مؤسسة الإمارات للتعليم المدرسي
EMIRATES SCHOOLS ESTABLISHMENT

United Arab Emirates

مدرسة المعالي للتعليم الأساسي ح2 - العين
Al Maali School for Basic Education - Al Ain

هيكل امتحان الفصل الثالث EoT3
Exam Coverage

Science Grade 7

Third semester

2023-2024

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1	Conclude that continentals were once joined, from the evidence of matching coastlines of Africa and South America and how they can fit together like puzzle pieces, give evidence and clues used to test and support Alfred Wegnar's hypothesis	Textbook, figures, investigation	10, 11, 12

Paper part - الأسئلة المقالية

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- Textbook, figures, investigation
- 10, 11, 12

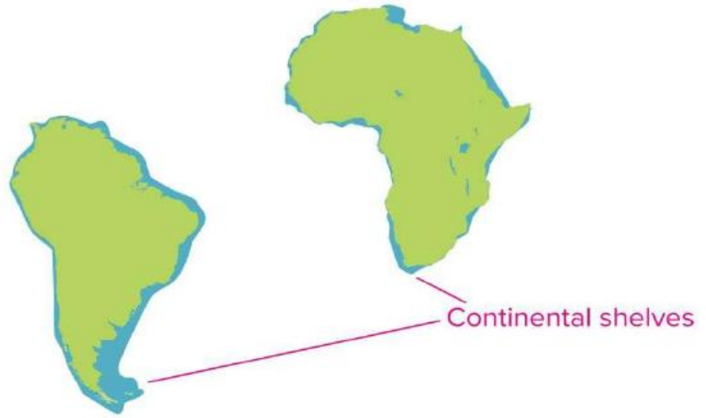
Why do some continents have matching shapes?

Hundreds of years ago, mapmakers noticed a jigsaw-puzzle pattern as they made the first maps of the continents. Can you see the puzzle?

INVESTIGATION

A Surprising Fit

1. Look at the outlines of South America and Africa. The green color represents the land above sea level. The blue areas along the coastlines are the continental shelves—areas of the continents that are under shallow water. Label the continental shelves on the image below.



2. What do you notice about the shapes of the continents including the continental shelves? What do you think the apparent fit of the continents suggests?

The eastern coast of South America and the western coast of Africa appear to fit together, which suggests they were once joined in the past.

COLLECT EVIDENCE

What does the fit of South America and Africa suggest? Record your evidence (A) in the chart at the beginning of the lesson.

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Paper part - الأسئلة المقالية

Matching Coastlines

In 1912, Alfred Wegener, a German scientist, observed the fit of the continents and arrived at a creative explanation for this pattern. What did he conclude?

INVESTIGATION

The Continental Drift Hypothesis

GO ONLINE Watch the video *Wegener's Hypothesis*. Then answer the questions that follow.

1. What was Pangaea?

Pangaea was a supercontinent, or single landmass, composed of all of the continents on Earth.

2. Describe Wegener's continental drift hypothesis.

Continental drift suggests that over millions of years, Pangaea split up and the continents drifted over Earth's surface.

The most obvious evidence that continents move on Earth's surface is that the continents appear to fit together like giant pieces of a puzzle. But scientists were skeptical, and Wegener needed additional evidence to help support his hypothesis.

3. If you had discovered continental drift, how would you have tested your hypothesis? Use the space below to jot down ideas of the evidence you would collect and clues you would search for.

the shapes of the continents, matching rock types, matching mountain ranges, or fossil clues.

Want more information?
Go online to read more about Alfred Wegener and the continental drift hypothesis.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

How do rocks provide evidence that continents move?

Wegener argued that the continents were once joined together in a single supercontinent he named **Pangaea** and later drifted apart. He named this new hypothesis **continental drift.** Several types of evidence have been used to support the idea that Earth's continents were once joined and drifted slowly over time to their present positions. How can you use rock evidence to reconstruct Pangaea?

LAB Reconstructing Pangaea

Safety

Materials

world map scissors glue stick

Procedure

1. Read and complete a lab safety form.
2. Obtain a world map from your teacher. Carefully cut out Greenland, North America, South America, Africa, Australia, Eurasia, which is Europe and Asia, and Antarctica.
3. Study the pieces. Locate mountain ranges on each landmass. Similar rock types and similar geologic structures in certain mountain ranges are evidence that some features once formed continuous mountain chains.
4. Use the shapes of the landmasses and the locations of the mountain chains to reconstruct Pangaea.
5. When you are sure of your reconstruction, glue the supercontinent in your Science Notebook. Create a sketch of your Pangaea in the Data and Observations section.

Data and Observations

Check students' sketches for accuracy.

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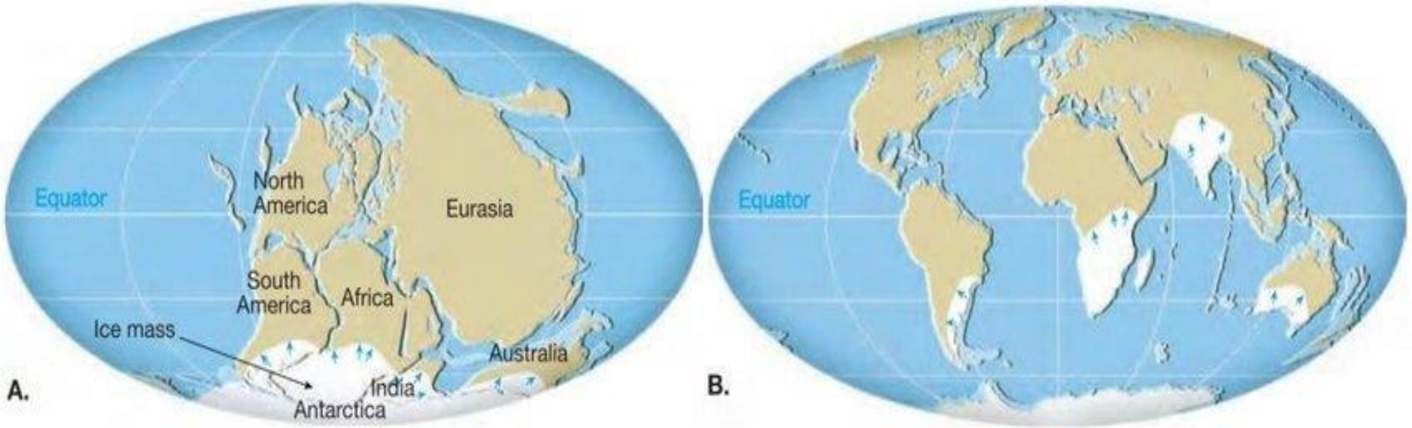
Paper part - الأسئلة المقالية



