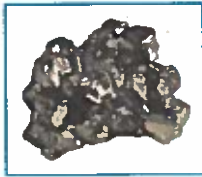


Rocks and Minerals

Vocabulary



mineral one of the parts that a rock is made of



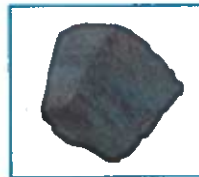
luster the way something shines in the light



streak the color of the powder made when a mineral is scratched on white tile



hardness the ability of a mineral to scratch another mineral



ore a rock that contains a useful mineral



magma hot, melted rock beneath Earth's surface



lava magma that reaches Earth's surface



igneous rock a rock formed from hot, melted rock that cools and hardens



What are rocks and minerals and where do they come from?



sediment tiny broken bits of rocks, plants, bones, and shells



sedimentary rock a rock formed from tiny pieces of broken rocks pressed together



fossil the remains of a once living thing from long ago



metamorphic rock a rock formed from another rock that is being squeezed and heated



rock cycle the continual changing of one kind of rock into another kind

What is a mineral?

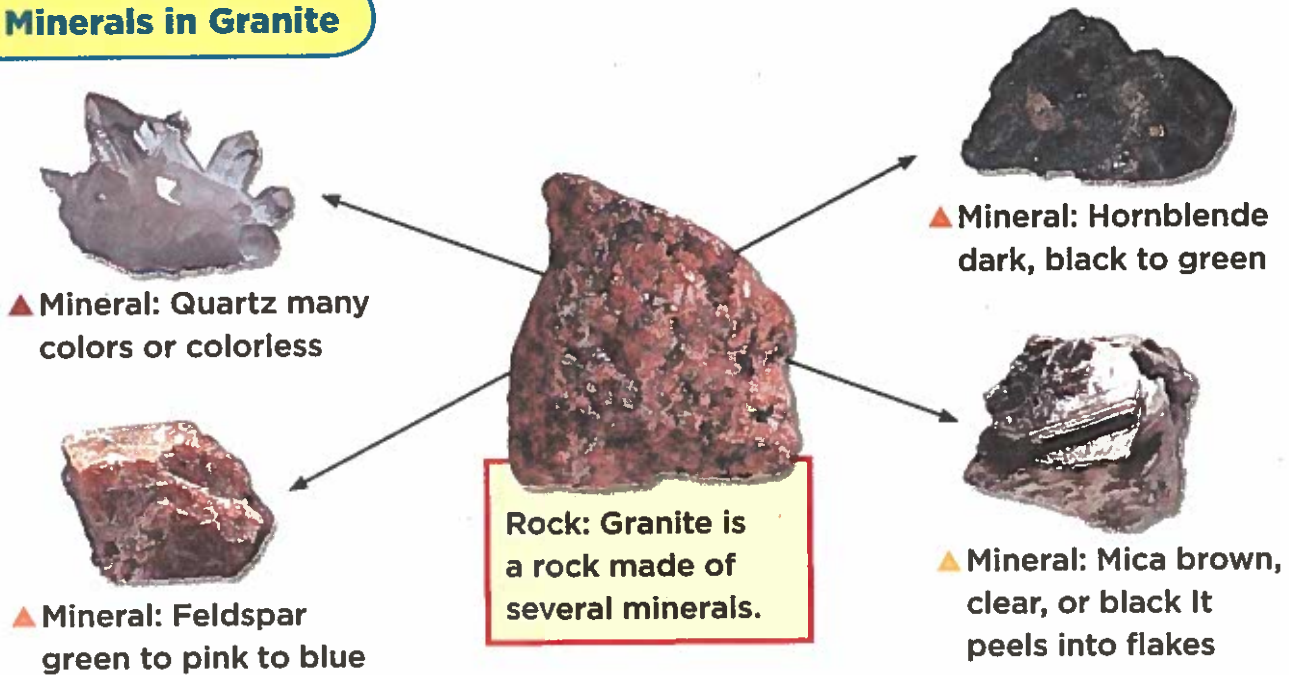
Pick up a rock—for example, a chunk of granite. You can see that it is made of small pieces of different colors and shapes.

The pieces in granite are minerals (MIN•uhr•uhlz). **Minerals**

are the parts that rocks are made of. Minerals are the building blocks of rocks. Rocks may be made of many minerals or just one.

There are thousands of minerals. They have different shapes and colors. Here are the four minerals that make up granite.

Minerals in Granite



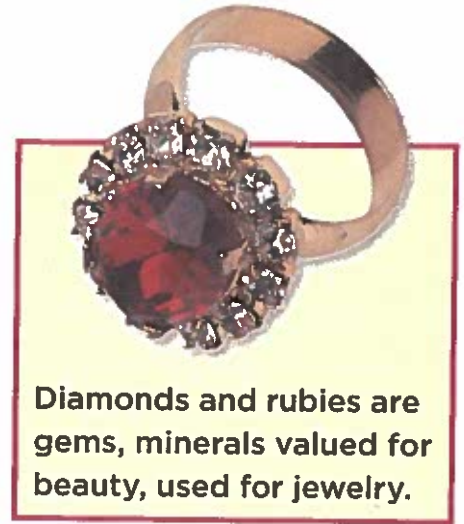
Quick Check

1. How are minerals different? _____ _____ _____	2. How are minerals alike? _____ _____ _____
--	--

What are minerals used for?

People can take minerals out of rocks. Then we can use the minerals in many ways. From toothpaste to eyeglasses, minerals are used to make many things we use every day.

Many minerals that we use are from ores (AWRZ). **Ores** are rocks that contain useful minerals. The mineral aluminum for example comes from the ore bauxite (BAWK•sight). We use aluminum for cans, pots and pans, and even baseball bats.



Diamonds and rubies are gems, minerals valued for beauty, used for jewelry.

Ways We Use Minerals

mineral	uses
quartz	glass and glass products
gypsum	drywall (for making walls in building)
copper	electrical wires; pots and pans

Quick Check

3. Why are minerals important? _____

How are minerals identified?

When you *identify* something, you are able to name it. How can you identify a mineral?

The color on the outside of a mineral is not the best clue to identify a mineral. Two different minerals can have the same color. For example, calcite and quartz can both be white. Any one mineral may come in many colors. Quartz can be white, purple, or pink.

Luster

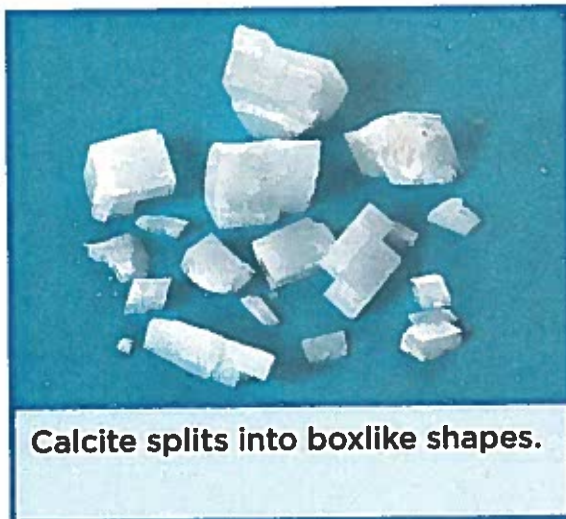
Luster can help you identify minerals. **Luster** is the way something shines in the light. Some minerals have a shiny or metallic luster, like a metal spoon. Other minerals have a nonmetallic luster. They may be dull or glassy.



Pyrite (PIGH•right) was called “fool’s gold.” It has a yellow color and a metallic luster like gold.

Splitting

Some minerals split, or break along flat surfaces. Calcite, for example, splits into boxlike shapes. Remember from page 54 that mica splits into flakes. Some minerals do not split evenly.



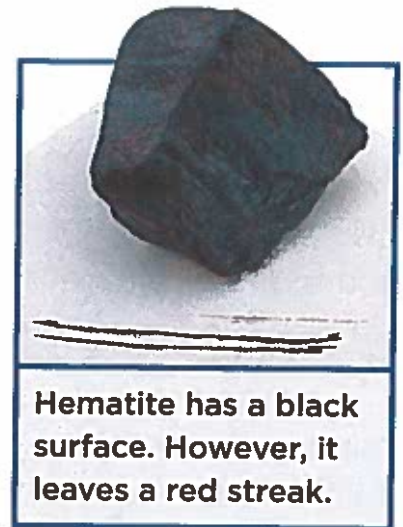
Calcite splits into boxlike shapes.



Some minerals, such as quartz, do not split along flat surfaces.

Streak

A helpful clue to identify a mineral is its streak. **Streak** is the color of the powder left when a mineral is rubbed along a rough white tile. Some minerals leave a streak that is the same color of the mineral. Others leave a streak that does not look like the color of the mineral. Pyrite has a yellow color but leaves a greenish-black streak.



Comparing Color and Streak

Mineral	Color of Outside of Mineral	Streak
gold	yellow	yellow
pyrite	yellow	greenish-black
calcite	white or colorless	always white

Quick Check

Match the clues with the letter of the mineral.

- _____ black color, reddish streak
 - _____ metallic luster, greenish-black streak
 - _____ splits into flakes
 - _____ splits in boxlike shapes
- mica
 - calcite
 - hematite
 - pyrite

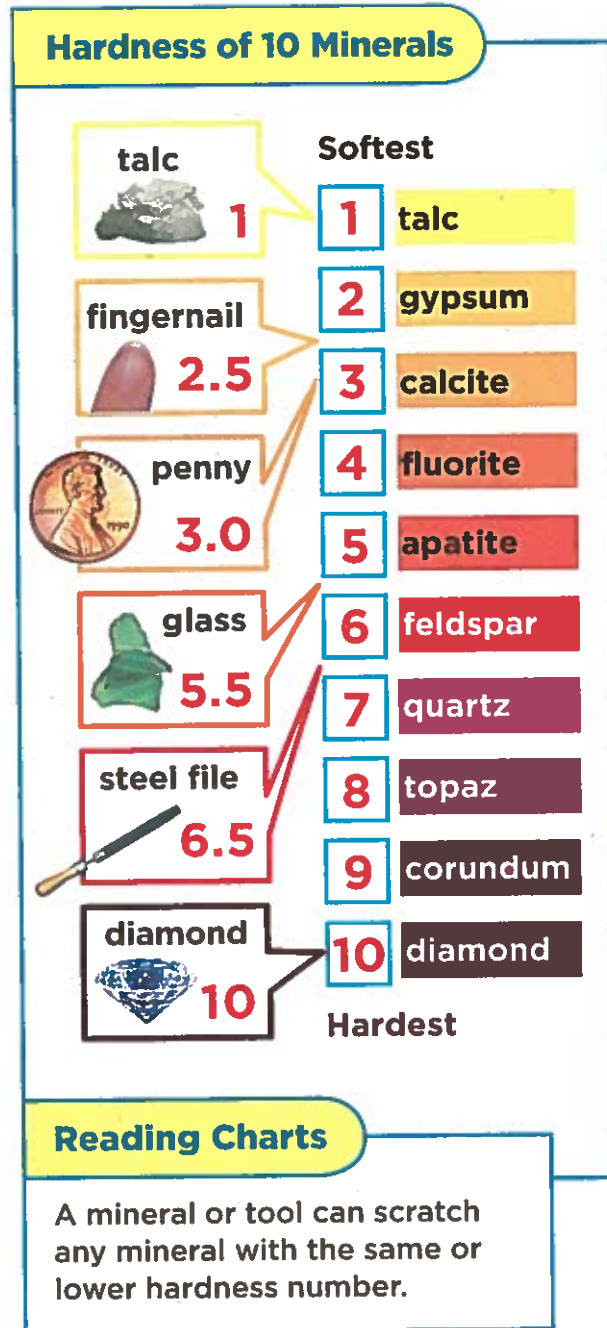
What is hardness?

The hardness of a mineral can also help you identify it. **Hardness** is the ability of one mineral to scratch another mineral.

Each mineral has a hardness number. Look at the chart. Talc is number 1, the softest. Diamond is number 10, the hardest.

A mineral can scratch any other mineral that has the same or a lower hardness number. For example, calcite, number 3, can scratch any mineral with a hardness number that is 3 or less. Calcite can scratch gypsum and talc.

You can use everyday items to find the hardness of minerals. Your fingernail can scratch gypsum and talc. A penny can scratch calcite, gypsum, and talc.



Mineral Identification Table

Mineral	Hardness	Luster	Streak	Color	Splits
quartz	7	nonmetallic	none	colorless, white, pink, purple, brown	breaks unevenly
mica	2-2.5	nonmetallic	none	dark brown, black, or silver-white	flakes
calcite	3	nonmetallic	white	colorless, white	boxlike shapes

The table sums up the clues you can use to identify some minerals. For example, quartz and calcite may both be white. However, quartz is much harder than calcite.

Quick Check

Tell how mica and calcite are alike and different.

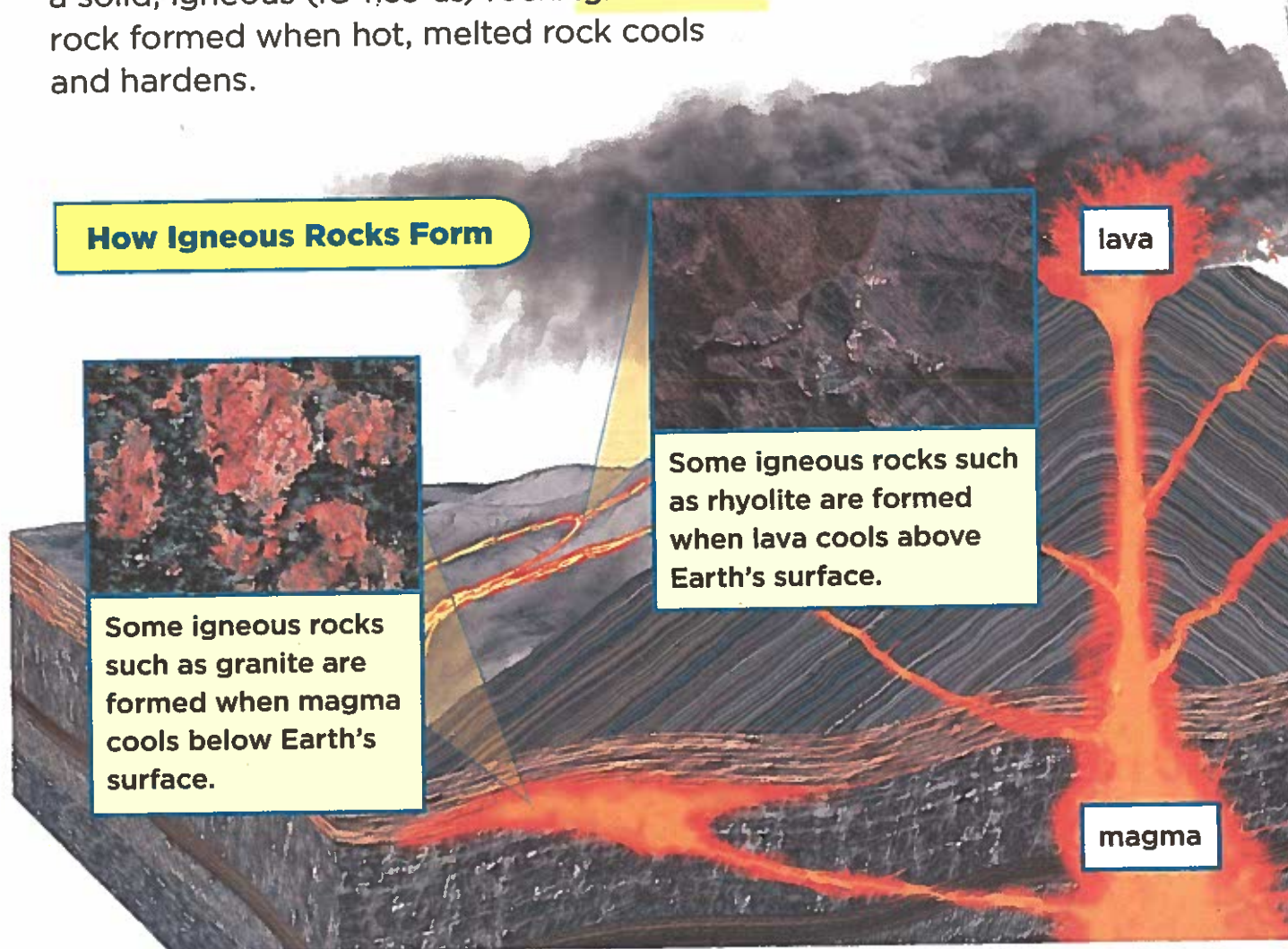
- Mica can have a _____ color and splits into _____.
- They both have a hardness of _____ or less and have a nonmetallic _____.
- Calcite can have a _____ color and splits into _____.

