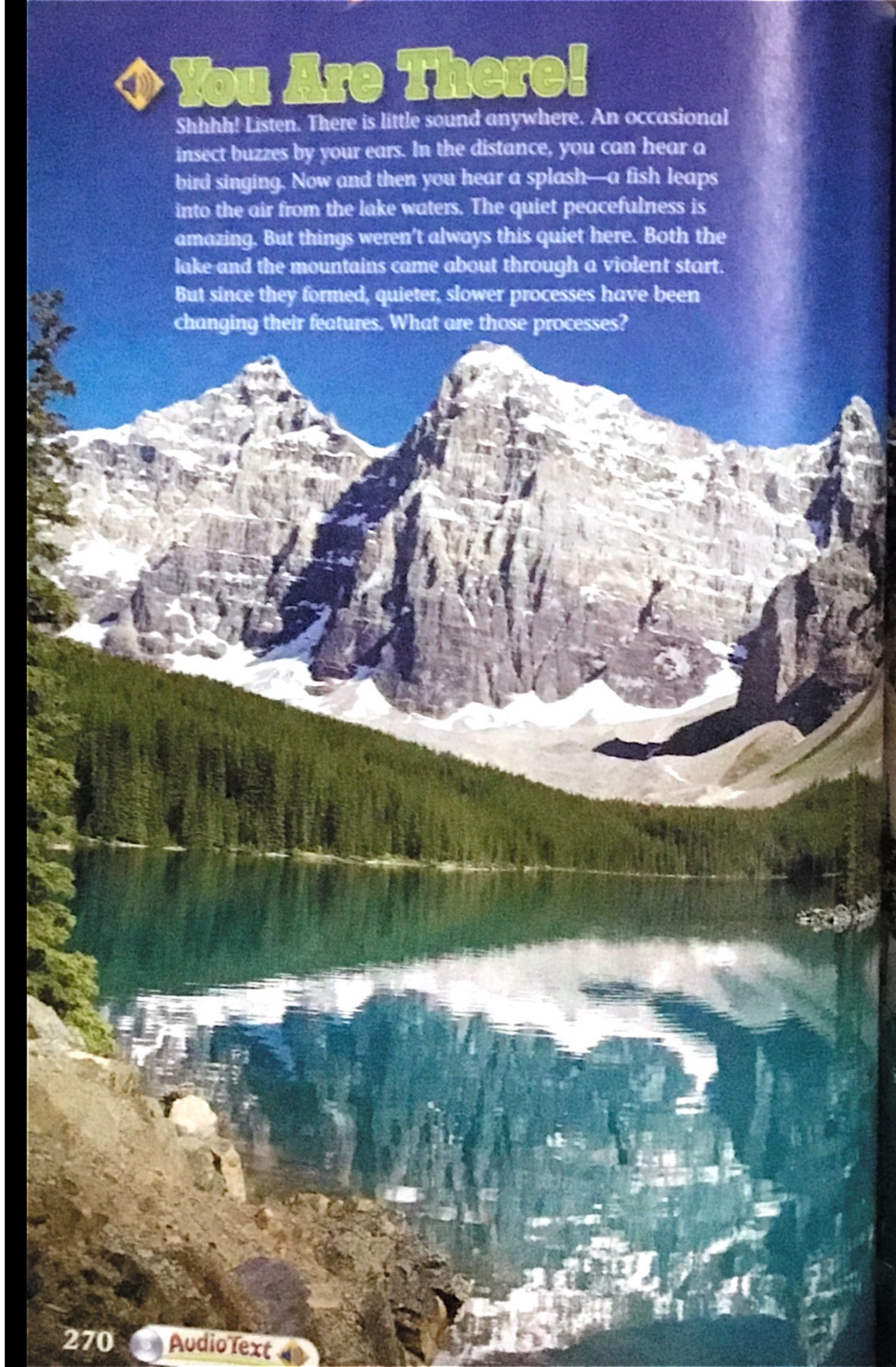


Chapter 10 Vocabulary

- **sediment** page 271
- **weathering** page 272
- **mechanical weathering** page 272
- **chemical weathering** page 272
- **erosion** page 273
- **deposition** page 274

You Are There!

Shhhh! Listen. There is little sound anywhere. An occasional insect buzzes by your ears. In the distance, you can hear a bird singing. Now and then you hear a splash—a fish leaps into the air from the lake waters. The quiet peacefulness is amazing. But things weren't always this quiet here. Both the lake and the mountains came about through a violent start. But since they formed, quieter, slower processes have been changing their features. What are those processes?