- Figure A is called Pangaea
- Figure B is called Gondwana
- The hypothesis that support earth’s continents were once joined and slowly over time moved to their present positions is called continental drift
- The ice caps shown in the map in white color, similar to the one covers Antarctica today surve as an evidence for the transition between A to B, what is the name giving to this evidence? glacial features
- Wegener found additional evidence in rocks that the climate of some continents had changed drastically, What evidence Wegener used to conclude this? Coal deposits

1	Conclude that continentals were once joined, from the evidence of matching coastlines of Africa and South America and how they can fit together like puzzle pieces, give evidence and clues used to test and support Alfred Wegnar's hypothesis	Textbook, figures, investigation	10, 11, 12

Paper part - الأسئلة المقالية

What two specific continents fit together most noticeably?

rning Outcomes Covered

- SCI.2.3.05.005

Africa and Australia

South America and Europe

South America and Africa

Antartica and Africa

2	Analyze the ocean topographic map by identify, classify and interpret various features visible on the ocean floor	Textbook, investigation, figures	30, 32, 33

Paper part - الأسئلة المقالية

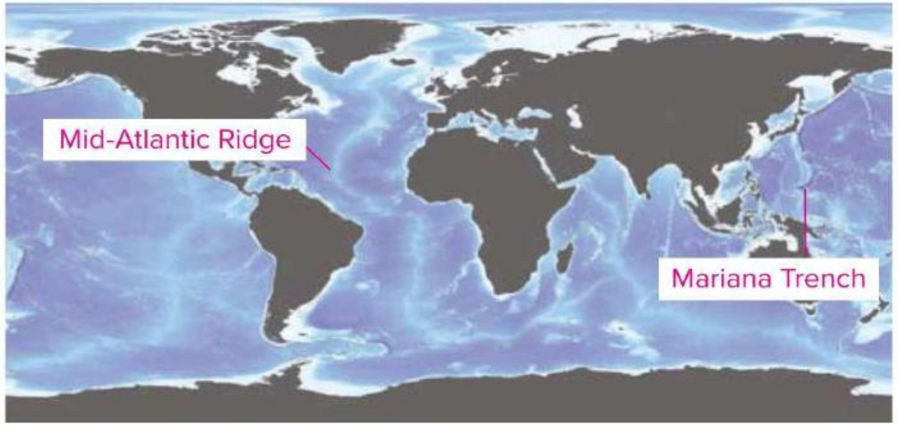
- Analyze the ocean topographic map by identify, classify and interpret various features visible on the ocean floor
- Textbook, investigation, figures
- 30, 32, 33

Ocean Floor Topography Once ocean depths were determined using sonar, scientists used these data to create a topographic map of the seafloor, much like you did in the *Simulating Sonar* lab. These new topographic maps uncovered a few surprising landforms. Let's dive in!

INVESTIGATION

Under the Sea

Examine the map below. The different colors indicate changes in water depths. Light blue indicates shallower depths; dark blue indicates deeper depths. The land regions are shaded in black.



1. Notice the light blue linear features that run along the ocean floors? These are vast mountain ranges deep below the ocean's surface called **mid-ocean ridges.** One such mountain range—the Mid-Atlantic Ridge—runs through the center of the Atlantic Ocean. Can you locate the Mid-Atlantic Ridge on the map above? Label it on the map.
2. The maps also revealed that underwater mountain chains had counterparts called ocean trenches. **Ocean trenches** are deep, underwater troughs on the seafloor. The Mariana Trench in the Pacific Ocean is the deepest landform on Earth. It is so deep it could fit Mount Everest with six Empire State buildings stacked on top! Can you identify an ocean trench on the map above? Label it on the map.
3. Return to the profile you created in the *Simulating Sonar* lab. Can you identify a mid-ocean ridge on your seafloor? Label it on your profile.

Paper part - الأسئلة المقالية

2	Analyze the ocean topographic map by identify, classify and interpret various features visible on the ocean floor	Textbook, investigation, figures	30, 32, 33

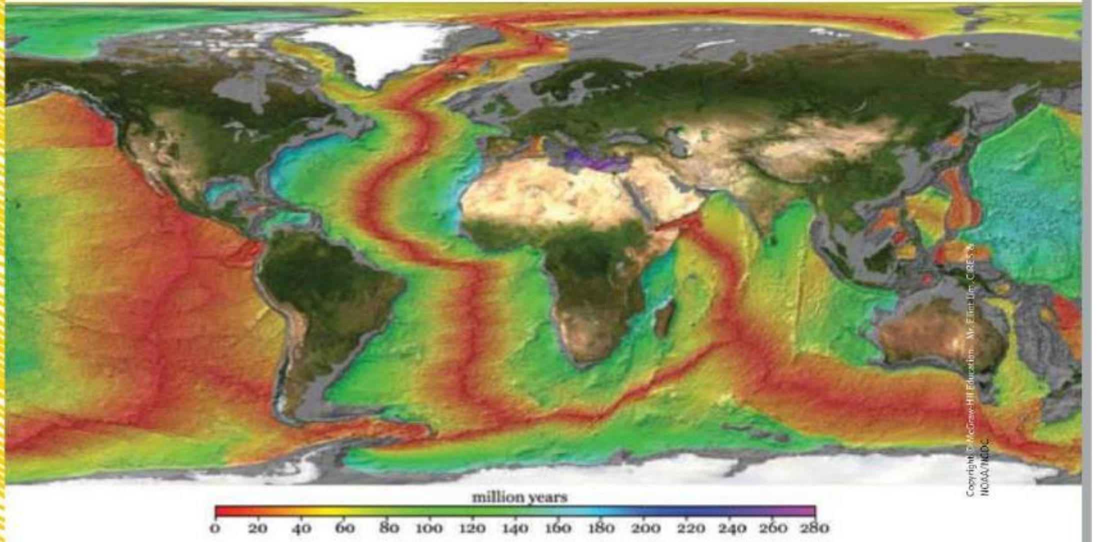
What pattern can be found on the seafloor?