Lesson 2 Igneous Rocks

How are igneous rocks formed?

The rocks you know are solids. However, deep below Earth's surface, rock is very hot. It is melted into a liquid. Hot, melted rock below Earth's surface is **magma** (MAG•muh). In some places, magma reaches the surface, as you see in the diagram. Magma that reaches the surface is **lava** (LA•vuh).

Above or even below the surface, the melted rock can cool off. When it cools off, it hardens into a solid, igneous (IG•nee•us) rock. **Igneous rock** is rock formed when hot, melted rock cools and hardens.



Underground Rocks

Magma can rise up from deep underground. It can cool off underground before it gets to the surface. The magma may take many years to cool off underground. It forms igneous rocks that have large pieces of minerals inside. Example:

- granite

Rocks Above Ground

Above Earth's surface, lava cools off quickly, in hours or even minutes. The minerals inside the rock are small. They may be so small that you cannot see each of them. Example:

- rhyolite (RIGH•uh•light)

Quick Check

Write the name of a rock next to each description. Use each rock twice.

rhyolite

granite

11. forms underground _____
12. forms above ground _____
13. has small minerals inside _____
14. has large minerals inside _____

Reading Diagrams

How can you tell from the diagram that magma must be hot?

LOG
ON

Science in Motion Watch how igneous rocks form @ www.macmillanmh.com

What are some properties of igneous rocks?

There are many different igneous rocks. They may have different minerals inside. The minerals are large pieces if the rock was formed underground. The minerals are small if the rock was formed above ground.

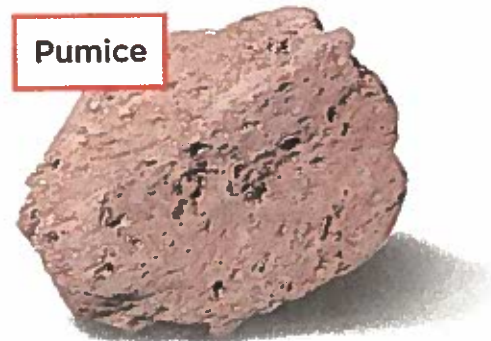
Granite

- formed underground
- is made of several different minerals
- has large minerals that make it feel rough (coarse)
- comes in many colors because of different colors of minerals inside



Pumice (PUM•is)

- formed above ground
- has tiny holes inside from trapped gases
- very lightweight
- feels scratchy, crumbly



Obsidian (uhb•SID•ee•uhn)

- formed above ground
- feels very smooth like glass
- has a glassy shine (luster)
- dark in color, often black





The Great Wall of China was made from blocks of granite. It was built over 2,000 years ago.

Uses of Igneous Rocks

Igneous rocks are useful in many ways because of their properties.

- Granite is hard and long lasting. It is used to make roads, sidewalks, buildings, and bridges.
- Pumice is scratchy and rough. It is used in cleansers to scrub off dirt.

Quick Check

Write the name of each rock once next to each description.

pumice

obsidian

granite

15. hard, used to make buildings _____

16. scratchy, used in cleansers _____

17. like shiny, smooth glass _____

Lesson 3 Sedimentary Rocks

How are sedimentary rocks formed?

Some rocks are formed from sediments (SED•uh•mentz). **Sediments** are tiny broken bits of rocks, plants, bones, shells, and other animal materials. Rocks formed when sediments are pressed together into layers are **sedimentary rocks**.



You can see the layers of sedimentary rocks along the Grand Canyon. The colors of these layers come from different kinds of sediments.

How Layers Form

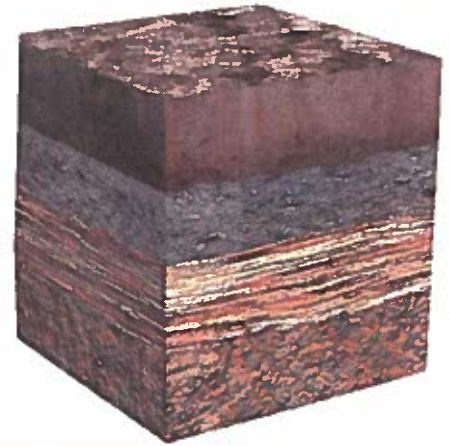
Layers of sedimentary rocks form in three steps.

- Moving things (wind, rivers, and streams) pick up and carry sediment.
- The moving things drop off sediment and layers form.
- Layers build up, one on top of another. Layers above press down on the layers below. The sediment in the lower layers are cemented together. They become sedimentary rock.

In the sediment that forms in a sedimentary rock, there are often pieces of living things, such as leaves and bones. The remains of living things from long ago are **fossils**.

Layers of Sediments

A
B
C
D



Reading Diagrams

Younger layers are found above older layers.



This fossil was found in sedimentary rock that was once underwater.

✓ Quick Check

Complete the diagram. With just a few words in each step, summarize how layers form.

First 18. _____



Next Drop off; layers form.



Last 19. _____

What are some properties of sedimentary rocks?

There are many different sedimentary rocks. They are made from different kinds and sizes of sediments. Some are softer than others. Some have layers. Some do not show layers. Many kinds contain fossils.

Limestone

- formed at bottoms of oceans
- formed from remains of once-living things, such as bones and shells
- usually white, chalky
- often has fossils



Limestone often contains fossils, such as this ancient fish.

Sandstone

- formed from bits of sand cemented together
- sand is made up of the mineral quartz
- may show ripples if it was formed underwater



This sample of sandstone is reddish from rust. The rust is cementing the sand together. You can see thin layers inside the rock.

Conglomerate (kuhn•GLOM•uhr•it)

- formed from rounded pebbles and stones, which may once have been carried by streams or rivers
- has several sizes and kinds of sediment
- looks chunky and feels rough



Conglomerate shows chunks of other rocks. No layers are visible.

Uses of Sedimentary Rocks

Sedimentary rocks have useful properties.

- Limestone is soft. It is used to make chalk.
- Shale can be molded. It is used for bricks and pottery.
- Soft coal was formed from the remains of ancient plants. The energy stored in soft coal is from ancient plants.

Sedimentary rocks help us piece together Earth's past. Fossils in these rocks show what life was like in the past.



Soft coal contains stored energy from plants that lived long ago.

Quick Check

20. How could you identify a piece of sandstone?

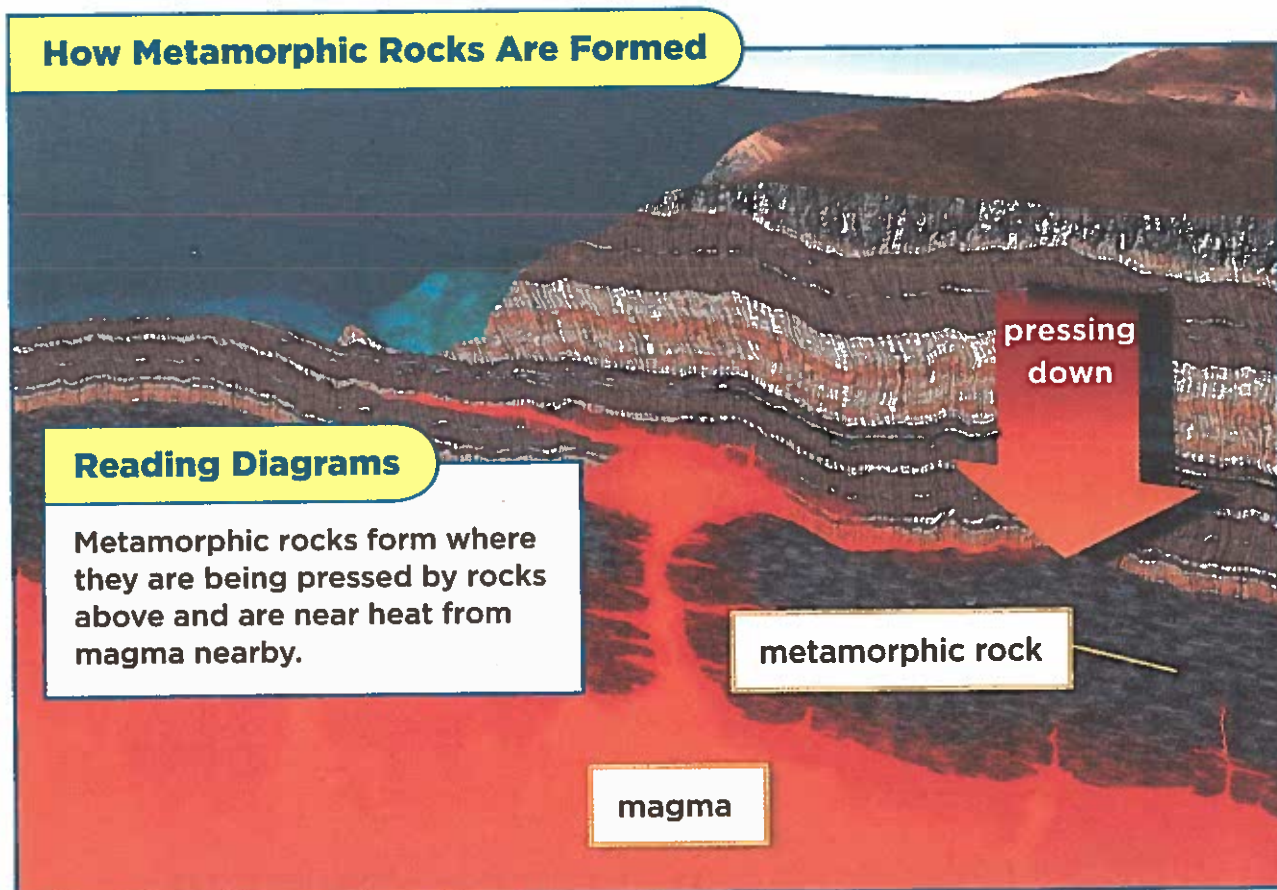
21. How could you identify a piece of conglomerate?

Lesson 4 Metamorphic Rocks

How are metamorphic rocks formed?

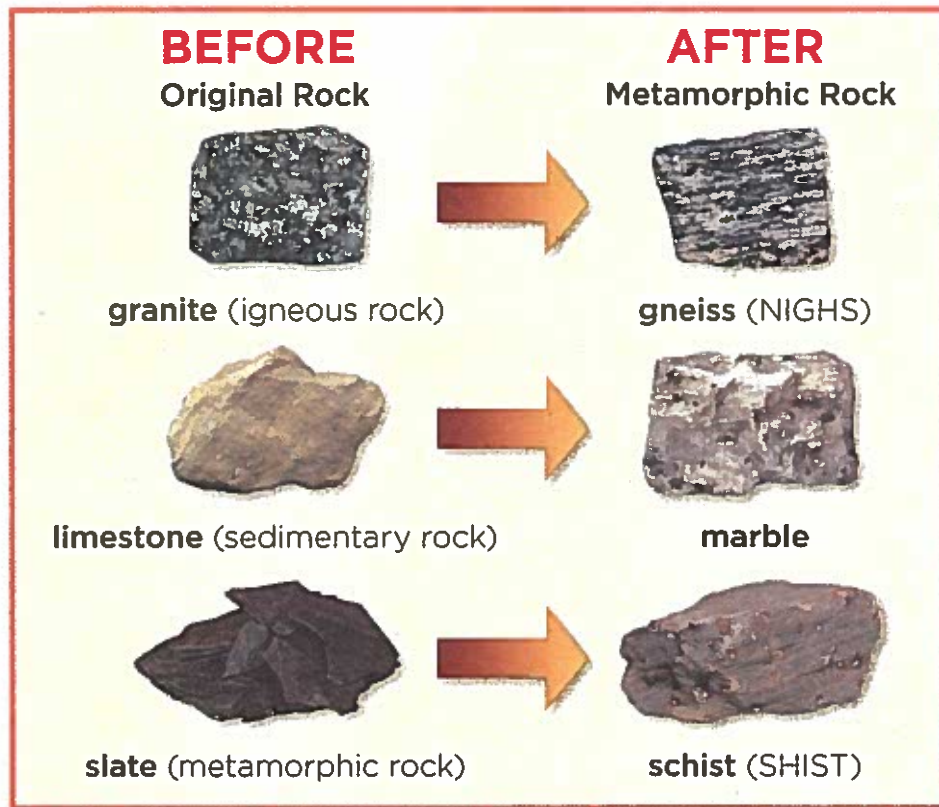
Below Earth's surface are many layers of rocks. Layers near the top press down on deeper layers. This pressing squeezes deeper layers together. Also, the deeper layers are heated by the hot magma that is nearby.

Deep inside Earth, rocks that are squeezed and heated can change into other rocks called **metamorphic** (met•uh•MAWR•fik) **rocks**. Metamorphic rocks can be formed from any kind of rocks.



Rocks Make-Overs

One metamorphic rock you may know is slate. Slate is a hard rock used to make chalkboards and roofs. It is formed from a soft sedimentary rock, shale. When shale is squeezed and heated deep inside Earth it becomes slate. Slate, in turn, can change into *another* metamorphic rock, schist (SHIST).



✓ Quick Check

Fill in the boxes to show how metamorphic rocks are formed

Deeper rocks are squeezed by rocks above.

Deeper rocks are **22.** _____

Summary

Any rock can be changed into **23.** _____

What are the properties of some metamorphic rocks?

Metamorphic rocks have many different properties because they come from many other kinds of rocks. They may be squeezed and heated differently and end up with different properties.

Gneiss

- forms from granite (igneous rock)
- has layers (or bands) across the rock
- has minerals that are large enough to be seen
- feels rough

BEFORE



granite
(igneous rock)



AFTER



gneiss

This piece of gneiss shows bands, or layers, of light and dark minerals.

Quartzite (KWARZ-ight)

- forms from sandstone (sedimentary rock)
- does not have layers (or bands)
- has small minerals inside
- feels smoother than gneiss

BEFORE



sandstone
(sedimentary rock)



AFTER



quartzite

Quartzite comes in many colors but most often looks glassy.