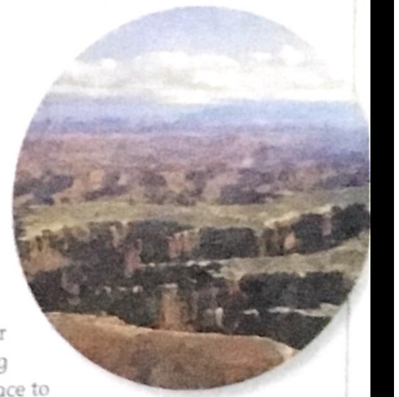
AudioText

Lesson 1

How does Earth's surface change?

Earth's surface is made up of many different features called landforms. As Earth's surface changes constantly, these landforms are shaped both suddenly and slowly.

Badlands National Park



Earth's Features

Do you see the river here in Badlands National Park? No? That's because it's far below the tops of the canyons. These canyons began with the flow of water over flat land. The water carved the landscape over a very long period. Over the years, the moving water dug deeper and deeper into Earth's surface to form the deep canyons we see today.

Even frozen waters can carve into Earth's surface. Many North American lakes, including the Great Lakes between the United States and Canada, were carved out by glaciers on the move. Glaciers are huge masses of slowly moving ice. As glaciers moved, they carried along huge amounts of rock and soil that dug out the lakes' bottoms.

Other landforms on Earth have also been shaped by both gradual and dramatic events. Rivers shift as they carry and deposit **sediments**, solid particles that are moved from one place to another. Although they are flat, plateaus share with mountains their high elevation compared to the land around them. Plains are also flat but support grasslands. The Great Plains of North America is actually a huge, high plateau.

1. ✓ Checkpoint Describe three ways that landforms were created on Earth's surface.
2. Social Studies in Science Find out what major landforms can be found in your state. Draw a map that shows the location of each. If possible, include a picture of each.

Weathering and Erosion

If you could go back and visit a particular place in your neighborhood 10 years ago, you might notice some changes. Few of those changes would be to its landforms. But if you could go back thousands of years, you'd probably be surprised how different the landforms were.

Many changes on Earth's surface can be seen only over thousands of years or more. These changes often are caused by the weathering and erosion of Earth's surface.

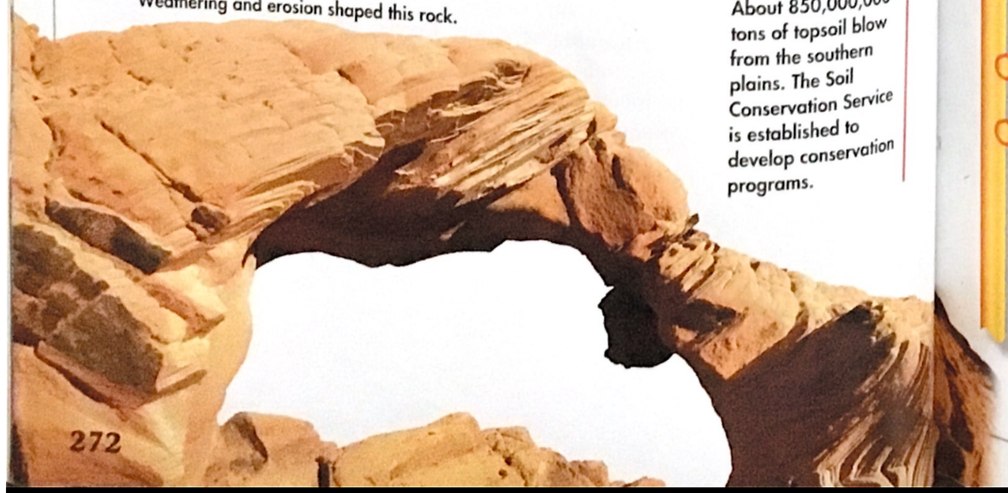
Weathering is the process of breaking down rock into smaller pieces. Some weathering takes place when forces such as water and ice break down rock. This process is called **mechanical weathering.** During mechanical weathering, the minerals that make up the rock do not change.