Rock samples from the seafloor also revealed a surprise. Scientists were able to determine the age of the ocean floor and create isochron maps. An isochron is an imaginary line on a map that shows points that have the same age—that is, they formed at the same time. These isochron maps revealed an interesting pattern.

INVESTIGATION

Stripes on the Seafloor

Study the isochron map of the seafloor. Each colored band on this isochron map represents the age of that strip of crust.



1. What pattern do you observe?

colored bands are symmetrical on either side of a mid-ocean ridge.

2. In general, where is the youngest crust located?

The youngest crust, shown in red, is generally located in the center of the oceans.

3. Compare the isochron map to the topographic map of the seafloor in the previous investigation. Which seafloor features are associated with young crust? What can you infer from this?

Mid-ocean ridges are associated with the youngest oceanic crust. New oceanic crust must form at mid-ocean ridges.

4. How does the age of the seafloor change as you move away from these features? What can you conclude from this evidence?

As you move away from the mid-ocean ridges, the crust becomes progressively older in symmetrical bands on either side of the ridges. This suggests that the crust is carried away in each direction.

GO ONLINE for additional opportunities to explore!

Want to learn more about the age of oceanic crust? Then perform one of the following activities.

☐ **Investigate** how patterns in drying glue can show age relationships in the **Lab** *Can you guess the age of the glue?*

OR

☐ **Calculate** the age of the Atlantic in the **Lab** *How old is the Atlantic Ocean?*

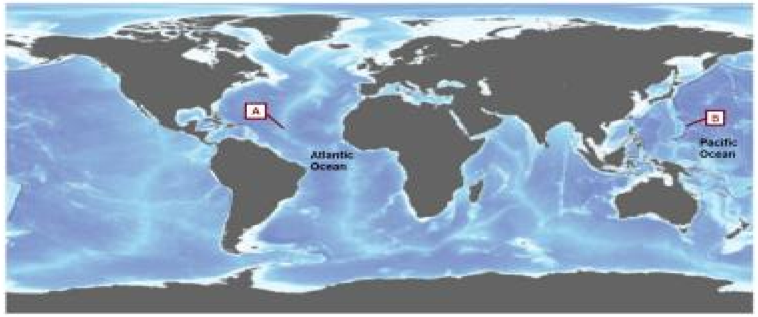
COLLECT EVIDENCE

How old is the crust along mid-ocean ridges and ocean trenches? Record your evidence (B) in the chart at the beginning of the lesson.

Paper part - الأسئلة المقالية

2	Analyze the ocean topographic map by identify, classify and interpret various features visible on the ocean floor	Textbook, investigation, figures	30, 32, 33

Study the map below, which of the following is correct?



arning Outcomes Covered

- SCI.2.3.05.002
- SCI.2.3.05.005

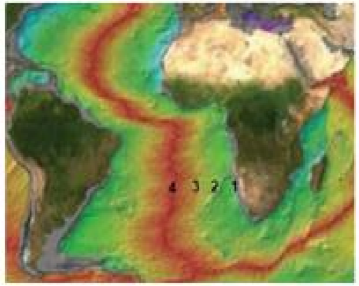
A is an example of the ocean trenches

B is a vast mountain ranges deep below the ocean's surface called mid-ocean ridges

B is the marina trench which is the deepest landform on Earth

A is a shallow-water ocean features and landforms

What is the correct order of the ocean-floor features (using the numbers on the map below) from the oldest to the youngest?



ning Outcomes Covered

- SCI.2.3.05.002
- SCI.2.3.05.005

1 > 2 > 3 > 4
Oldest → youngest

3	Compare and contrast between plate boundaries according to: shape, movment, and location	Textbook, lab, investigation, table, figures	48, 49, 52, 64
	Compare types of volcanoes and Explain how volcanic landscapes form and differentiate types of volcanoes on Earth and Hot spots		56, 58, 59

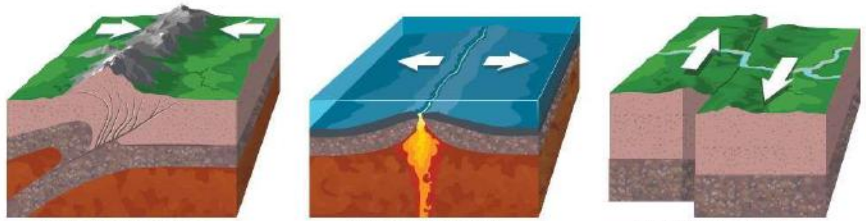
Paper part - الأسئلة المقالية

- Compare and contrast between plate boundaries according to: shape, movement, and location
- Textbook, lab, investigation, table, figures
- 48, 49, 52, 64

Analyze and Conclude

Analyze the movement of the crackers in each of your models. As plates move relative to each other, they form different types of boundaries. The type of boundary depends on the relative motion of the plates.

Study the diagram of plate boundaries below. Then answer the questions that follow.



12. What type of plate boundary do the crackers in Part I represent?
In Part I of the lab, students are modeling a transform boundary, in which the plates slide past each other.

13. How does the model in Part I simulate an earthquake?
The rubbing crackers vibrate and crumble as they slide past each other. The vibrations represent an earthquake.

14. What type of plate boundary do the crackers in Part II represent?
In Part II of the lab, students modeled a convergent boundary. In this boundary type, two plates collide.

15. What landform does Part II model?
The wet graham crackers represent mountains that form when two plates collide.

16. Suppose you substituted a piece of thick cardboard for one of the graham crackers in Part II. Which material would slide beneath the other? What ocean structure might this model?
Because the cardboard is more dense, it would slide beneath the cracker, modeling an ocean trench.