Marble

- forms from limestone (sedimentary rock)
- does not have layers (or bands)
- can have small minerals and feel smooth
- can have larger minerals and feel rough

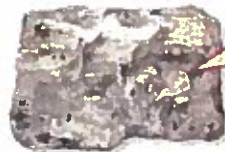
BEFORE



limestone
(sedimentary rock)



AFTER



marble

Marble comes in many colors, but is often white.

Slate

- forms from shale (sedimentary rock)
- has layers
- has small minerals and feels smooth

BEFORE



shale
(sedimentary rock)



AFTER



slate

Slate has thin, flat layers.

✓ Quick Check

Circle the letter of the correct answer.

24. Quartzite

- a.** feels very rough **b.** has layers **c.** feels smoother than gneiss

25. Marble

- a.** always is green **b.** may feel rough **c.** has layers

26. Gneiss

- a.** has layers **b.** feels smooth **c.** has small minerals

What are some uses of metamorphic rock?

Metamorphic rocks are useful because of their properties. They are used for buildings, sidewalks, statues, and jewelry. Here are some examples:

- Marble is used for buildings and statues because it does not split when it is carved.
- Slate is used for roofs because it is waterproof. It is used for walkways because it is hard and smooth.
- Quartzite is used for making glass and pottery. It is also used for tile floors and stone walls.

A hard form of coal is a metamorphic rock. It is formed from soft coal, which is a sedimentary rock. Hard coal comes from deeper inside Earth than soft coal. It burns cleaner and longer than soft coal.



▲ This roof is built with shingles. The shingles are small flat pieces of slate.

Quick Check

Match the rock and its use.

- | | |
|---------------------|-------------------------|
| 27. _____ slate | a. burned for energy |
| 28. _____ marble | b. used to make statues |
| 29. _____ quartzite | c. used to make glass |
| 30. _____ hard coal | d. used to make roofs |

How can you be a rock detective?

How can you tell if a rock is an igneous rock? How can you tell a sedimentary rock from a metamorphic rock? You can identify each kind of rock by several clues.

Sedimentary Rocks

- may contain fossils
- often have layers and can break apart

Igneous Rocks

- are usually hard
- do not have layers
- may have minerals that twinkle in the light
- may look glassy (obsidian)

Metamorphic Rocks

- may have colored bands

Quick Check

Match the rock and its clue.

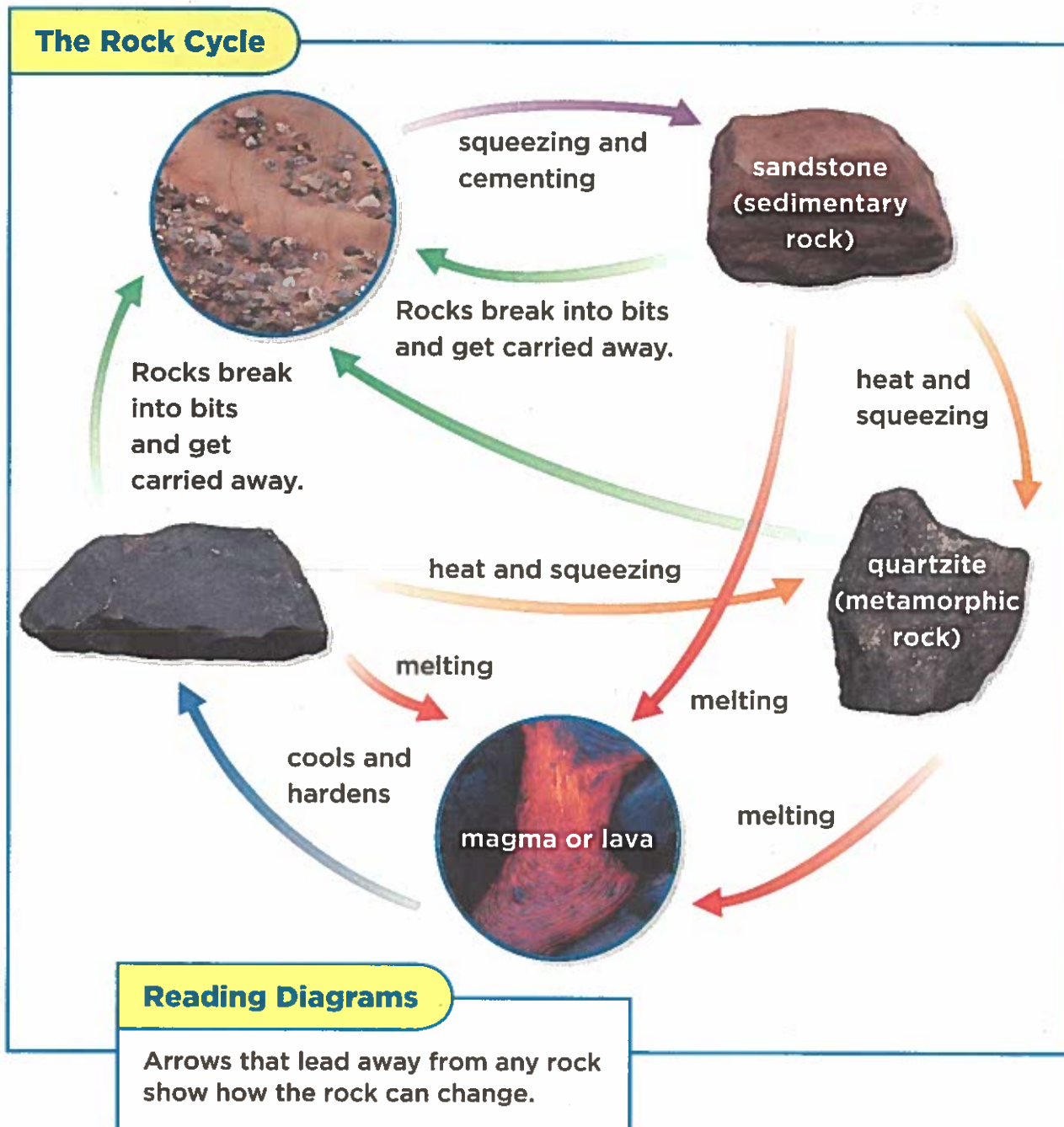
- | | |
|------------------------------|-------------------------------------|
| 31. _____ metamorphic | a. may have fossils |
| 32. _____ igneous | b. colored bands |
| 33. _____ sedimentary | c. is hard and has no layers |



Fossils are found in sedimentary rocks, such as shale, sandstone, or limestone.

The Rock Cycle

Rocks are changing all the time. Any rock is changing into another kind of rock. The continual changing of one kind of rock into another kind is the **rock cycle**. The arrows shows some of the ways kinds of rocks are changing into each other all the time.



How to Read the Rock Cycle

Put your finger on any picture of a rock in the rock cycle. Find the arrows that lead away from the picture. Here is one pathway, following just the outer arrows:

1. Start with “magma or lava” at the bottom of the rock cycle.
2. Follow the blue arrow to the left. Magma or lava cools and hardens and becomes igneous rock.
3. Follow the green arrow leading up from igneous rock to the rock bits. Igneous rocks break into bits and get carried away.
4. Follow the purple arrow leading away from the rock bits. The bits can be pressed and cemented into a sedimentary rock.
5. Follow the gold arrow leading down from sedimentary rock. A sedimentary rock can be heated and squeezed to form a metamorphic rock.

Now follow some of the arrows *inside* the diagram.

Quick Check

Sandstone (sedimentary rock) has three arrows pointing away from it. Read the arrows to tell three things that can happen to sedimentary rock.

34. _____

35. _____

36. _____

Rocks and Minerals

Complete the sentences below. Fill in each blank with one letter.

1. The ability of a mineral to scratch another mineral is called
○○_ _ _ _ .
2. A rock that is formed from another rock that is squeezed and
heated is _ _ _ _ ○ _ _ _ _ _ _ _ _ _ _ ○ _ _ _ _ .
3. Chalk is a _ _ _ _ ○○ _ _ _ _ ○ _ _ _ _ _ _ _ _ _ _ that is
formed from tiny pieces of fossil shells.
4. Some igneous rocks are formed from ○ _ _ _ _ _ beneath Earth's
crust that has cooled and hardened.
5. Useful minerals can be mined from ○ _ _ _ .
6. A rock is made of one or more _ _ _ _ ○ _ _ _ _ _ _ _ _ _ _ ○ _ _ .

Write out all the letters that are in the circles.

Use the letters from inside the circles above to name two minerals described below. Clue: Look at the table in page 58.

7. If you add the hardness of these two minerals, the sum is 11.

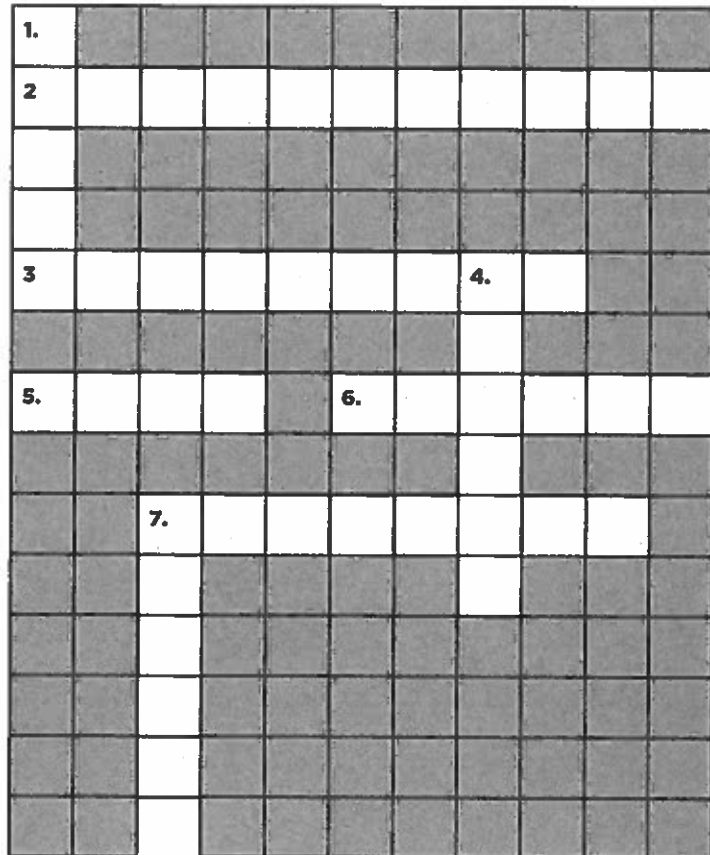
Use the clues below to fill in the crossword puzzle.

ACROSS

- 2. a rock formed from hot, melted rock that cools and hardens
- 3. the continual changing of one kind of rock into another kind
- 5. magma that reaches Earth's surface
- 6. the remains of a once living thing from long ago
- 7. tiny broken bits of rocks, plants, bones, and shells

DOWN

- 1. a part that a rock is made of
- 4. the way something shines in the light
- 7. the color of the powder made when a mineral is scratched on white tile



Slow Changes on Earth

Vocabulary



weathering breaking down rocks into small pieces



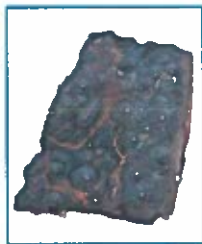
horizon a layer of soil



physical weathering breaking down rocks into small pieces by hitting them or making them split



erosion carrying away broken pieces of rock



chemical weathering breaking down rocks by chemicals in the air, water, or ground.



deposition dropping off pieces of rock that were carried by wind, water, or ice



humus rotted plant and animal remains that becomes part of the soil



plain a flat stretch of land without any hills or mountains



What causes Earth's surface to change slowly?



landform any natural feature on Earth's surface



canyon a deep, narrow landform with steep sides, usually with a river running through it



valley the low land between hills or mountains



delta land built from rock pieces dropped off at the end of a river



barrier island long, narrow land built up from sand dropped off shore



sand dune a hill built from sand that is carried and dropped off by wind

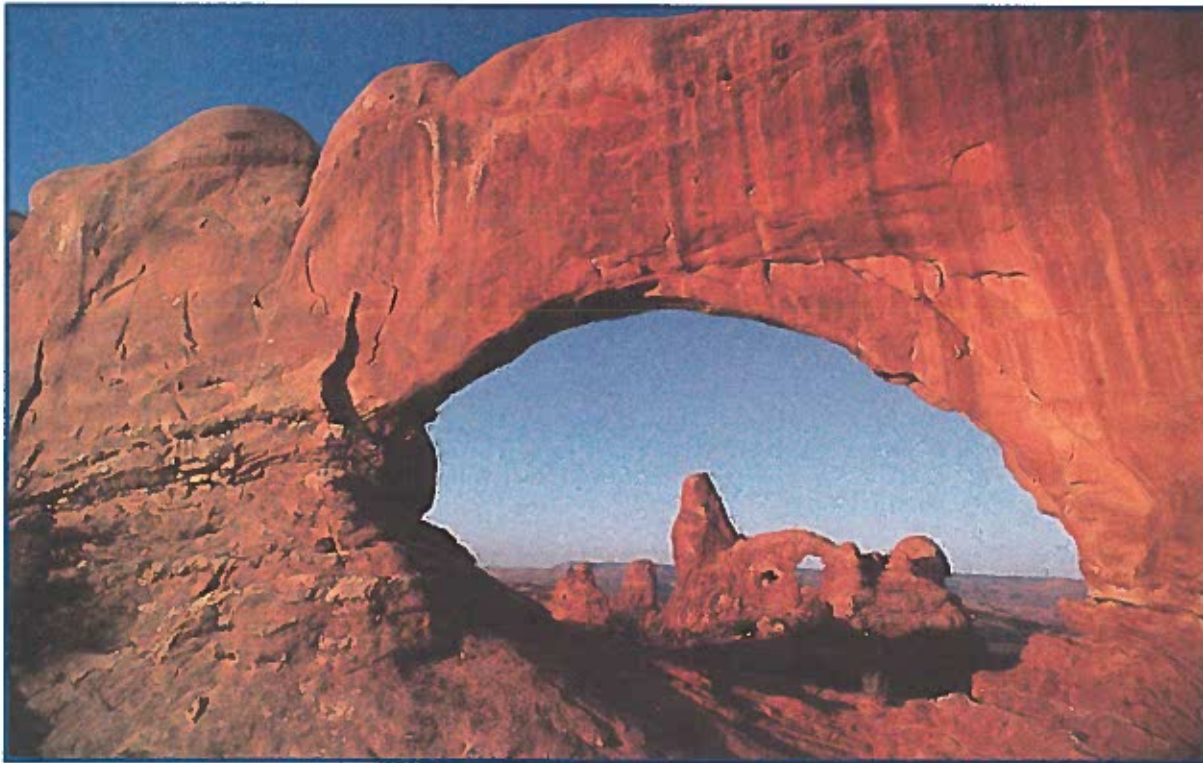


glacier a large moving sheet of ice

What is weathering?

Rocks everywhere are slowly breaking down into small pieces. For example, wind, freezing, and even the growth of plants can cause a rock to break. The breaking down of rocks into small pieces is **weathering** (WETH•uhr•ing).

Weathering can happen in many ways. **Physical weathering** is breaking down rock by hitting them or an any other way making them split apart. Wind and rain are two main causes of physical weathering.



▲ Physical weathering slowly drilled these holes in solid rocks in Arches National Park.