Most rocks have small cracks in their surfaces. These cracks may be smaller than the width of a hair, but it is in these cracks that mechanical weathering begins. Water can seep into these cracks and freeze. The freezing water expands and pushes against the sides of the crack, making it larger. When the ice melts, water moves back into the cracks again. The rock freezes and thaws over and over again, making the cracks larger each time.

Sometimes soil forms in the cracks of the rock. Plants begin to grow, and their roots push the crack open even farther. Some types of plants can produce chemicals that eat into rocks to cause cracks and holes.

During **chemical weathering,** the actual minerals that make up rock change. The change can be caused when the minerals react with other substances in the environment, such as water or oxygen, to change the mineral content of rocks.

Weathering and erosion shaped this rock.



Dust Bowl

1930
Little rain falls in the southern plains, but crops flourish.

1931
Severe drought hits the midwest and southern plains. Dust begins to blow.

1932
Fourteen dust storms hit the area.

1933
Thirty-eight dust storms occur.

1934
Fewer dust storms, but they spread as far as New York. About 35 million acres of farmland have been destroyed.

1935
Many cattle are destroyed because crops cannot be grown to feed them. About 850,000,000 tons of topsoil blow from the southern plains. The Soil Conservation Service is established to develop conservation programs.

1936
The number of dust storms increases.

1938
Conservation methods, including replowing farmland into furrows and planting trees, result in 65 percent less soil blowing.

1939
Rains arrive, bringing an end to the drought.

What happens to the pieces of rock when weathering breaks them apart? **Erosion** is the process by which soil and sediments are transferred from one location to another—usually by wind, water, ice, and gravity. Erosion can carry eroded materials for hundreds of kilometers.

Weathering and erosion continuously change Earth's surface. Over time, these processes can flatten mountains or dig deep canyons in layers of rock.

Soil Erosion

Erosion can have more immediate effects too. When areas of soil are not covered by plants, the soil can be eroded easily. The roots of plants help prevent soil erosion. That's one reason farmers plant cover crops—crops planted between harvests to reduce erosion. The cover crops also add nutrients to the soil.

When soil erodes, a chain of destructive events might occur. One example is what happened in the southern plains of the United States in the 1930s. Years of drought and poor farming practices left many areas of soil bare. The area became known as the Dust Bowl because of the severe dust storms that blew for eight years. The blown dust was so heavy that children wore dust masks to school. In some places the dust was so thick that people couldn't see even during the day. Dust piled up like snow drifts.

The drought affected not only the land. People had health problems. Some died. Dust damaged cars and farm equipment. Farmers lost their land. Millions of people were left without jobs. Along with the bad came the good. Farmers learned better farming methods and an era of soil conservation began. People learned to take care of the land.

Lesson Checkpoint

1. Water can seep into rocks and dissolve minerals. The dissolved minerals can be washed away. What type of weathering is this? Explain your answer.
2. The Mississippi River carries sediments from Minnesota to the Gulf of Mexico. What is the name of this process?
3. **Draw Conclusions** Over the next 100 years, are Earth's landscapes likely to remain the same? Why or why not? How about over the next 10 years?

Lesson 2

How does water affect Earth's features?

Through erosion, water changes the shape and design of Earth's surface. As it flows downhill in complicated, ever-changing systems of streams and rivers, water carries and deposits many tiny pieces of rock and soil.