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Paper part - الأسئلة المقالية

17. What type of plate boundary do the crackers in Part III represent?
In this part, students are modeling a diverent boundary, in which the plates move away from each other.

18. What shape does the yogurt create when the crackers move? What do you think the yogurt represents?
The yogurt creates a triangular peak and represents magma at a mid-ocean ridge.

THREE-DIMENSIONAL THINKING

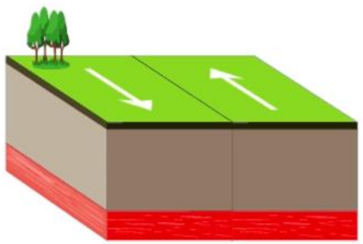
WRITING Connection **Explain** why examining time and space phenomena using small-**scale models** such as those in the Lab *Living on the Edge* helps you better understand the **system.**

In science, phenomena often occur on various spatial and temporal scales that are difficult to study in nature. For example, the plate tectonics system involves changes on a planetary scale over a range of time from fractions of a second to billions of years. Models can be used to study systems and phenomena that are too big or too small, or that happen too quickly or too slowly to observe directly.

Plate Boundaries In the *Living on the Edge* lab you modeled the three types of plate boundaries. When two plates move toward each other, the boundary between them is called a **convergent boundary.** A **divergent boundary** is where two plates move apart from each other. **Transform boundaries** are where plates slide horizontally past each other.

COLLECT EVIDENCE
What happens where plates meet? Record your evidence (A) in the chart at the beginning of the lesson.

Transform Boundary



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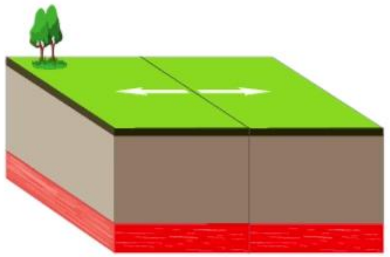
Divergent Boundary



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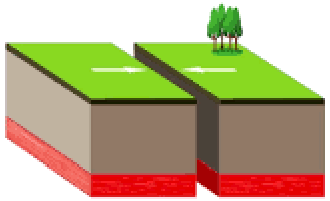
Convergent Boundary

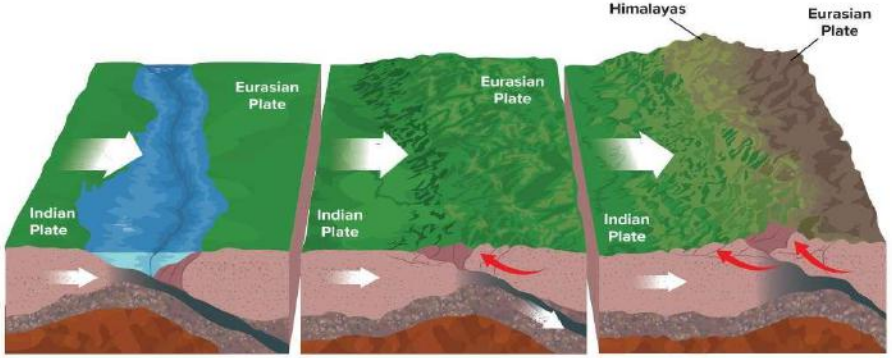


CEA

3	Compare and contrast between plate boundaries according to: shape, movment, and location Compare types of volcanoes and Explain how volcanic landscapes form and differentiate types of volcanoes on Earth and Hot spots	Textbook, lab, investigation, table, figures	48, 49, 52, 64 56, 58, 59

Paper part - الأسئلة المقالية

Fold Mountains As you just modeled in the *Fold Mountains* lab, squeezing—or compressional—forces can create mountains. When two continental plates collide at a convergent boundary large mountain ranges form. The tectonic plates are under extreme pressure and fold or crumple upward, forming fold mountains. But the mountains form slowly and in stages over millions of years. The Himalayas, for example, formed as the Indian Plate converged with the Eurasian Plate, as shown in the figure below. The Himalayas are the largest and highest mountain range in the world, and they are still growing!

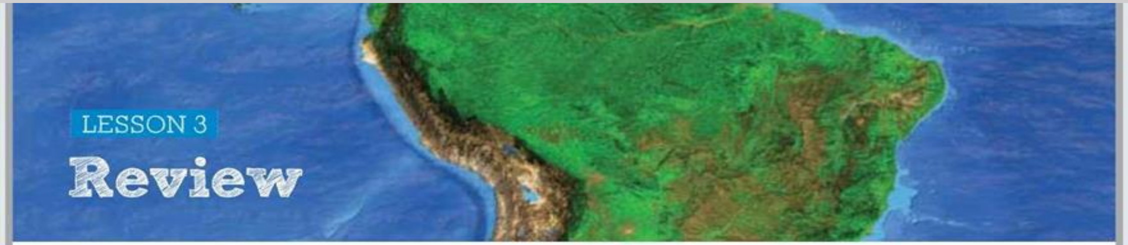


The Andes are also an example of fold mountains. As the denser Nazca Plate collides with the South American Plate, it is forced under the South American Plate in a process called **subduction.** This causes the leading edge of the South American Plate to fold upward. The Andes, shown to the right, are the longest mountain range on Earth.

Not all of Earth's mountains are fold mountains. You have probably heard of faults. A **fault** is a break in Earth's crust along which movement occurs. What you might not be aware of is that faults can create mountains.

COLLECT EVIDENCE

How did the Andes form? Record your evidence (B) in the chart at the beginning of the lesson.



Summarize It!

1. **Organize** information about tectonic plate boundaries in the chart below.