Here are some causes of physical weathering:

- **Freezing and Melting** Water from rain or snow can seep into cracks in rocks. If the water freezes, ice forms. The ice can widen the cracks. Later the ice melts back into liquid water. Freezing and melting over and over break the rock apart.
- **Plants** Plant roots can grow into cracks in rocks and cause them to widen. Eventually the rock splits apart.
- **Peeling Off.** The surface of some huge rocks may peel off into large flakes.
- **Wind** Wind can carry sand and small rocks. Wind-driven sand and rocks act like slow drills. They drill into softer rocks.



Roots growing into a crack in a rock can slowly split the rock apart.



The surface of this mountain, Half Dome, peeled away.

Quick Check

Describe how each of the following causes weathering.

1. Freezing _____

2. Plant roots _____

3. Wind driven sand _____

What are some other causes of weathering?

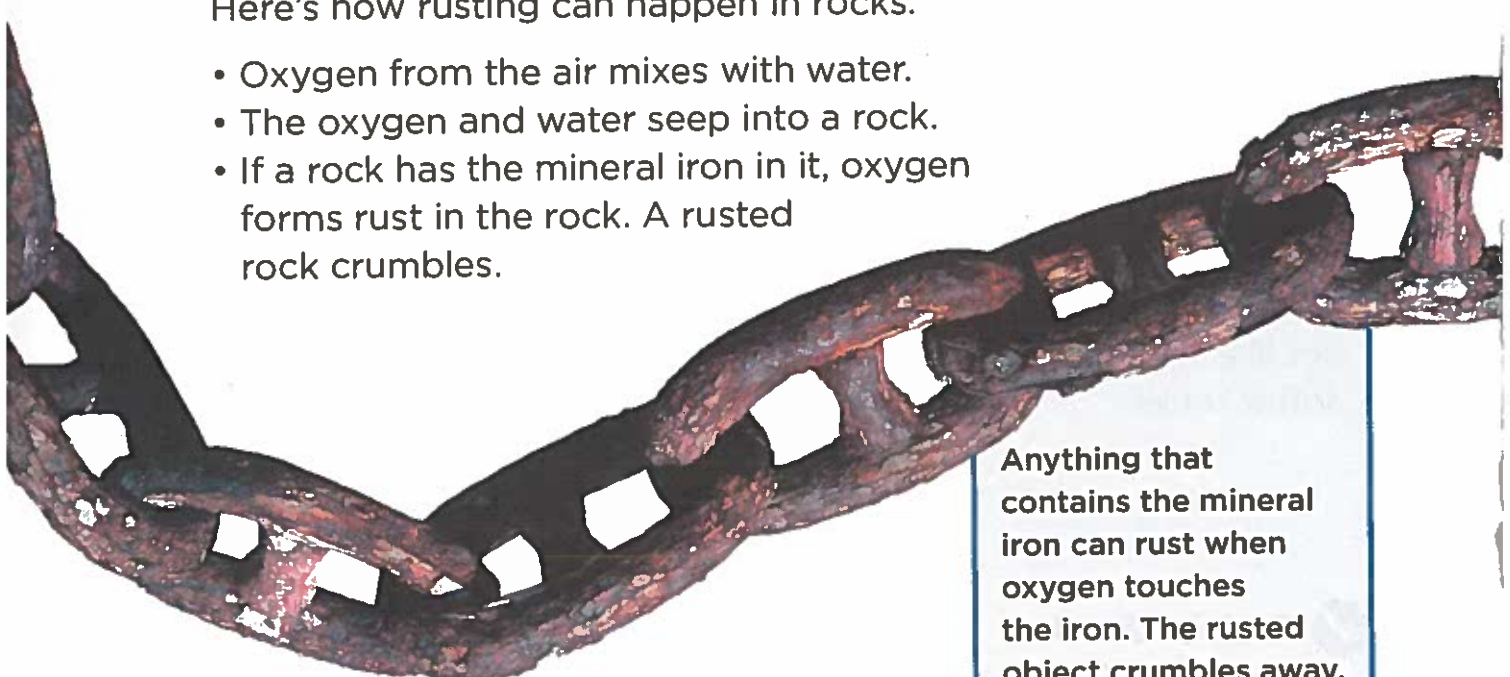
You may have seen rust on a bicycle fender. Rust forms slowly and makes the fender crumble. Rust can also form in rocks.

Rust in rocks is a kind of chemical weathering. **Chemical weathering** happens when chemicals in the air, water, or land break down rocks. Here are some examples.

Oxygen

Here's how rusting can happen in rocks:

- Oxygen from the air mixes with water.
- The oxygen and water seep into a rock.
- If a rock has the mineral iron in it, oxygen forms rust in the rock. A rusted rock crumbles.



Anything that contains the mineral iron can rust when oxygen touches the iron. The rusted object crumbles away.

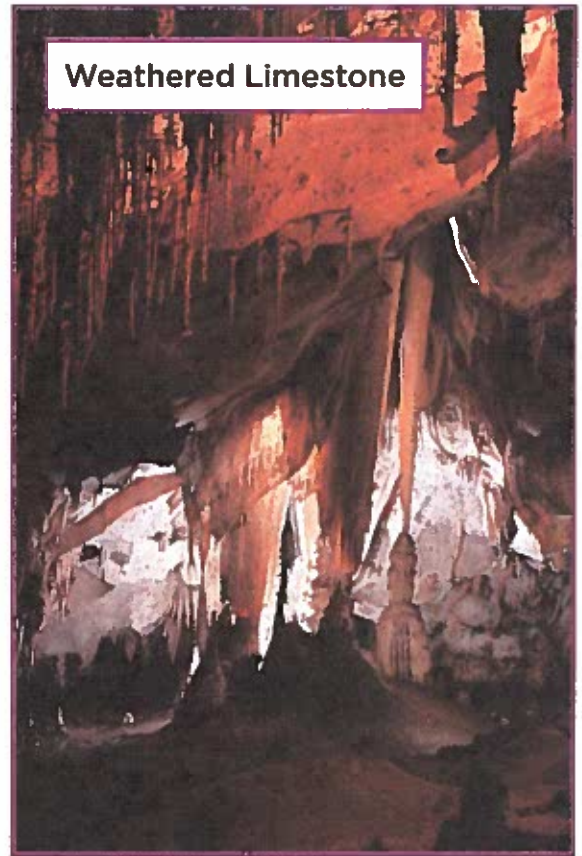
Acids

Acids are chemicals that can gradually eat away rocks. Acids seep into soil from rotting plants. Water seeping through the soil can pick up the acids. When acids come into contact with some kinds of rocks, it can gradually eat away the rocks.

Carbon Dioxide

Carbon dioxide is a gas in the air. It mixes with rainwater and forms an acid. This acid can seep through limestone and eat away a hole in the rock. Over many years, the hole slowly gets bigger and becomes a cave.

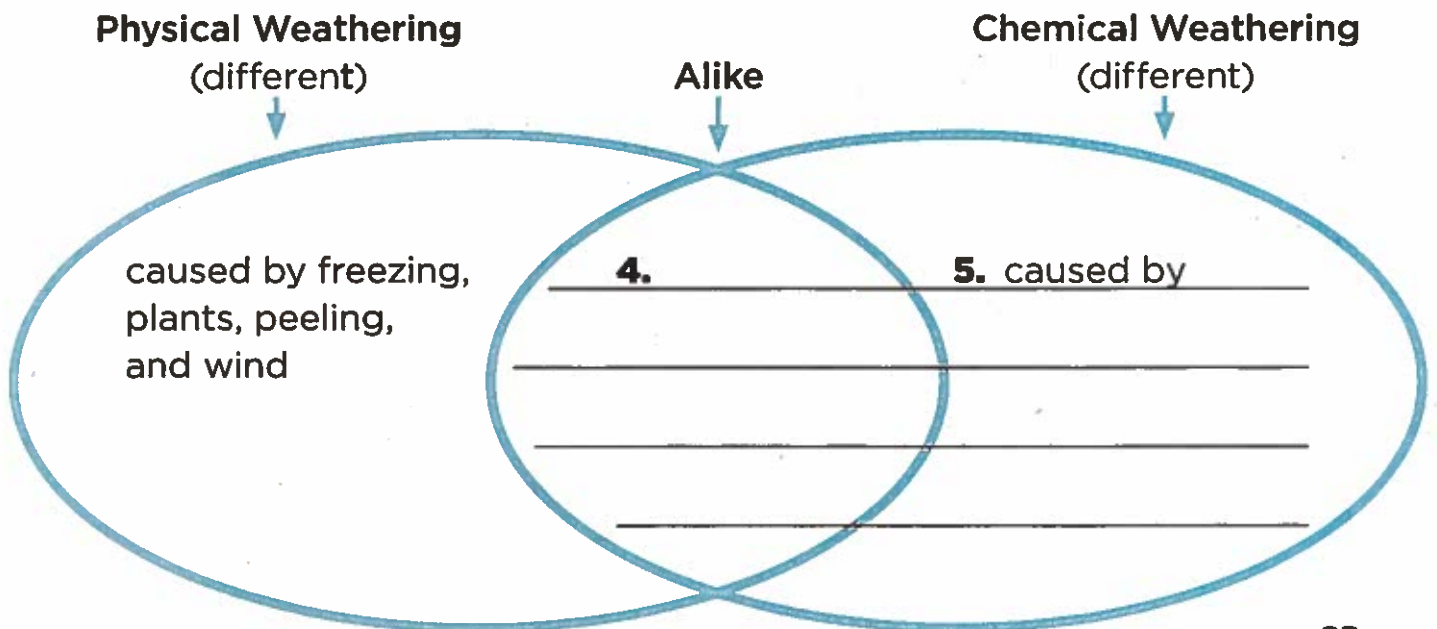
Carbon dioxide also comes from rotting remains of animals and plants. Rainwater soaks through the remains, picks up the gas, and forms the acid. The acid then can seep through the soil and eat away holes in rocks.



The drip-like formations from the roof of a limestone cave come from water and acid dripping into the cave.

✓ Quick Check

Fill in the diagram to show how chemical weathering and physical weathering are alike and different.



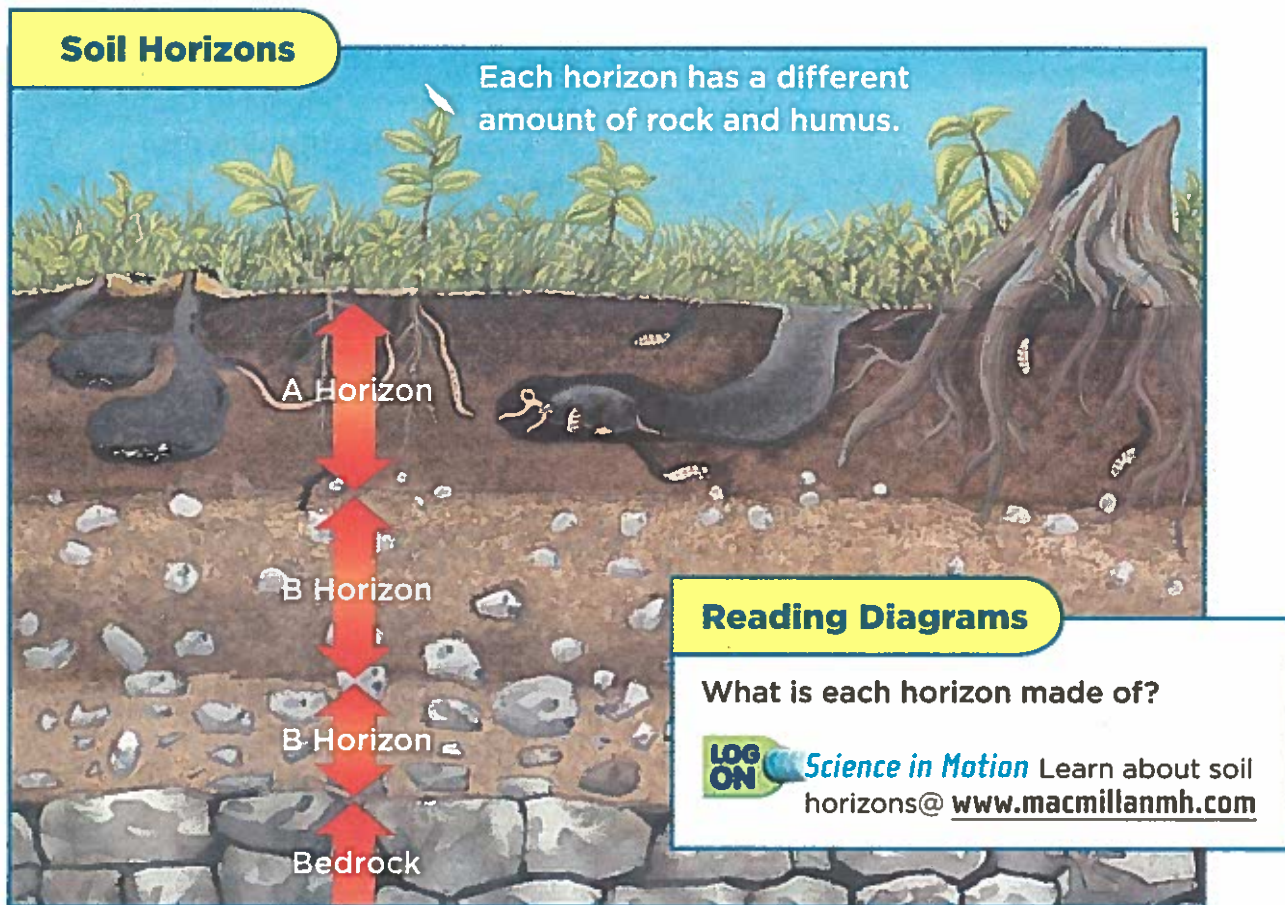
How is soil formed?

What happens to rocks that get broken down into smaller and smaller pieces. In time, the pieces become part of soil.

Soil consists of:

- broken down pieces of rock
- **humus** (HYEW•muhs), which is rotted plants and animals material
- water
- air
- bacteria, some of the tiniest living things (which can be seen only with a microscope)
- plants and animals living in the top layer.

Over time, soil forms layers called **horizons**. Horizons are different from each other.



Here are the three horizons, top to bottom.

Horizon	Description
A Horizon	The A horizon is topsoil. This layer has plants and animals living in it. Plant roots grow down into it. Animals dig homes in it. It is rich in humus. There are few large rocks.
B Horizon	B horizon is the subsoil. Some plant roots may grow down into this layer. There is little humus. Broken pieces of rock are scattered through this layer.
C Horizon	This layer is made up largely of chunks of rock broken by weathering. There is also some rock that has not been broken. There are no plant roots or humus.

Beneath the horizons is *bedrock*. Bedrock is rock that has not been broken down or has only been partly broken down.

- Bedrock may be the same rock as in the layers above. OR
- The layers above the bedrock may have been carried there from another place and may have different rocks.

Quick Check

Match the layers with the descriptions.

6. ____ A horizon **a.** largely rocks broken by weathering
7. ____ B horizon **b.** rock that is mostly not broken by weathering
8. ____ C horizon **c.** rich in humus
9. ____ bedrock **d.** very little humus and some plant roots

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Lesson 2 Erosion and Deposition

What causes erosion?

Rocks are slowly breaking down into smaller pieces all the time by weathering. The pieces of rock are then carried away by wind or by moving water. Carrying away broken pieces of rock is **erosion** (i•ROH•zhuhn).