Deposition

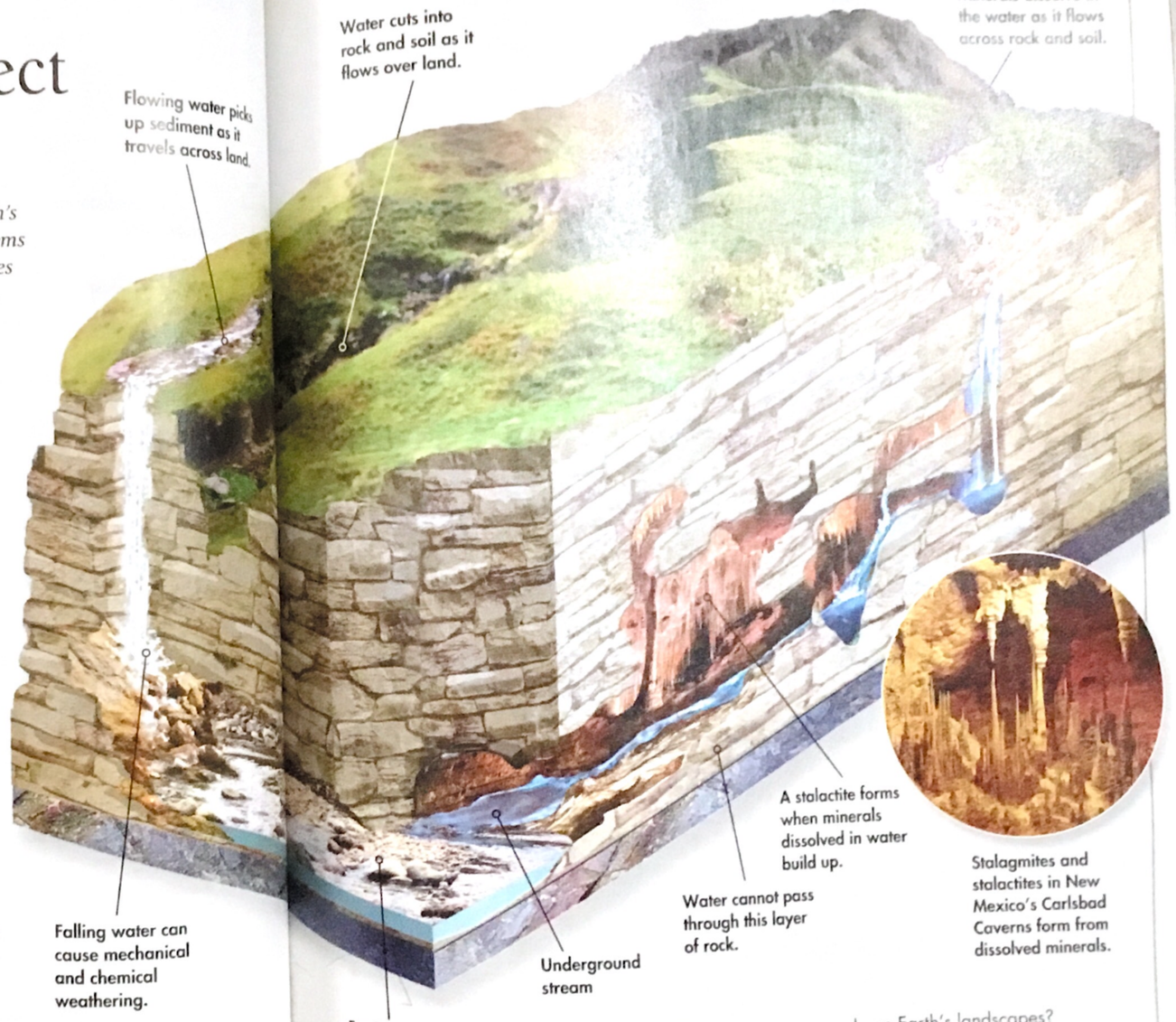
Did you ever get hit by a huge splash of water? If you did, you know that water can hit with quite a force. All moving water has energy, and water running downhill is the main process that shapes Earth's surface. During mechanical weathering, the high energy of running water can break down rock and soil into bits of sediments. Water can also chemically weather rock when it dissolves minerals and other materials in the rock. This process changes the mineral make-up of rock.

The sediments that form during weathering are eroded and deposited at another location. This process of adding sediments to a new place after being carried from another is called **deposition.** In the process of deposition, the shape and direction of a river's flow changes. You can see some effects of erosion and deposition in the picture.

Minerals in Lakes and Oceans

As rivers flow to the ocean, they carry along sediments and dissolved minerals. Ocean plants and animals use some of these dissolved minerals to carry on life processes. Other dissolved minerals settle out of the water and form mineral deposits in lakes, along the coast, and on the ocean floor.

One mineral carried by water is salt. Rivers carry an estimated four billion tons of dissolved salts to the oceans each year. As ocean water evaporates, it leaves behind dissolved salts and other minerals. As a result of this process over thousands of years, the amount of salt in the ocean has increased.



Stalagmites and stalactites in New Mexico's Carlsbad Caverns form from dissolved minerals.

1. **Checkpoint** How does water shape Earth's landscapes?
2. **Math in Science** The amount of dissolved salts in ocean water is about 3.5 percent or 35 grams of salt for every 1000 grams of seawater. Some freshwater lakes may have about 0.5 percent salts. How many grams of salts are there in every 1000 grams of freshwater?

River Systems

You might picture a river as a flat, quiet body of water, but it can change quite a lot over time. Rivers and streams are dynamic systems, which means they are always changing.