	Convergent Boundary	Divergent Boundary	Transform Boundary
Description of Plate Motion	Plates collide	Plates spread apart	Plates move past one
Example of a Result of This Type of Plate Motion	Mountains volcanoes Fault Earthquake Ocean trenches	Mid-ocean ridges Faults Earthquake Underwater mountains	Faults Fault zones
Scale of Example (Rapid or Slow/Large or Small)	Mountains are created slowly over million of years.		Earthquakes occur rapidly

Paper part - الأسئلة المقالية

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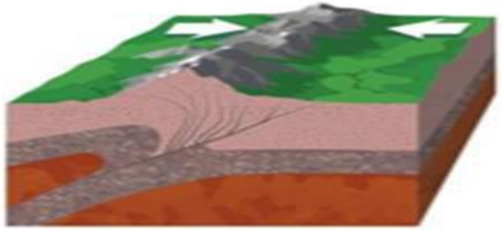
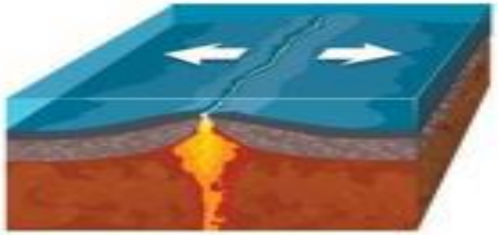
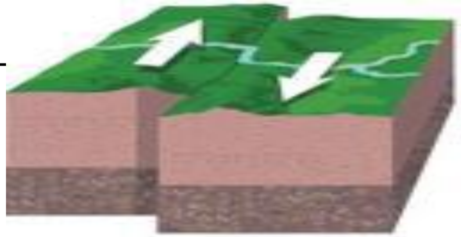
Compare between the different types of boundaries

			
Name of the boundary	**convergent**	**divergent**	**transform**
Movement (motion) **force**	Two plates move toward each other Collide Compression	two plates move apart from each other Spread apart Tension	plates slide horizontally past each other Move past one another
Location **Shape**	Marianas Trench Himalayas – Andes Ocean trenches -subduction zone Fold Mountains volcanoes Fault Earthquake	Mid-Atlantic Ridge Mid-ocean ridges Faults Earthquake Fault-block mountains	San Andreas Fault in California Fault zones Faults

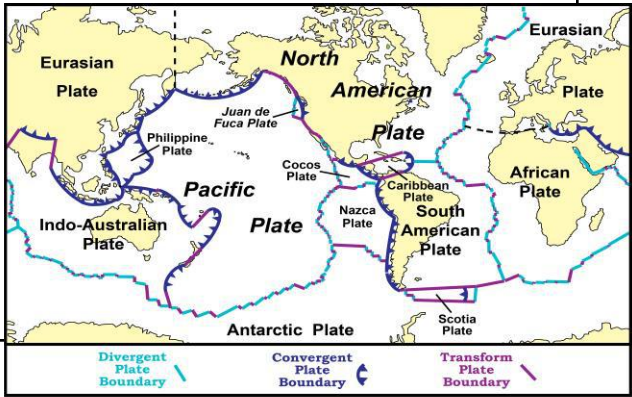
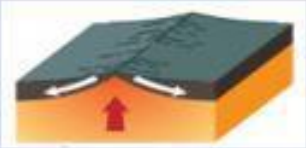
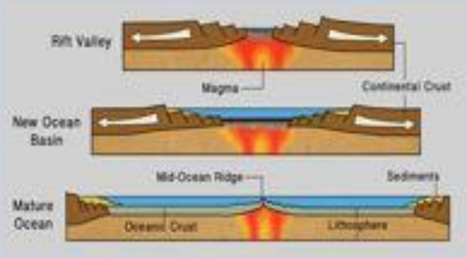
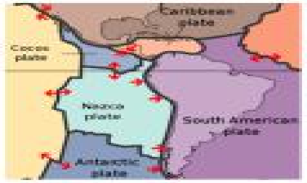


Plate tectonic boundaries	Divergent	Convergent	Transform
Diagram			
Motion	Move apart from each other Spreading	Move toward each other Subduction	Slide horizontally past each other Lateral sliding
Force	Tension	Comparison	Shear
Earthquake activity	Yes	Yes	yes
Volcanic activity	Yes	Yes	No
Topography	**Mid-ocean Ridge** Example: mid- Atlantic Ocean **Rift**  **Pillow lava**	**Fold mountain**  Example: Himalayas- Continental-continental  Example: Andes- Oceanic- continental **Trench** Example: Mariana trench in pacific ocean  **volcanic Arc**  Example: Aleutian Oceanic-Oceanic	**Fault Zone** Example: San Andreas Fault in California 

The Andes mountains is formed as the oceanic denser plate "Nazca Plate" is forced under the "South American Plate". What is the name of this process?



Learning Outcomes Covered

- SCI.2.3.05.004

a. Fault

b. Subduction

c. Transformation

d. Divergent

3	Compare and contrast between plate boundaries according to: shape, movment, and location	Textbook, lab, investigation, table, figures	48, 49, 52, 64
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Paper part - الأسئلة المقالية

- Compare types of volcanoes and Explain how volcanic landscapes form and differentiate types of volcanoes on Earth and Hot spots
- Textbook, lab, investigation, table, figures
- 56, 58, 59

How do volcanic landscapes form?

Some of Earth's mountains are volcanic mountains. Perhaps you have heard of some famous volcanoes such as Mount St. Helens, Kilauea, or Mount Pinatubo. A **volcano** is a vent in Earth's crust through which molten rock flows. Volcanoes can be as small as a car. They also can be more than 10 km in height. What happens when a volcano erupts?

INVESTIGATION

Take Cover

1. Observe the demonstration. Record your observations below.

Students will observe a "volcanic eruption" when baking soda is added to vinegar. The larger beads will be erupted closer to the volcano than the smaller beads, but might move away from the "volcano" as it continues to erupt.

2. What happened when the baking soda was added to the vinegar? How were the different-sized beads erupted?

When the baking soda was added to the vinegar, the two substances reacted and produced a mini "volcanic eruption." The smaller beads were erupted much farther than the larger beads, which were deposited closer to the model volcano.

3. How do you think volcanoes change Earth's surface?

Volcanoes can change Earth's surface by adding new rock to the crust. Lava can also destroy or cover anything in its path.