Moving Water

Rivers and waves cause erosion. Small streams and large rivers pick up small pieces of rock as they flow downhill. They can carry the rock pieces for long distances and eventually drop them off.

Waves can break rocks apart in small pieces and sand. The waves can then carry the pieces to new places.



Waves carry sand, pebbles, and rocks and drop them off in new places.

Wind

Wind carries sand, soil, and small pieces of rock. At the same time, wind-driven sand can drill into rocks and wear them away.

Dropping Off Pieces of Rocks

Whenever moving water and wind slow down, they drop off some of pieces of rock they are carrying. Dropping off broken pieces of rock is **deposition** (dep•uh•ZISH•uhn).

Wind can drop off rocks just about anywhere. Rivers drop them off along the sides, or banks. Just about everything gets dropped off at the mouth, or end, of a river.



This photo of the Mississippi was taken by a satellite way above the ground. The river is flowing into the Gulf of Mexico and drops off all that it carries. ▶

✓ Quick Check

Write a sentence about each of these words. Explain how one of these happens first and which happens later.

erosion

deposition

10. _____

11. _____

What affects erosion?

Erosion goes faster when:

- the size of rock pieces and soil is small
- wind or moving water is fast and strong, as in floods or wind storms
- when there are no plants to hold the soil and pieces of rocks down. Plant roots hold soil together and slow up erosion.
- when soil is dry and sandy.

The Dust Bowl

During the 1920s soil was overused by many farmers. In the 1930s, there was almost no rain for almost 10 years. Crops would not grow. The dry, bare soil was carried away by winds causing the Dust Bowl.



Thick clouds of dust blew for miles. When the wind slowed down, the dust was dropped off onto farmland and homes.



The Dust Bowl was the dry, bare area where clouds of sand and dust blew everywhere. Whenever the wind slowed down, sand and dust were dropped off and covered homes and farms. Thousands of farmers had to leave their farms.

Slowing Up Erosion

Today farmers can slow up erosion.

- They plant trees between fields to block the wind and hold the soil down.
- They plant crops in strips. One strip is a food crop. The next strip is a plant that holds soil down.
- They plow across a slope, not up and down a slope. This kind of plowing keeps water from rushing downhill and carrying soil away.



Strips of different crops are planted across a slope rather than up and down a slope.

Quick Check

Fill in the missing “Effects” with

slow erosion or fast erosion

Cause	→	Effect
soil with plant roots	→	12. _____
strong winds	→	13. _____
plowing across a slope	→	14. _____
dry, sandy soil	→	15. _____

 -Review Summaries and quizzes online @ www.macmillanmh.com

What is a landform?

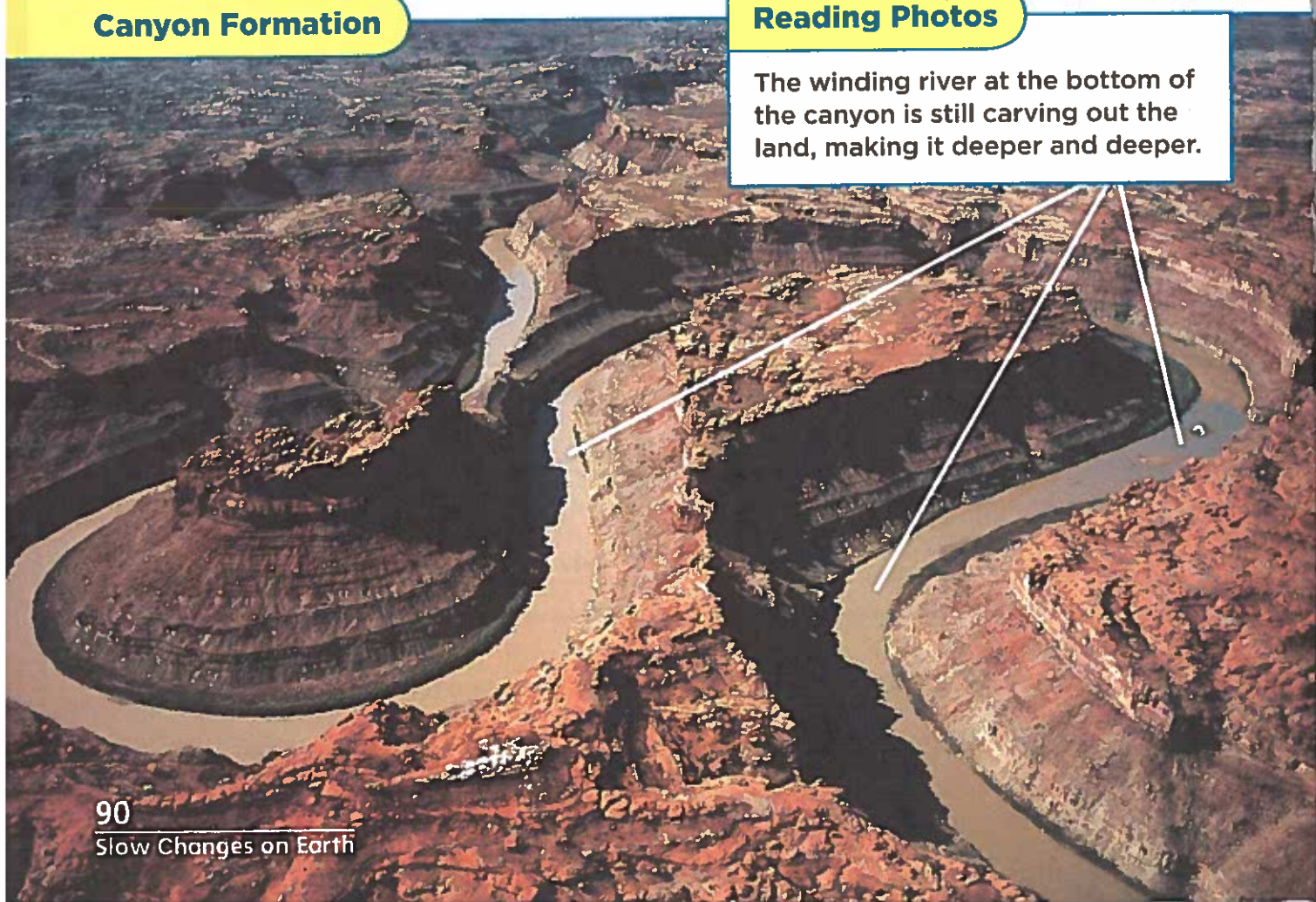
If you traveled across North America, you would see many landforms. **Landforms** are the natural features on Earth's surface. They include:

- mountains, the tallest landforms
- hills, land rising above the surface but not as tall as mountains
- **plains**, wide, flat stretches of land without any hills or mountains
- winding rivers
- beaches
- deserts

Canyon Formation

Reading Photos

The winding river at the bottom of the canyon is still carving out the land, making it deeper and deeper.



Fast Changes, Slow Changes

Some landforms change quickly. For example, a mudslide can flow down a hill in minutes.

Most landforms such as a canyon, change slowly over many years. A **canyon** is a deep narrow landform with steep sides. Canyons often have rivers at the bottom.

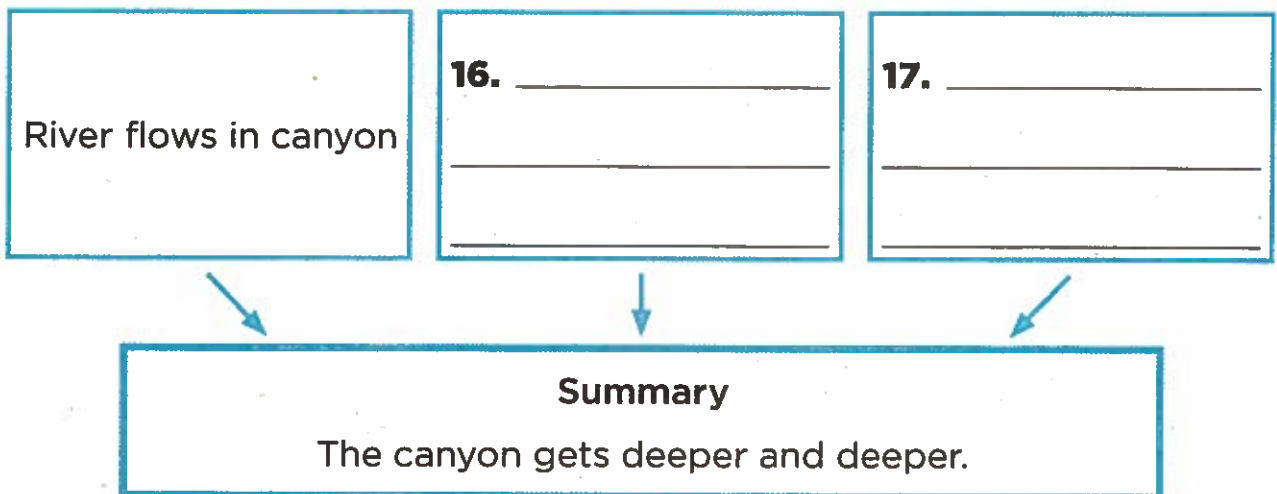
A river drills into the land at the bottom of the canyon and breaks the rocks. The river then carries away the broken rocks. The bottom of the canyon becomes deeper and deeper.



▲ Homes in the Los Angeles, California area damaged by mudslides

✓ Quick Check

Complete the diagram. With just a few words in each box to sum up how canyons form.



How can running water change land?

When it rains or when snow melts, water can:

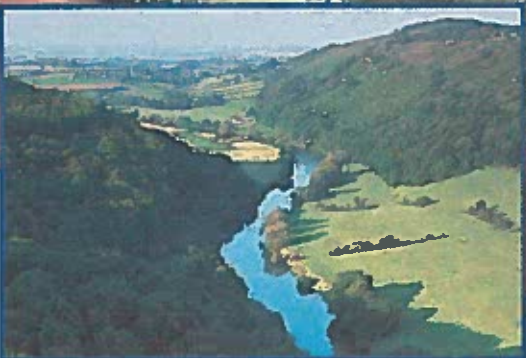
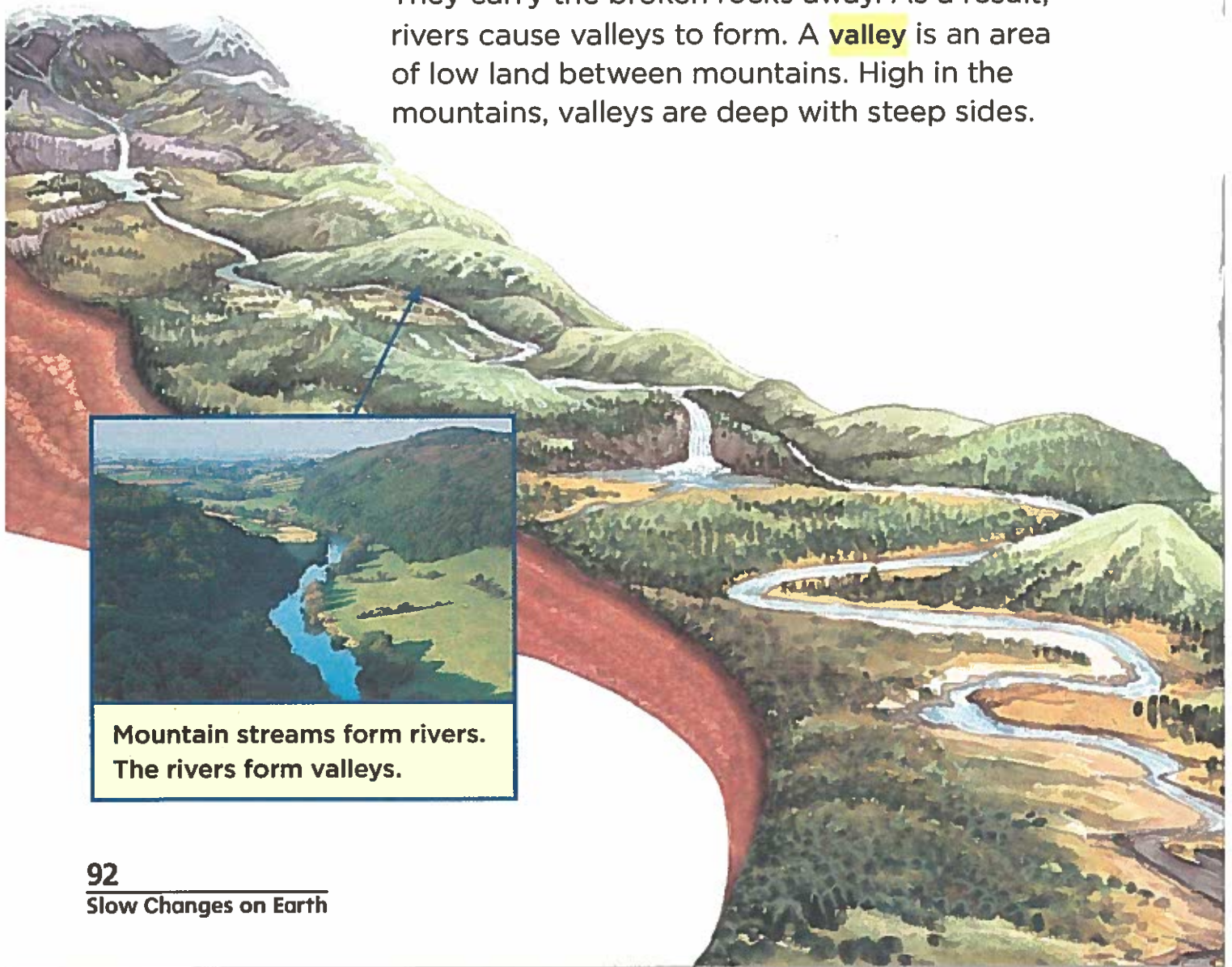
- soak into the land
- run over the land.

Water that runs over the land flows downhill. As it flows, the water forms a pathway to the sea. That pathway is a river.

Down from the Mountains

High in the mountains water from rain or melted snow forms streams as it flows downhill. The streams come together and form larger rivers.

The rivers break up rocks along their sides. They carry the broken rocks away. As a result, rivers cause valleys to form. A valley is an area of low land between mountains. High in the mountains, valleys are deep with steep sides.



Mountain streams form rivers. The rivers form valleys.

Rivers Curve

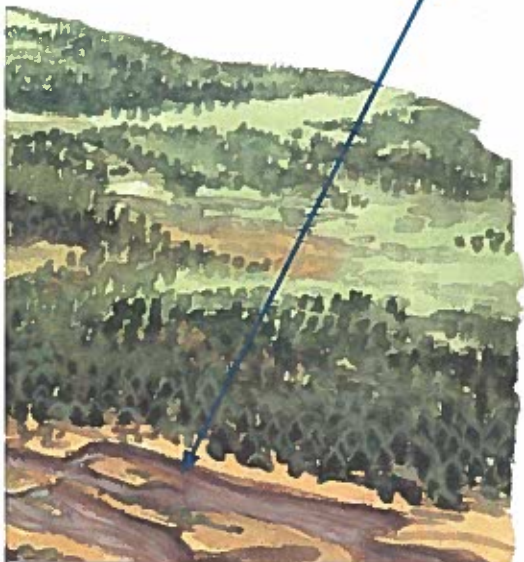
As a river flows down mountain, it reaches flatter land. The river slows down. Along one side of the river, moving water drops off some of the rocks it was carrying. The moving water wears away the other side of the river. By dropping off rocks on one side and wearing away the other, a river forms wide curves.