A stream begins on land that is higher than sea level. Its water flows because gravity pulls the water downward to a lower area. As a stream flows, other streams may join it, until a river forms. The flowing river water wears down soil and rock and carries the sediments away.

The sediments a river carries can be deposited in different places. That's because as water slows down, it has less energy and can carry less sediment. Heavier sediments are deposited first. Finer, lighter ones can be carried for hundreds of kilometers. Waters often slow down at the low areas at the mouth of the river. There fine sediments are deposited in areas called river deltas.

This fan-shaped deposit of sediments in Death Valley, California, marks the end of the road for sediment carried from far upriver.

Bends in rivers can become more dramatic as sediments are deposited. Sometimes deposition can cut the bends off from the rest of the river, forming lakes.

Floodplains

When rivers and streams flood their banks, their water often slows down and sediments are deposited. Flooding can move huge amounts of sediments to places that would otherwise never receive them. A floodplain is that part of the landscape that is likely to receive the overflow water and sediment from a flooded river.

In some places farmers depend on flooding. That's because the sediments add to the soil important nutrients for growing crops. Often, however, floods are very destructive. Those living in the floodplain can lose homes, villages, or even their lives.

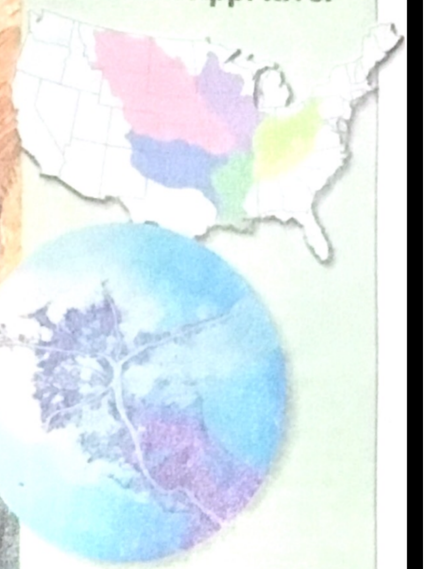
The Nile has flooded local homes here in the Sudan.

Fan-shaped deposits can be especially obvious where mountains drop rapidly to the water below that receives the river's sediments.

Lesson Checkpoint

1. What is the source of much of the salt in ocean water?
2. Why do sediments settle out of flowing water as it slows down?
3. **Writing** in Science **Narrative** Describe a journey from the point of view of one grain of sand. Start your trip as the sand grain is first worn away from a mountaintop rock. Describe events as the grain is carried a long distance and deposited in a river delta.

The Mississippi River



Beginning as a stream flowing out of Lake Itasca, Minnesota, the Mississippi River becomes one of the largest river systems in the world. Water from 31 states drains into the Mississippi before it reaches the Gulf of Mexico. The land drained by a river is called its drainage basin. How many of these facts about the Mississippi River did you know?

- The river's length is 3,705 kilometers.
- The area of its drainage basin is 3.2 million square kilometers.
- Each second 600,000 cubic feet of its water empties into the Gulf of Mexico.
- The river provides habitats for 241 fish species, 38 species of mussels, 45 amphibian species, and 50 species of mammals. It also serves 40 percent of the nation's migratory birds.

Lesson 3

How do waves affect coastal landforms?

The well-known surfing waves in Hawaii define the adjective *tubular*. As the very powerful waves begin to break, they fold over and stretch along the length of the waves, forming a tube in which surfers can ride along with the wave.

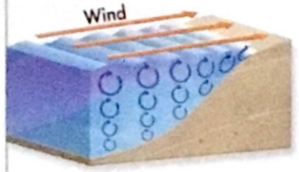
High-energy ocean waves cause erosion along coasts. Waves wear down coastal landforms and build up new ones. Because of waves and wind, coastal landforms are always changing.

Wave Energy

Can you imagine being hit by the huge wave in the picture? Like any wave, this one carries energy. In fact, ocean waves carry and pass along a great deal of energy.

If you have ever watched ocean waves, you probably thought that the water moves forward with the waves. But only energy moves. The water stays in the same spot, rising and falling in a circular motion. As a wave approaches, the water moves slightly forward and then downward and back in a circular loop. Each time a wave passes, the water ends up just about where it started.

As waves move toward shore, the shallower ocean bottom interferes with the waves' movements. The ocean floor can cause the bottom of waves to slow down. The tops of the waves continue to move quickly, so the tops tumble forward. Eventually the waves tumble toward shore to form a breaker.