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Paper part - الأسئلة المقالية

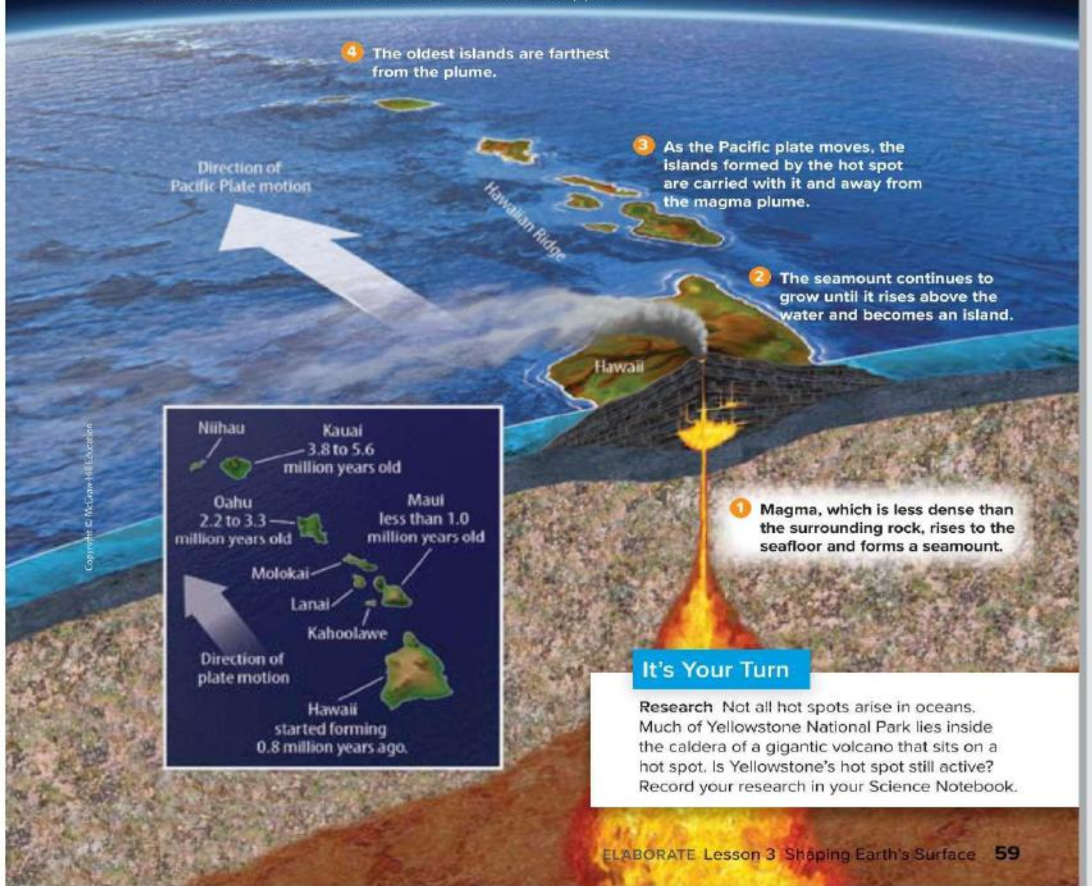
Hot Spots!

HOW NATURE WORKS

Volcanoes on a Plate

Not all volcanoes form at plate boundaries. Some, called hot spot volcanoes, pop up in the middle of a tectonic plate. A hot spot volcano forms over a rising column of magma called a mantle plume. The origin of mantle plumes is still uncertain, but evidence shows they probably rise up from the boundary between Earth's mantle and core.

As a tectonic plate passes over a mantle plume, a volcano forms above the plume. The tectonic plate continues to move, and a chain of volcanoes forms. If the volcanoes are in the ocean and if they get large enough, they become islands, such as the Hawaiian Islands. Here is how this happens:

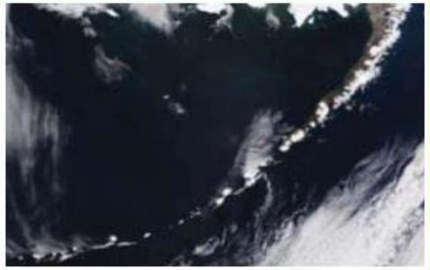


It's Your Turn

Research Not all hot spots arise in oceans. Much of Yellowstone National Park lies inside the caldera of a gigantic volcano that sits on a hot spot. Is Yellowstone's hot spot still active? Record your research in your Science Notebook.

Volcanoes on Earth The slow and large-scale motion of Earth's tectonic plates causes the formation of volcanoes and the rapid and sometimes catastrophic eruptions that result. Sometimes lava that flows from volcanoes slowly covers the region surrounding the volcano. At other times, volcanoes can erupt explosively. Volcanic eruptions constantly shape Earth's surface. They can form large mountains, create new crust, and leave a path of destruction behind. Let's look at a few examples of volcanoes on Earth.

Volcanoes can form in the ocean where oceanic plates converge and one plate subducts. These volcanoes emerge as islands. A curved line of volcanoes that forms parallel to a plate boundary is called a **volcanic arc.** Most of the active volcanoes in the United States are part of the Aleutian volcanic arc in Alaska. They formed as a result of the Pacific Plate subducting under the North American Plate. ▶



◀ Volcanic arcs can also form on land where an oceanic plate subducts under a continental plate. Volcanoes in the Cascades, such as Mount Shasta shown to the left, are a result of the Juan de Fuca plate subducting under the North American Plate. Recall that the Andes Mountains in South America are also a result of an oceanic plate subducting under a continental plate. The world's highest active volcano is located in the Andes. Nevada Ojos del Salado is nearly 6,900 m tall!

Lava does not erupt only from volcanic mountains on land. More than 60 percent of all volcanic activity on Earth occurs along mid-ocean ridges. As the seafloor slowly spreads apart along mid-ocean ridges, lava erupts into the rift formed by the separating plates. This lava takes the form of giant pillows, like those shown to the right, and is called pillow lava. Eruptions at divergent boundaries tend to be nonexplosive. ▶

COLLECT EVIDENCE

How did the volcanic peaks in the Andes form? Record your evidence (C) in the chart at the beginning of the lesson.