Into the Ocean

A river reaches its end, or mouth, when it flows into an ocean. At the mouth, a river drops off what it is carrying. The dropped off material forms a **delta** (DEL•tuh), an area of land at the mouth of a river.



Pieces of rock, soil, sand, and mud are dropped at the end of the river. The dropped-off material builds up into a delta.



Quick Check

Match the part of the river with the landform.

- | | |
|-----------------------|--------------|
| 18. _____ curves | a. mouth |
| 19. _____ delta | b. mountain |
| 20. _____ deep valley | c. flat land |



Wave action wore away a hole in this cliff in Cabo San Lucas, Mexico.

How can waves change land

As waves pound on a shore, they can cause beaches to change. Waves can pick up sand and move it to another part of a beach. Large waves in a storm can wash away a beach in hours.

Changing Rocky Cliffs

Waves can pound into the bottom of a rocky cliff. The bottom of the cliff slowly wears away. The top of the cliff eventually falls because there is little support underneath. The remaining rocks are broken into small pieces and washed away.

Quick Check

21. What do you think will happen to the cliff in the photo as time goes by? _____

Barrier Islands

Barrier islands are long, narrow strips of land built up from sand that was dropped along a shore. Barrier islands run along coasts. They protect coasts from being worn away by waves.

A barrier island changes shape all the time. Waves pick up sand from one part of the island and drop it on another part.



◀ Barrier islands protect the coast of Long Island in New York.

Quick Check

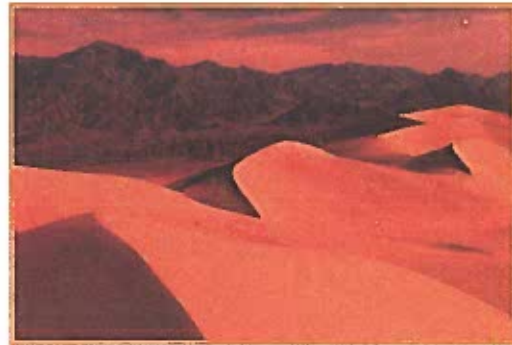
Fill in the boxes with ways waves can change the land.

Waves pick up and drop off sand.	22. _____ _____ _____	23. _____ _____ _____
<p>Summary Waves change the land.</p>		

How can wind change land?

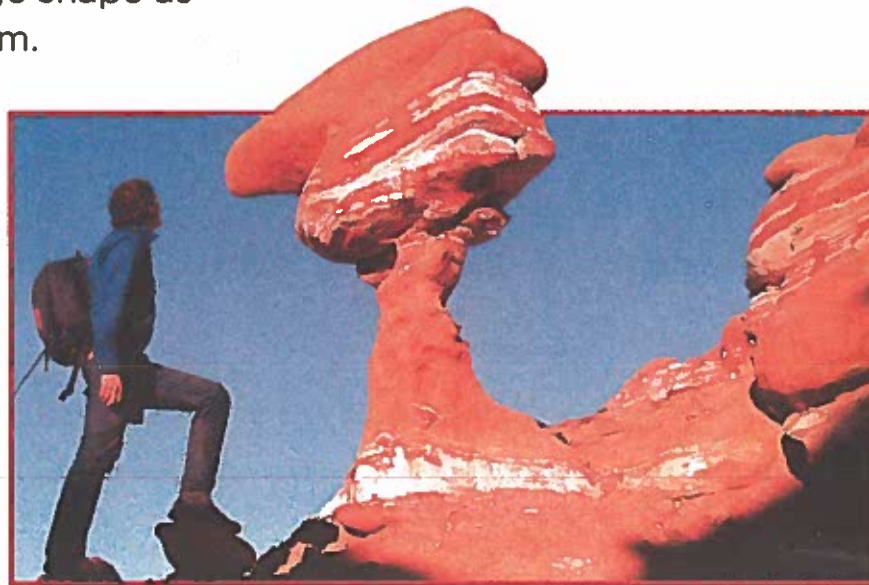
Wind carries sand and bits of rock. These wind-driven particles act like tiny drills. They can drill away softer parts of a large rock or even of a landform, like a hill. Over many years what remains of the landform is a rock with an unusual shape.

Wind can build sand dunes. **Sand dunes** are hills built from sand that is carried and dropped off by wind. When wind is blocked by a rock or a clump of grass, the wind drops off sand. Gradually a small hill builds up around the rock or clump of grass. Sand dunes can change shape as wind blows across them.



These smooth, low hills are sand dunes in Death Valley California.

Wind-driven sand drilled away at the softer parts of this rock and made this unusual shape. ▶



Quick Check

Complete the sentence with two answers.

Wind changes the land by making

24. _____

25. _____

How can ice change land?

Many cold parts of Earth have glaciers (GLAY•shuhrz). **Glaciers** are large, thick sheets of ice. They can move slowly across the land by flowing downhill.

Over millions of years, glaciers have moved through valleys and across plains. They have crushed rocks and moved them along. As glaciers melt over time, they leave behind valleys with a wide, deep shape.



Hubbard glacier in Alaska is 122 kilometers (76 miles) long.



After a glacier moved through a valley, the valley has a U shape.

Quick Check

Answer the question in complete sentences.

26. Why are glaciers able to change the shape of the land? _____

Slow Changes on Earth

Use a word from the box to name each example described below.

1. Ice forms in a crack in a rock and makes the rock split. _____
2. Chemicals in the air mix with rocks and eat away holes in them or make them crumble. _____
3. long, narrow land that forms along a coast or protects the coast _____
4. sand that is dropped by wind around a rock or clump of grass _____
5. sand, soil, and pieces of rock carried away by moving water and wind _____
6. sand, soil, and pieces of rock dropped off by moving water or wind _____
7. hill, mountain, valley, or canyon _____
8. a layer of soil, such as topsoil or subsoil _____

barrier island
chemical weathering
deposition
erosion
horizon
landform
physical weathering
sand dune

Answer the question. Use at least one word from the box at the top of the page.

9. How can moving water change the land?

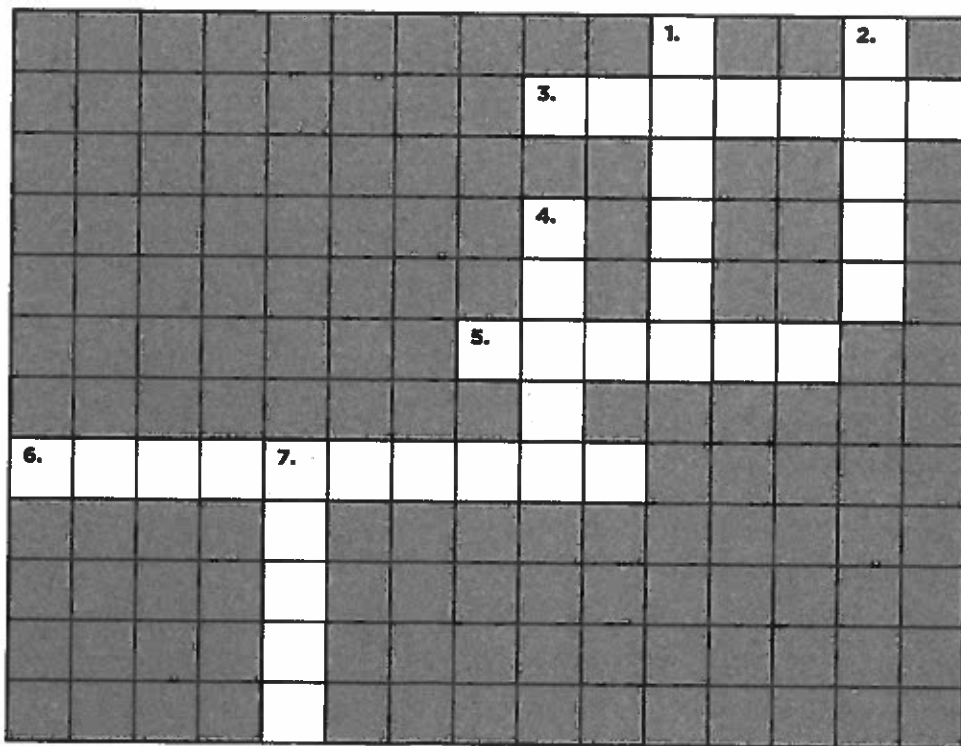
Read each clue. Write the answers in the blanks and then fill in the crossword puzzle.

Across

- 3.** a large moving sheet of ice
- 5.** a deep, narrow landform with steep sides, usually with a river running through it
- 6.** breaking down rocks into small pieces

Down

- 1.** the low land between hills or mountains
- 2.** land built from rock pieces dropped off at the end of the river
- 4.** a flat stretch of land without any hills or mountains
- 7.** rotted plant and animal remains that becomes part of the soil



CHAPTER 5

Fast Changes on Earth

Vocabulary



landslide the quick downhill movement of loose rocks and soil



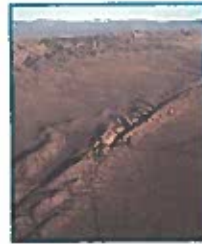
flood large amount of water overflowing the sides of a river or a drain



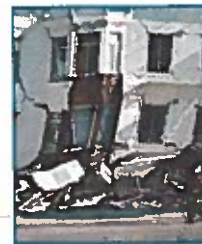
mudslide water-soaked land that slides down a hill



plate a large, moving piece of the crust



fault a crack in the crust



earthquake a sudden movement in the crust



What causes Earth's surface to change quickly?



volcano a mountain that builds up around an opening in the crust



vent the opening in the center of a volcano



hot spot a place in the crust where magma rises almost to the surface



crater a cuplike shape that forms around the vent of a volcano



crust Earth's outermost layer



tsunami a giant wave caused by an earthquake

How do landslides change the land quickly?

You may have seen skaters or skiers move down a hill. Loose rock and soil can move down a hill as well. They can move slowly, only centimeters a year. However they may also move quickly.

The quick downhill movement of loose rocks and soil is a **landslide**. In California landslides often occur in the mountains and along the coast.

Landslides happen when loose rocks are shaken, causing them to move downhill, such as by:

- an earthquake or erupting volcano
- storms with heavy rains
- building homes and offices in hilly areas
- the freezing of water in rocks, which can make them split.



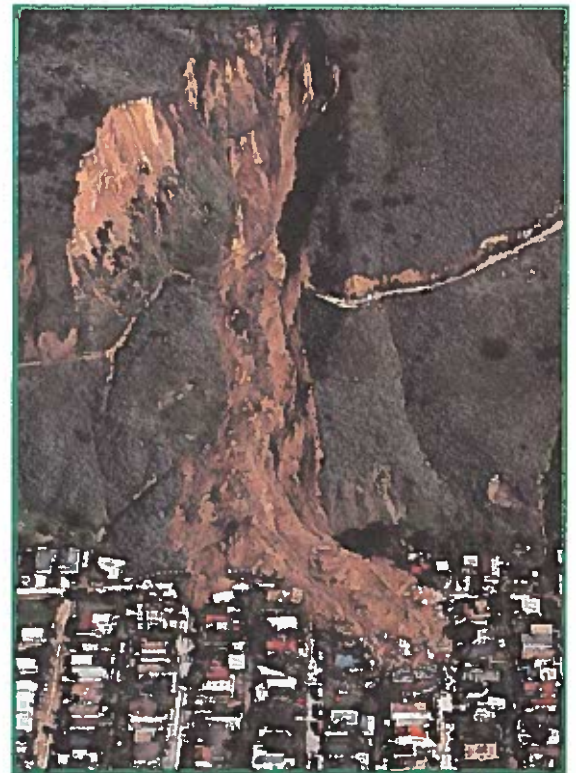
This landslide in California was caused by the Loma Prieta earthquake in 1989. ▶

A landslide can move a huge amount of rocks and soil. As it moves it can carry along and bury homes and cars.

On the Lookout for Landslides

You can protect yourself from landslides:

- during heavy rains, listen to the TV or radio for landslide warnings
- learn the signs of a possible landslide: tilting of trees and poles, cracking sounds of trees, cracks in bottoms of buildings
- move away from the path of an oncoming landslide. If you can't, curl up into a tight ball to protect your head.



▲ Over 35 homes were damaged in the La Conchita landslide in January of 2005.

✓ Quick Check

What are two causes of a landslide? What is an effect of landslides? Fill your answers in the diagram.

Cause	→	Effect
1. _____	→	landslide
2. _____	→	landslide
landslide	→	3. _____

How do floods change the land quickly?

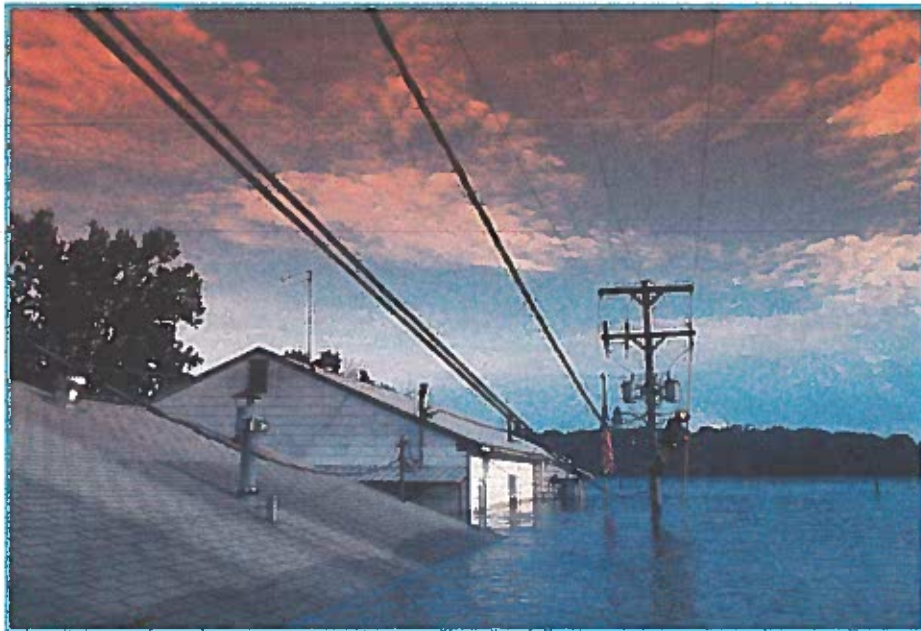
In any rainfall, some water soaks into the ground and some flows across the land. In a heavy rainfall, water may not soak into the ground fast enough. As a result, a very large amount of water can flow across the land.

The flowing water may spill into a river or drain. A large amount of water overflowing the sides of a river or a drain is a **flood**.

Effects of Floods

The large amount of water and its fast speed can cause much damage:

- floods can damage cars and buildings
- floods can wash away bridges
- floods can carry away soil from farmland
- floods can carry soil and mud and drop them onto homes, streets, and cars.



▲ Flooding of the Mississippi River in the early 1990s caused billions of dollars of damage.

Floods and Mudslides

Heavy rain and floods may soak into the land on a hill and cause a mudslide. A **mudslide** is water-soaked land that slides downhill. The flowing mud can bury homes and cars. The mud blocks floodwater from draining away.

On the Lookout for Floods

During heavy rains, listen to the local weather reports for *flood watches* and *flood warnings*.

- A flood watch means flooding is possible. Get ready to leave in case you are told to do so.
- A flood warning means that a flood is occurring or will occur soon. You will have to move to higher ground.