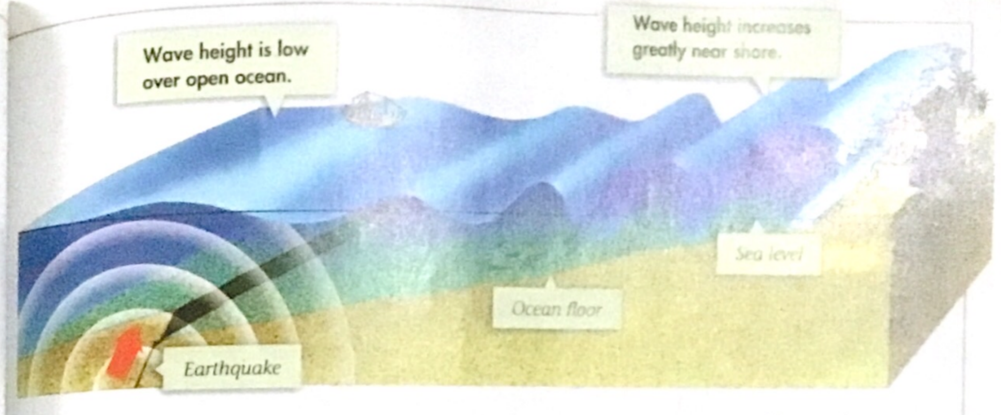
Wind Waves
The circular movement of water gets smaller as you go deeper into the water. Wave energy is strongest at the water's surface.

Causes of Waves

The familiar waves we spot at the beach are often caused by wind. These waves form in the open ocean. As winds touch ocean water, energy transfers from the wind to the water, forming waves. The size of waves depends on the speed of the wind, how long it blows, and on how much of the sea it blows over.

Waves are also formed through tectonic activity. Volcanic eruptions, earthquakes, and landslides take place underwater or along coasts. These events can form tsunamis, waves that travel at incredible speeds and reach great heights before they crash into the shore.

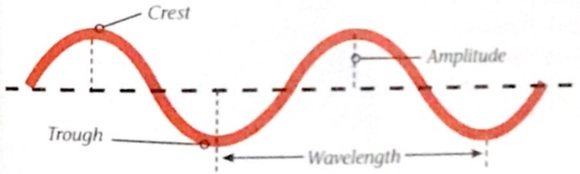
Tsunamis can cause tremendous damage and loss of life. On December 26, 2004, a powerful earthquake erupted in the Indian Ocean near Sumatra, Indonesia. It caused deadly tsunamis to crash the shore of several countries. More than 100,000 people were killed.



Tsunami
Compare the tsunami with wind waves on page 278.

Wave Characteristics

Scientists use certain characteristics to describe all waves, including water waves. The highest part of a wave is the crest. The lowest part is the trough. The heavy dotted line shows the water's position before a wave passes through it. If you measure from that line to the crest or the trough, you know a wave's amplitude.



On a calm day, the amplitude of ocean waves is small. But when strong winds blow, the waves pick up energy, and the amplitude greatly increases.

Wavelength is the distance from one crest to the next or from one trough to the next. The wavelength of small ripples of water may only be a few millimeters. Those of huge waves may be several meters.

1. **Checkpoint** Identify and define four wave characteristics.
2. **Draw Conclusions** Why do you think tsunamis are so destructive?

Beaches: Dynamic Systems

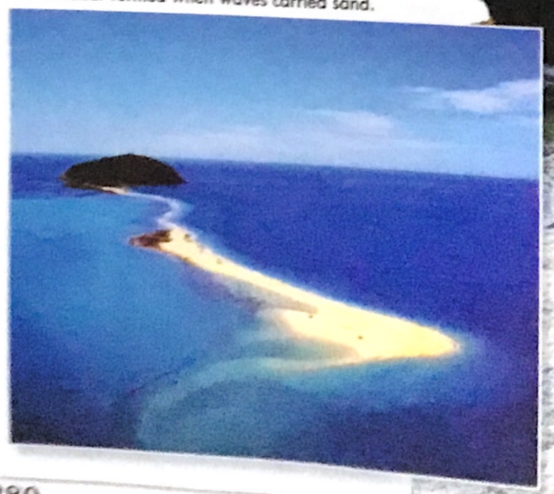
With all the energy carried by waves, it's not so surprising that they can dramatically change an ocean beach. The great amounts of energy in large waves can cause cracks in even huge rocks. Over time, the cracks can become larger, until finally pieces of rock break off.