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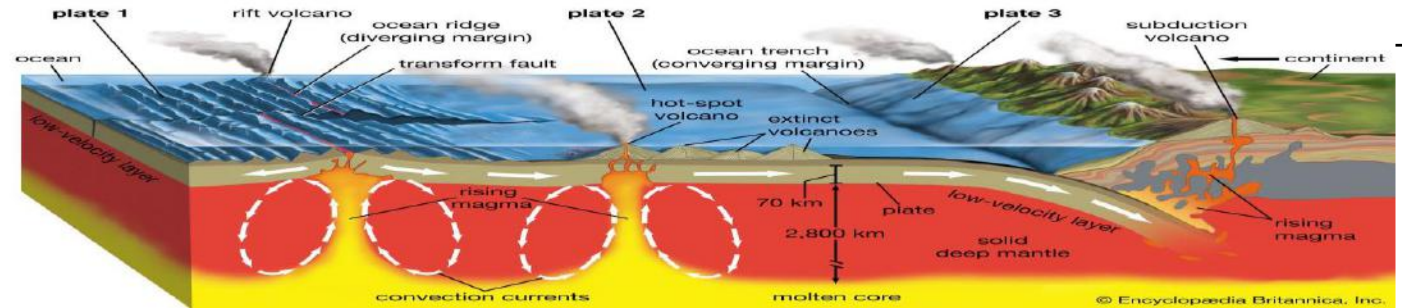
Paper part - الأسئلة المقالية

Types of volcanoes

	At Convergent boundary		At Divergent boundary	In middle of plate boundaries
	Ocean-ocean plates	Ocean-continental plates		Hot spot volcano
Types of volcanoes	Oceanic plates converge and one plate subducts	Oceanic plate subducts under a continental plate	As the seafloor slowly spreads apart along mid-ocean ridges, lava erupts into the rift formed by separating plates	forms over rising column of magma called a mantle plume in the middle of a tectonic plate
How volcanic landscapes form	These volcanoes emerge as islands. A curved line of volcanoes that forms parallel to plate boundary called volcanic arc	Volcanic arc form on land where an oceanic plate subduct under a continental plate	more than 60% of all volcanic activity on earth occurs along mid ocean ridges. This lava takes the form of giant pillow called pillow lava Eruptions tend to be nonexplosive.	A volcano form above the plume. The tectonic plate continues to move, and a chain of volcanoes forms. If they get large enough, the become islands such as the Hawaiian islands.



What type of mountains are formed when molten rock erupts onto Earth's surface and hardens?

Outcomes Covered

:I.2.3.05.002
:I.2.3.05.004

Uplifted mountains

Fold mountains

Volcanic mountains

Fault-block mountains

4	Complete the rock cycle and relate types of rocks (sedimentary, Igneous and Metamorphic) together through the processes of weathering	Textbook, investigation, summarize it	118, 119, 122

Paper part - الأسئلة المقالية

- Complete the rock cycle and relate types of rocks (sedimentary, Igneous and Metamorphic) together through the processes of weathering
- Textbook, investigation, summarize it
- 118, 119, 122

Uplift Some metamorphic and igneous rocks form deep within Earth. How are they exposed at Earth's surface? The process of uplift is a tectonic process that brings rocks from deep in the crust to Earth's surface where they are exposed to the environment. Uplift slowly moves large amounts of rock up to Earth's surface and to higher elevations. Uplift is driven by Earth's internal heat energy which results in tectonic motions and often is associated with mountain building.

How do rocks change?

You just learned how natural processes on Earth's surface lead to the formation of igneous, sedimentary, and metamorphic rock. Are these processes connected?

INVESTIGATION

Rock Cycle

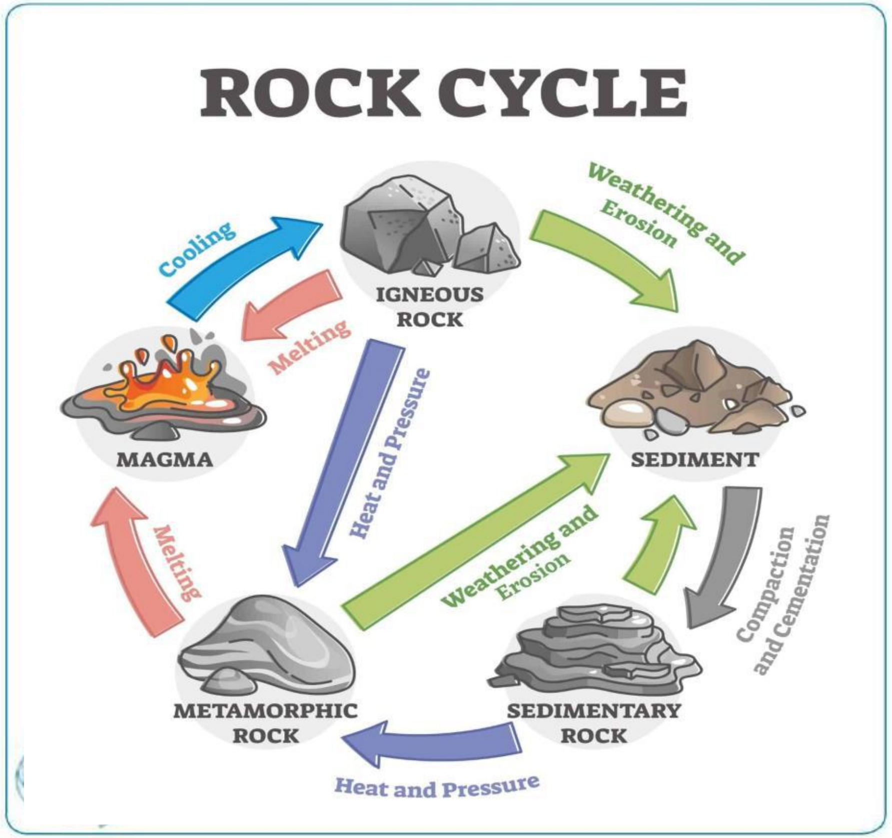
1. Describe the processes involved in the formation of igneous, sedimentary, and metamorphic rock. Indicate whether each process is a physical or chemical change.