This car in San Bernardino was buried by a mudslide in 2003.

✓ Quick Check

Fill in the missing “Cause” or “Effect” in each row of the diagram.

Cause	→	Effect
4. _____	→	flood
flood	→	5. _____
6. _____	→	mudslide

Lesson 2 Earthquakes

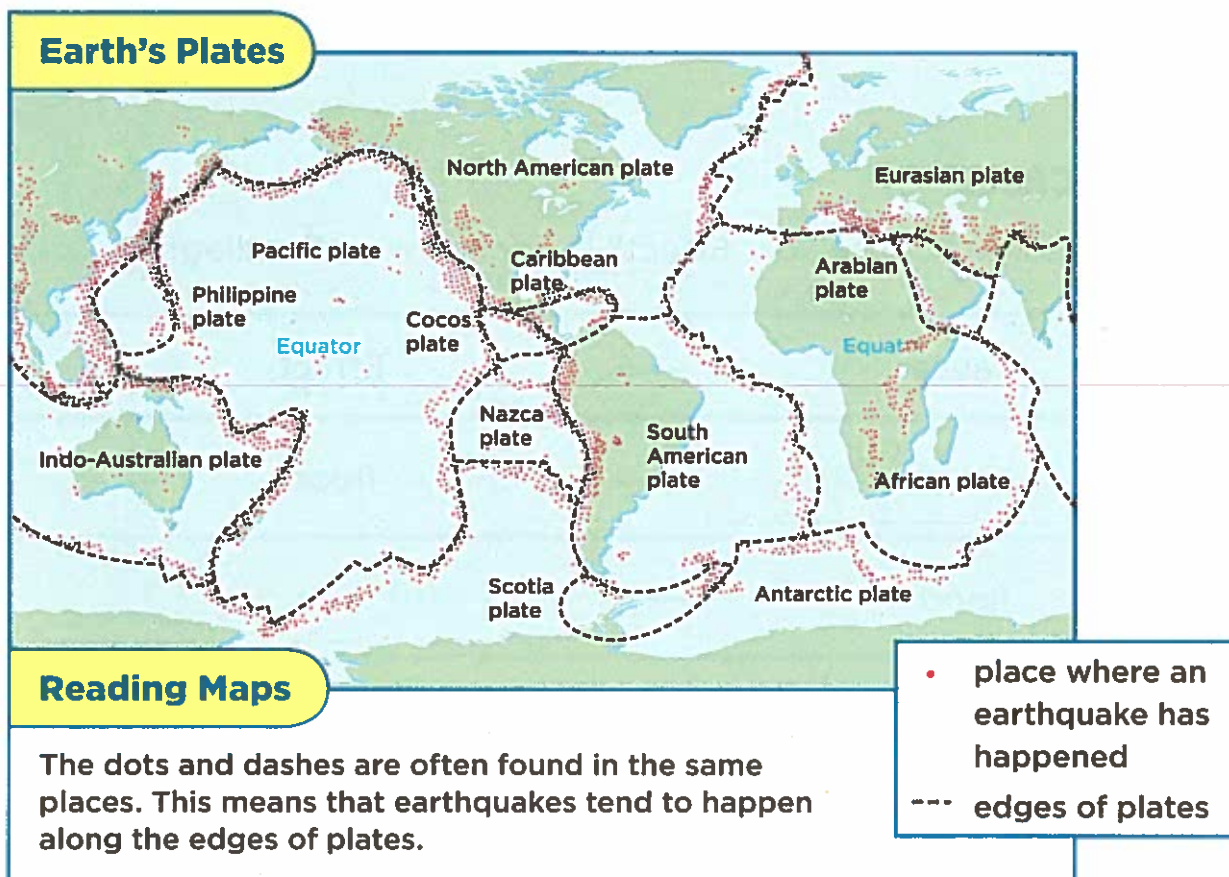
What are earthquakes?

Earth's surface is always changing. Most changes are slow, such as weathering. Sometimes changes happen quickly. For example, Earth's surface can shake or shift suddenly.

Earth's Moving Crust

Earth's surface is covered with its crust. The **crust** is Earth's outermost layer, much like an apple has an outer layer of skin. The crust is made up of all of Earth's land, including the ocean bottoms.

The crust is broken into huge pieces, or **plates**. The plates fit together like puzzle pieces. Unlike puzzle pieces, the plates can move.





▲ Route 14 near Sylmar, California, was heavily damaged as a result of an earthquake on January 17, 1994.

At the edges of the plates, there are cracks in the crust. These cracks are called **faults**. Along a fault, two plates can move by:

- sliding past each other
- pushing into each other
- pulling apart.

When plates move, earthquakes can happen. An **earthquake** is a movement in the crust caused by a sudden shift of the plates.

As the red dots in the map show, earthquakes tend to happen at the edges of the plates. Most earthquakes happen around the Pacific Ocean.

 **Quick Check**

Match the description with the word.

- | | |
|---------------------------------|---------------|
| 7. _____ happens at plate edges | a. crust |
| 8. _____ piece of the crust | b. earthquake |
| 9. _____ crack in the crust | c. plate |
| 10. _____ all of Earth's land | d. fault |

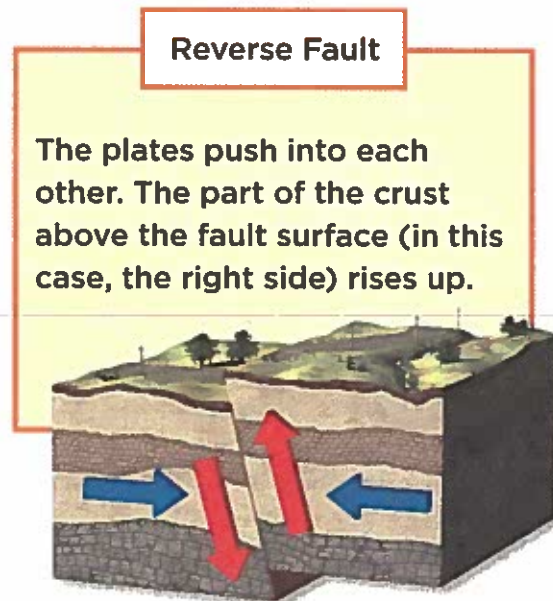
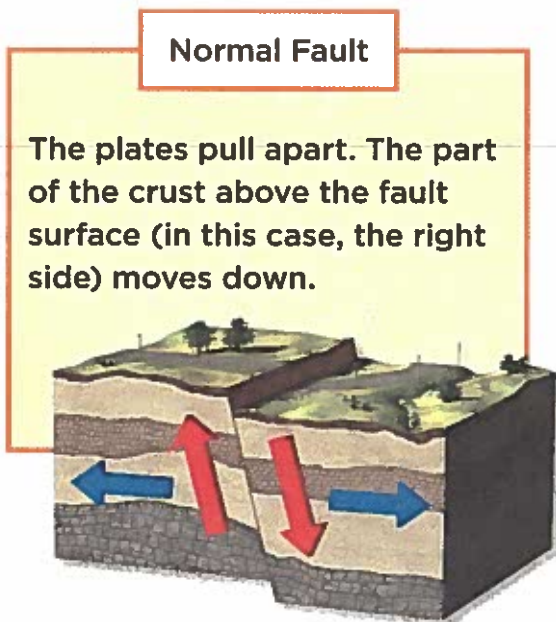
What causes an earthquake?

Earthquakes happen along cracks, or faults, in the crust. Along a fault, parts of the crust on either side may:

- rise up or move down
- slide past each other.

The movement may be very slow, just centimeters a year. In that case, an earthquake does not happen. Instead, when parts of the crust move up or down *slowly* over many years, mountains may be formed.

When the movement is sudden, an earthquake happens. The ground shakes, or vibrates. The ground may split open. The ground vibrates in all directions from the center of the earthquake. People far from the center of the earthquake may feel a slight shaking.



Earthquake Safety

People who live where earthquakes happen can stay safe. Here are some safety tips:

- Place breakable or heavy objects on lower shelves. Bolt down appliances. These are two ways to keep heavy objects from falling.
- Locate *safe spots* at home and school—such as under a sturdy table.
- If outside in a quake, move to an open space away from buildings or power lines. This way you can stay safe from things falling on you.
- Have family earthquake drills. Together find a safe spot. Then drop, cover, and hold on. Arrange a meeting place outside the home.
- Drivers should stop during an earthquake. Passengers should stay inside the car.



The Sierra Nevada mountains formed over centuries where plates pull apart.



Along the San Andreas Fault, rocks slide past each other. Many earthquakes in California take place along this fault.

Quick Check

Fill in the missing “Cause” and “Effects” in the diagram.

Cause	→	Effect
sudden movement along a fault	→	11. _____
12. _____	→	Mountains may form.
Bolt appliances down.	→	13. _____
Move away from tall buildings.	→	14. _____

What is a tsunami?

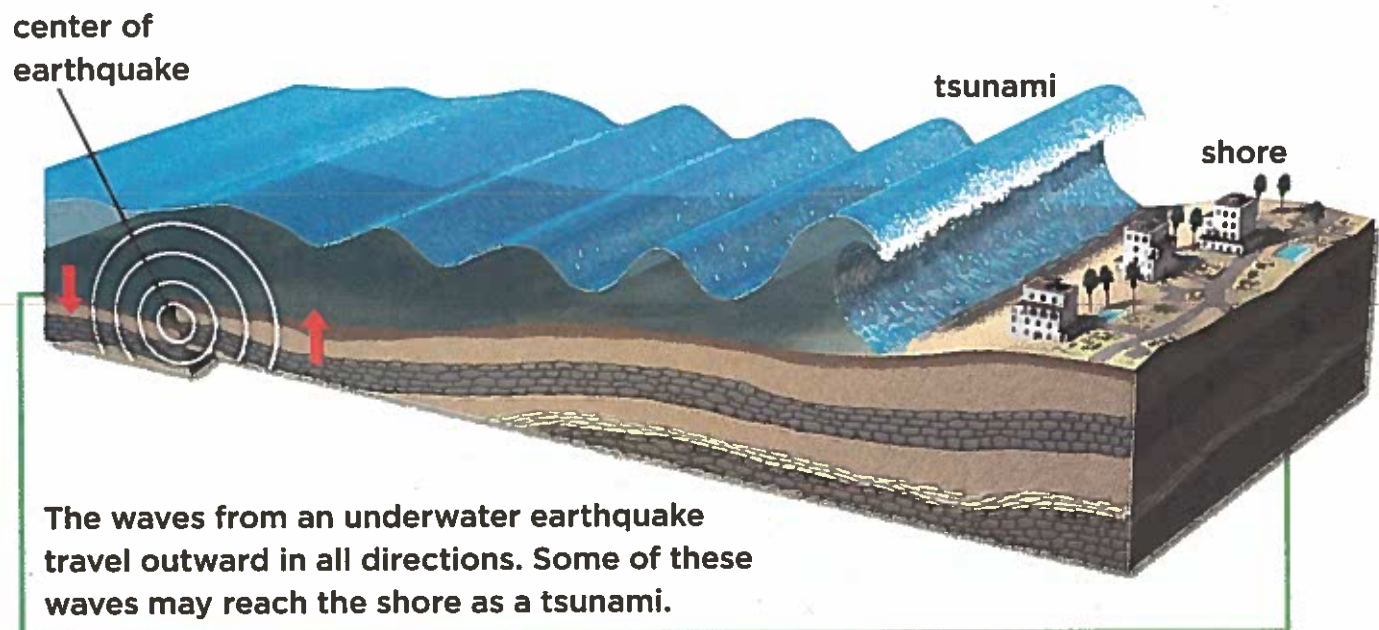
Have you ever seen small waves rise and fall as they reach a shore. However, some large ocean waves can be 30 meters (100 feet) tall and travel at a speed of 960 kilometers (600 miles) per hour. That kind of a wave is a tsunami (sew•NAH•mee).

Tsunami is a giant ocean wave.

Tsunamis are caused by:

- underwater landslides
- underwater erupting volcanoes
- most often, underwater earthquakes.

An earthquake may be strong enough to set a wave moving. In deep water the wave may pass by unnoticed. Closer to the shore, the wave slows down, but gets taller.



A tsunami may reach the shore as one huge wall of water or as several smaller waves. Either way, they are fast and powerful. They wash away beaches, property, and lives.

In December 2004, an earthquake in the Indian Ocean caused a tsunami to hit Sumatra. Then tsunamis reached Sri Lanka in two hours and South Africa in seven hours—800 kilometers (5,000 miles) from the earthquake.

If you are near a coast and learn of an earthquake, listen to news reports for tsunami warnings. If there is a warning, move to higher ground immediately.



Nearly 300,000 people lost their lives in the tsunami of December 2004, mostly in Sumatra.

 **Quick Check**

15. What are some ways a tsunami can form?

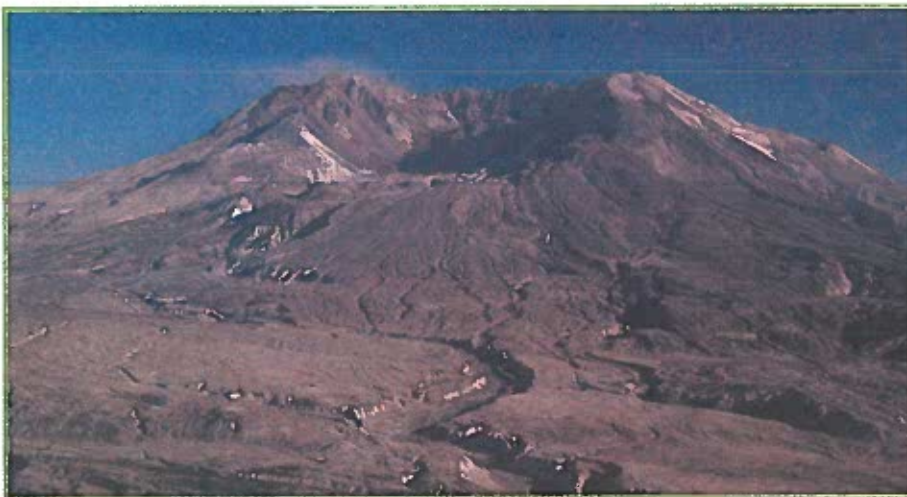
16. Why are tsunamis dangerous?

What is a volcano?

Did you ever shake a can of soda and then open it. Shaking releases gas from the soda. The gas explodes in a spray. Something similar can happen to a volcano.

A **volcano** is a mountain built up around an opening in the crust. The opening may form from a crack. Sometimes magma may melt upward and crack the land. In either case, a volcano may *erupt* suddenly—forcing out melted rock, gases, and pieces of solid rock.

A volcano erupts when magma (melted rock) below the volcano rises to the surface. Gases escape from the magma as it rises. If the gases escape slowly, a volcano erupts gently. If the gases escape quickly, a volcano explodes.