Waves also carry sediments, such as stones and sand, that can wear down coastal landforms. When these sediments hit coastal features, they act like sandpaper to wear away rock.

Waves also build up beaches by moving sand along the shore. The way the sand moves depends on the angle at which waves strike the shore. When waves move at an angle toward the shoreline, they push water along the shoreline. The movement of water, called a longshore current, can move materials from the shoreline to an area in the water away from the shore. One landform created this way is a sandbar, which you can see in the picture below. Sandbars are ridges of sand, shells, and stones. The tops of the sandbars can be above or below water.

The steep, rocky towers of Australia's "Twelve Apostles" show the work of the ocean's energy over a very long period.

This sandbar formed when waves carried sand.



Lagoons are quiet places where sand, rock, or islands separate the water body from the open ocean. Water moves between lagoon and ocean through one or a few narrow passes. Waves and currents build the barriers that form a lagoon.

The dunes along this quiet cove are stable enough to support plants.

Wind, too, can change landforms along a coast. On rocky shores, wind can shape cliffs and large rocks into amazing shapes. Along quieter, sandy coastlines, wind can blow loose sand into piles, called dunes, along the edge of a beach. Beach dunes are usually small but can be very large.

Coastal landforms are constantly changing as water and wind act on them. Not all beaches are the same. The color and texture of any beach are determined by the sources of its sand and rock. White sand comes from a very different kind of rock than does the black sand of Hawaii's famous volcanic rock beaches. Even major structures that make up a beach, such as rocky cliffs or flat patches of sand, are very different from one beach to another.

Lesson Checkpoint

1. What are two examples of mechanical weathering along an ocean beach?
2. What agent of erosion builds sand dunes?
3. **Draw Conclusions** Why is a beach more likely to change rapidly if it is placed along a river mouth where there are many winter storms than if it is found along a quiet stretch where there are no rivers and few storms?

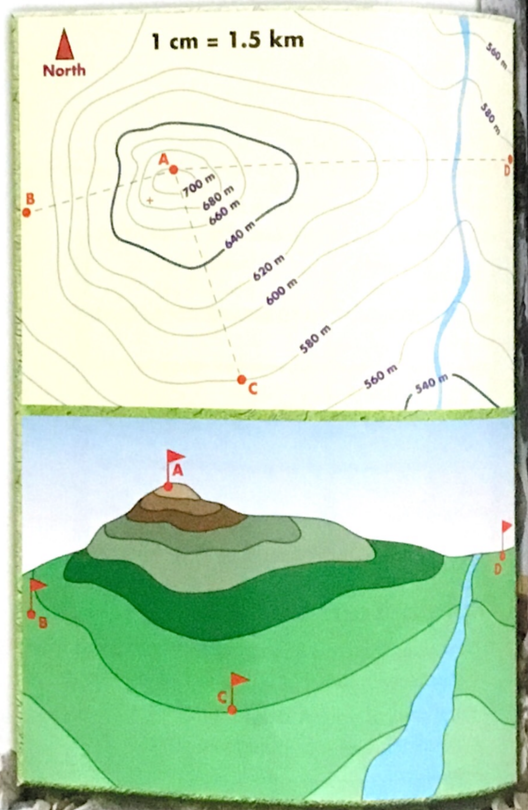
Math in Science

Topographic Maps

Hikers often use topographic maps when planning hikes. This is especially helpful when hiking in the mountains. Hikers there must consider the vertical distance as well as the distance from start to finish.

A topographic map shows the elevation of the land (how high it is above sea level) using contour lines. Every point along a contour line is at the same elevation. The elevation of each contour line is marked somewhere on the line. The difference in elevation from one line to the next is called the contour interval. The land between contour lines slopes up if you move toward another line with a higher elevation or down if you move toward a line of lower elevation.

Shown here is a drawing and a topographic map of the same mountain. The lowest contour line on this map is at an elevation of 540 meters. Locate it on the map. Every fifth contour line is drawn darker to make it easier to read the map. Point A on the map is near, but still below, the summit of the mountain. Points B, C, and D are starting points for three different hiking trails.



Tools Take It to the Net pearsonsuccessnet.com

Use the picture and topographic map on page 284 to answer each question.