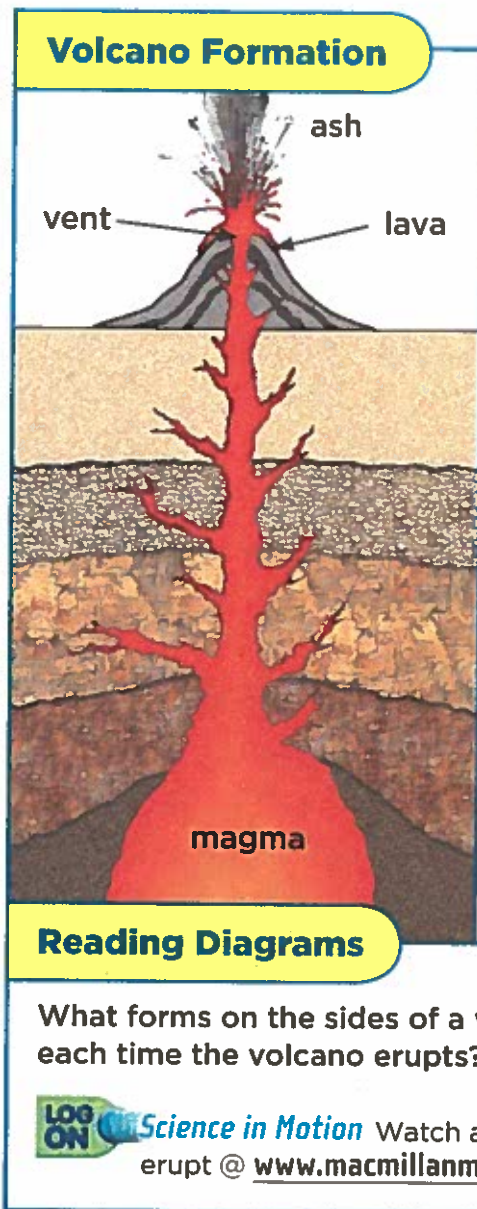
▲ When Mount St. Helens erupted in 1980, it “blew its top,” leaving a huge cuplike opening at the top. The land around the volcano was buried under ash and soot.

Rising Magma

At the center of a volcano is an opening called a **vent**. The vent may form from movement along a fault. Or magma may melt upward and crack through the surface.

As magma rises up through a vent, it reaches the surface. When magma reaches the surface, it becomes *lava*. Lava is melted rock that starts to cool and harden.

Lava can ooze or explode out of a volcano. Either way, it hardens into a layer around the vent. Some volcanoes release ash, which also forms a layer. The volcano gets bigger each time the volcano erupts and lava and ash build up around the vent.



Reading Diagrams

What forms on the sides of a volcano each time the volcano erupts?



Science in Motion Watch a volcano erupt @ www.macmillanmh.com

✓ Quick Check

Fill in the boxes to explain how a volcano can erupt.

First 17. _____



Next 18. _____



Last The volcano erupts. Lava or ash is released.

What are some kinds of volcanoes?

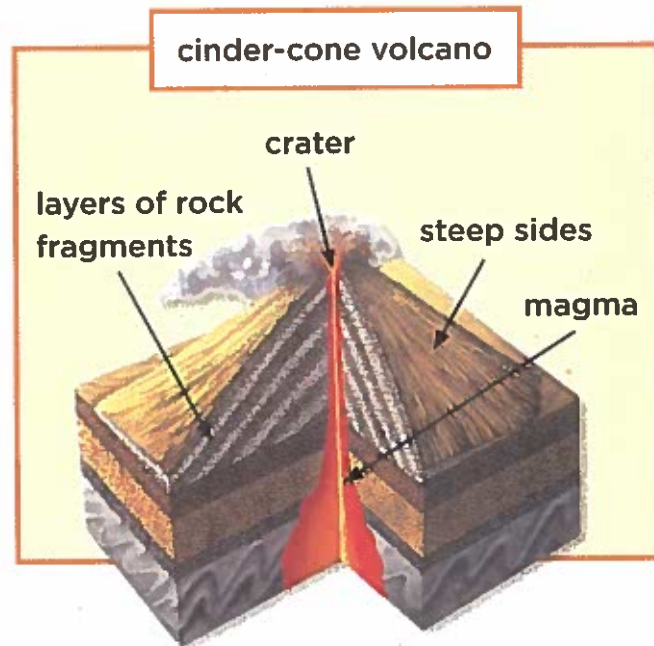
Volcanoes have different shapes. The shape depends on how a volcano erupts and what it releases when it erupts.

Cinder-Cone Volcano

This kind of volcano:

- is shaped like a cone and has steep sides
- has thick magma inside. This magma has lots of trapped gas.
- forms from explosions.

With each explosion, lava bursts into the air. The lava hardens into rock fragments. The fragments settle into a layer around the vent. A cuplike shape, a **crater**, forms around the vent.



This cinder-cone volcano is in Lassen Volcanic National Park in northeastern California. ▶

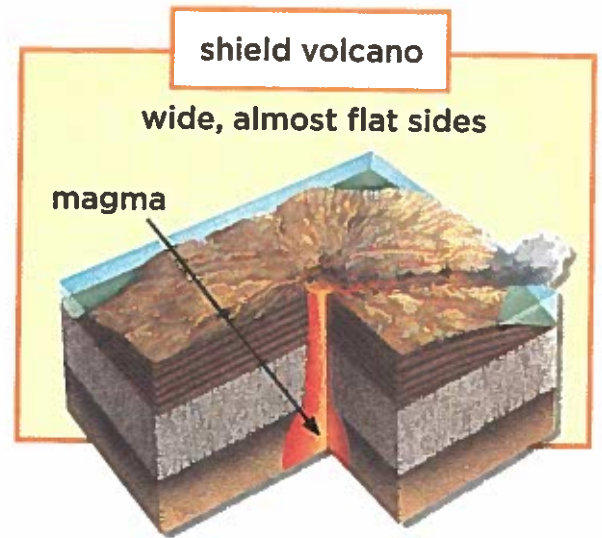


Shield Volcano

This kind of volcano:

- has wide, almost flat sides
- forms from lava flowing from one or more openings.

This kind of volcano forms from layers of lava that build up over years. The Hawaiian Islands are all shield volcanoes.

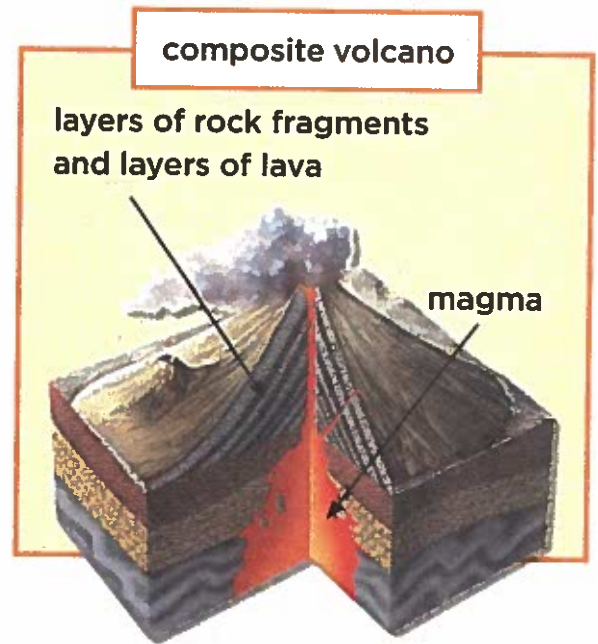


Composite Volcano

This kind of volcano:

- is made up of layers of lava and ash
- has a cone shape with sides that match, one as steep as another.

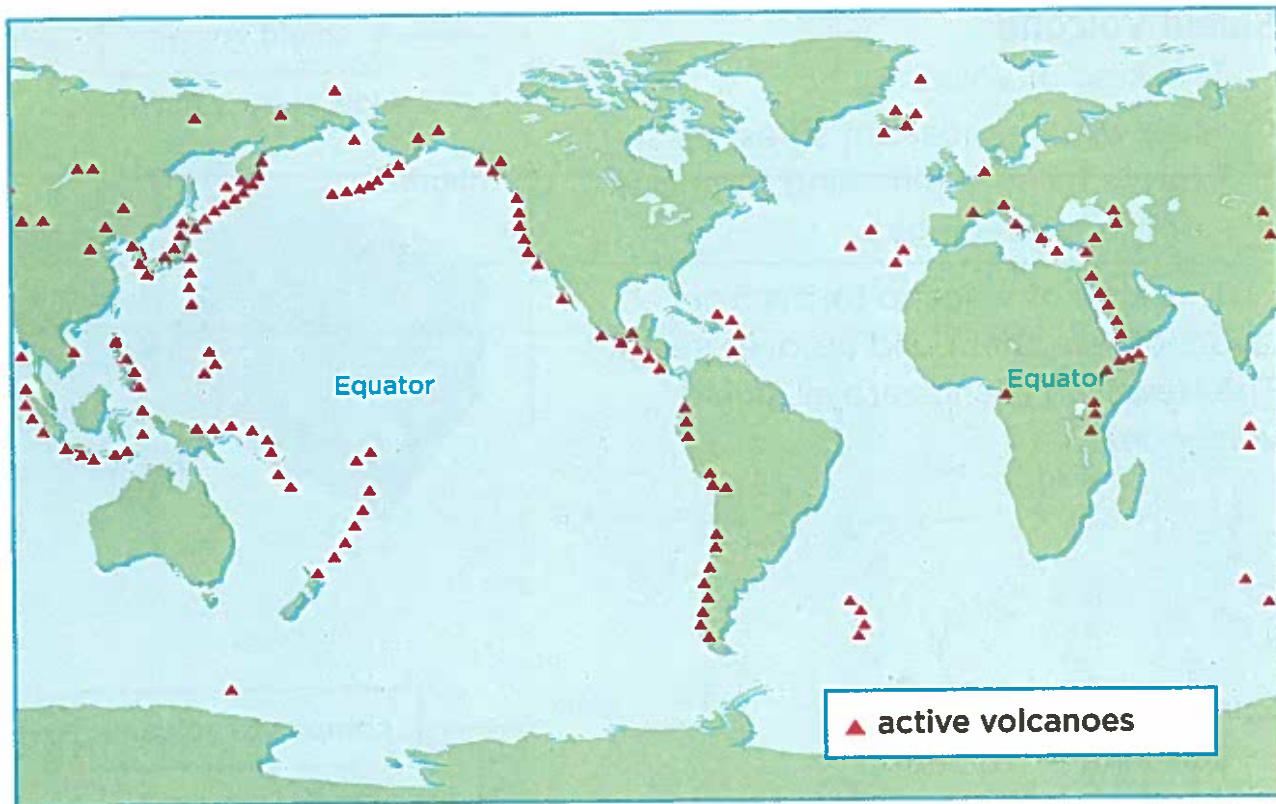
This kind of volcano forms when it erupts in two ways. It erupts quietly releasing lava. Then it explodes releasing ash. These two ways keep "taking turns."



Quick Check

Match the volcano with the description.

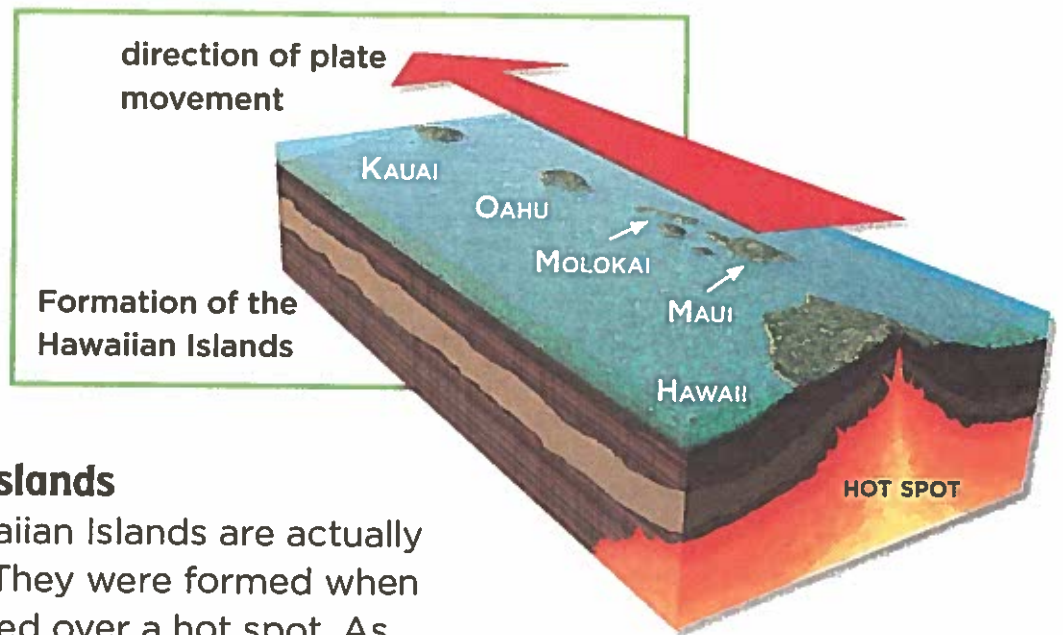
- | | |
|-----------------------|------------------------------|
| 19. _____ cinder-cone | a. wide, almost flat sides |
| 20. _____ shield | b. forms from lava and ash |
| 21. _____ composite | c. forms from rock fragments |



Where do volcanoes form?

Many volcanoes form at the edges of plates. Remember, plates are pieces of the crust. Volcanoes form where two plates meet.

- **When two plates push together** One plate moves under the other. The plate that moves down under melts and forms magma. The magma rises and forms a volcano
- **When two plates pull apart** Magma rises up through an opening when plates pull apart. These volcanoes often form along the ocean bottom.
- **Hot spots** Some volcanoes form in the middle of a plate. They form when a plate moves over a hot spot. A **hot spot** is a place where magma has melted part of the way through the crust.



Hawaiian Islands

The Hawaiian Islands are actually volcanoes. They were formed when a plate moved over a hot spot. As the plate moved, magma rose up and broke through the surface. The magma formed one volcano after another in a chain. Hawaii is the youngest island, the only one still erupting.

Volcano Safety

To stay safe where volcanoes may erupt:

- stay away from lava flows
- have breathing masks and goggles ready
- obey your town's warning system. Leave immediately if told to do so.

✓ Quick Check

How do volcanoes form at each place?

22. where two plates push together _____

23. hot spot _____

24. Why are breathing masks important if you live near an active volcano? _____

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Fast Changes on Earth

Use a word from the box to name each example described below.

1. _____
the quick downhill movement of loose rocks and soil
2. _____
water-soaked land that slides down a hill
3. _____
a sudden movement in the crust
4. _____
a giant wave caused by an earthquake
5. _____
a mountain that builds up around an opening in Earth's crust
6. _____
a place in the crust where magma rises almost to the surface

earthquake
hot spot
landslide
mudslide
tsunami
volcano

Answer the question. Use at least one word from the box at the top of the page.

7. How can moving water change the land? _____

Write the missing words in the blanks. Then find the same words in the puzzle.

1. A cuplike shape that forms around the vent of a volcano
_____.
2. Earth's outermost layer _____.
3. A crack in Earth's crust _____.
4. Large amount of water overflowing the sides of a river or a drain
_____.
5. A large, moving piece of Earth's crust _____.
6. the opening in the center of a volcano _____.

O M D O H G I V B J T U I G Y
Y E X S P S D O W Z S I H Z Y
W W X G Y S I I V D U C I E G
N V P E F L T E H R R H G G G
H E W O B H U G S A C N K Q E
L T K S B V U Y D F A U L T U
Q N K N L J I V M O H U A Q G
K N I P C H Q C E S O L S A K
V N N J V B N X T N P L W P L
R E T A R C E U P L T N F B C
F P U A B J T N O Y E F D V B
I W M O P S B V C P K U H F L
K L R M H J T C B E B G R M T
I J Y G V F N J C V T R G G T
Z Q I M I B W Q W V Q H I Q D