1. What is the contour interval for this map?
2. What is the elevation of Point A? Is this the height of the mountain? Explain your answer.
3. The closer that the contour lines are together, the steeper the climb is. From which starting point would the climb to the top be the steepest?
4. Use the map scale and a ruler to find the distance from each starting point to Point A. Include the vertical distance from the closest elevation line to the elevation line for Point A.
5. Reagen and Ryan are planning a hike up this mountain. Ryan used the map and a ruler to find that their hike will be 4.5 km to Point A if they begin at Point B. Why does Reagen disagree with him?

Lab zone Take-Home Activity

Find a topographical map and plan a hike to the top of the mountain. Estimate the total distance of your hike, including the vertical distance. Also estimate how long the hike will take. Write a story about your planned hike.

Chapter 10 Review and Test Prep

Use Vocabulary

chemical weathering (p. 272)	**mechanical weathering** (p. 272)
deposition (p. 274)	**sediment** (p. 271)
erosion (p. 273)	**weathering** (p. 272)

Choose the term from the list above that best matches each phrase.

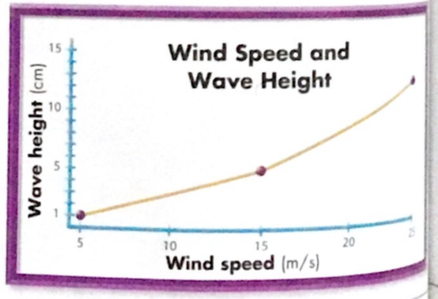
1. Adding sediments to a new place after being carried from another
2. Movement of materials from Earth's surface through the action of wind, water, and ice
3. Rock is broken down but the minerals that make up the rock do not change
4. Process that changes the mineral make-up of rock
5. Solid particles that are moved from one place to another
6. The process of breaking down rock into smaller pieces

Explain Concepts

7. Describe how water running downhill is the main process that shapes Earth's landscapes.
8. Explain how salts collect in the ocean.
9. How are the processes of weathering, erosion, and deposition related?
10. How do erosion and deposition affect beaches?
11. Describe two examples of mechanical weathering.
12. What are two sources of energy for water waves? Explain.

Process Skills

13. **Interpreting Data** The height of ocean waves is determined by the speed of the wind, the distance across the water the wind travels, and the amount of time that the wind blows. According to the graph, what are the wave heights reached at wind speeds of 5 meters/second, 15 meters/second, and 25 meters/second? Between which wind speeds do the wave heights seem to be increasing most rapidly?

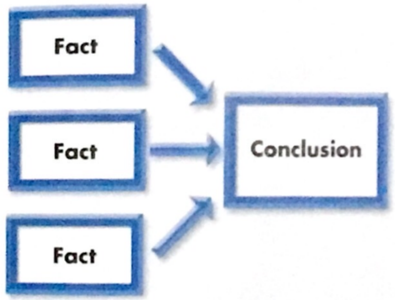


14. **Model** Draw a model that explains the movement of water in an ocean wave.

Draw Conclusions

15. Read the following passage, and then fill in a graphic organizer similar to the one below. List three facts from the passage, and then make a conclusion about changes that take place on Earth's surface.

> The water in rivers slowly dissolves rock and carries away sediment from the land. Wind and waves constantly change coastal areas. Earthquakes, floods, volcanoes, and other sudden events can dramatically change the landscape.



Test Prep

Choose the letter that best completes the statement or answers the question.

16. Broken-down rock and soil are moved from place to place on the Earth's surface through
    - Ⓐ tectonic activity.
    - Ⓑ chemical weathering.
    - Ⓒ wave action.
    - Ⓓ erosion and deposition.
17. Water flows in a river because of
    - Ⓕ erosion.
    - Ⓖ gravity.
    - Ⓗ deposition.
    - Ⓘ weathering.
18. What is the most important reason that rivers and streams cause erosion?
    - Ⓐ Their moving water has energy.
    - Ⓑ They flood their banks.
    - Ⓒ They deposit sediments in deltas.
    - Ⓓ They create deltas.
19. Explain why the answer you chose for Question 18 is the best. For each of the answers that you did not choose, give a reason why it is not the best choice.
20. **Writing in Science** **Expository** Summarize the many processes and events that change Earth's surface. Divide them into two groups, those that cause sudden, dramatic change, and those that cause slow and steady change over time.