Igneous rocks form through the processes of melting, cooling, and crystallization. The processes of melting and crystallization are chemical changes. Sedimentary rocks form through the processes of weathering, erosion, sedimentation, and lithification. The process of weathering can be physical or chemical. The processes of erosion, sedimentation, and lithification are physical. Metamorphic rocks form through the process of exposure to extreme heat, pressure, or hot fluids. Deformation of rock is the result of a physical change. Growth of new minerals is a result of a chemical change.

4	Complete the rock cycle and relate types of rocks (sedimentary, Igneous and Metamorphic) together through the processes of weathering	Textbook, investigation, summarize it	118, 119, 122

Paper part - الأسئلة المقالية

2. Create a diagram that models the relationships among these processes and the Earth materials they cycle. Use arrows to show connections.



The Rock Cycle The series of processes that change one type of rock into another type of rock is called the **rock cycle.** The energy that drives these forces is derived from the Sun and Earth's hot interior. The rock cycle describes how one rock type can change into another rock type through natural processes. As materials move through the rock cycle, they can take the form of igneous rocks, sedimentary rocks, or metamorphic rocks. At times, the material might not be rock at all. It might be sediment, magma, or lava.

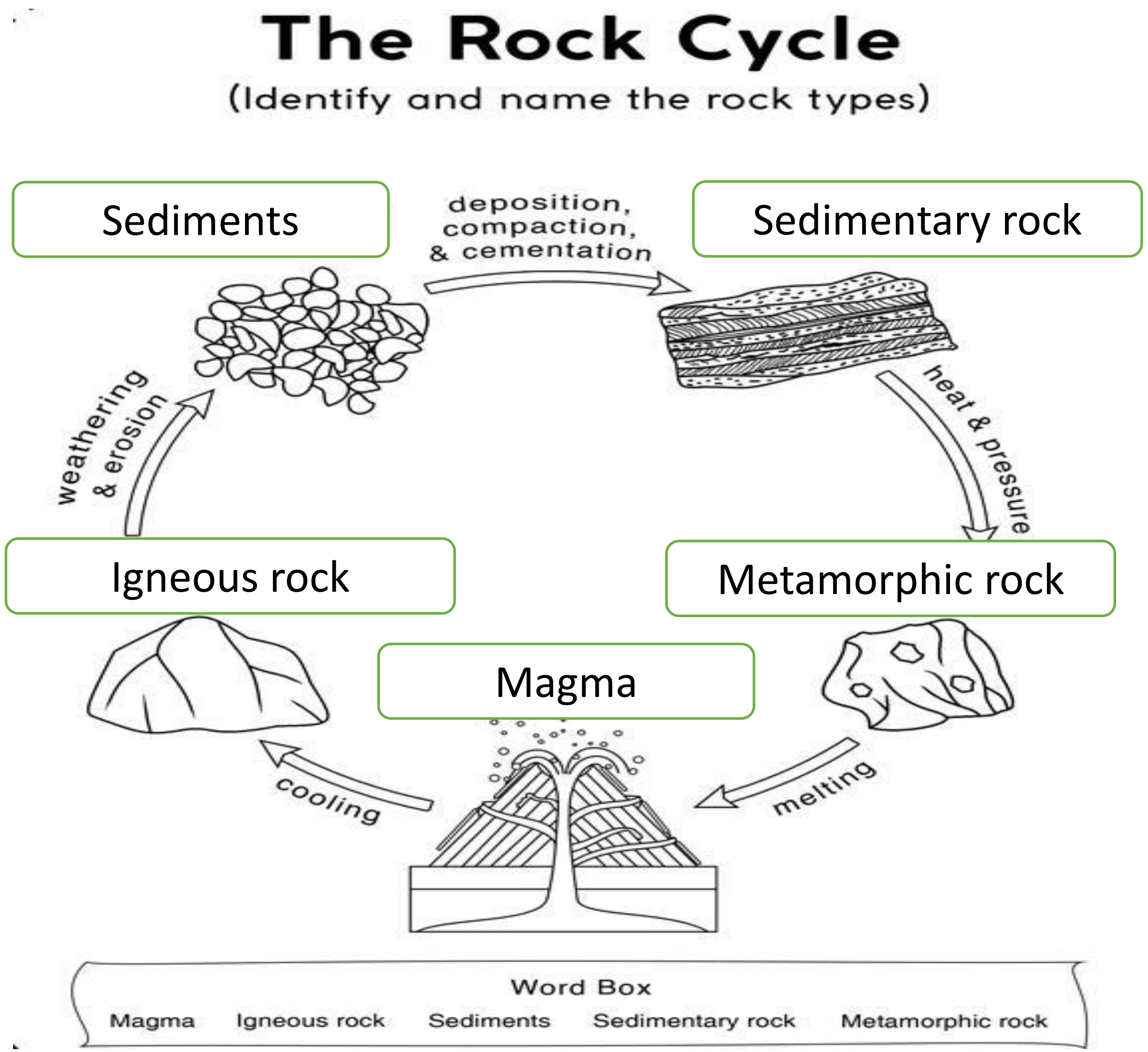
Summarize It!

1. **Explain** Using the model you created in the last investigation, describe the processes that cycle Earth's materials and the flow of energy that drives these processes.

Students should describe how different processes, such as weathering, erosion, melting, and crystallization, cycle matter on Earth's surface, producing both physical and chemical changes in Earth's materials. These processes are driven by energy from the Sun and from Earth's internal heat.

4	Complete the rock cycle and relate types of rocks (sedimentary, Igneous and Metamorphic) together through the processes of weathering	Textbook, investigation, summarize it	118, 119, 122

Paper part - الأسئلة المقالية



- **How to relate types of rocks (sedimentary, Igneous and Metamorphic) together through the processes of weathering?**
- Rocks (sedimentary, igneous and metamorphic) exposed to the atmosphere are very unstable and subject to the processes of weathering and erosion.
- This process breaks the original rock down into smaller fragments and carries away dissolved materials. Sedimentary rocks form from deposits that accumulate on the Earth's surface.

5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92
	Compare between chemical & physical change		73

Paper part - الأسئلة المقالية

- List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes
- textbook, figures, investigation
- 76, 80, 84, 85, 87, 88, 90, 92

After Weathering... You just discovered that materials on Earth are slowly weathered over time through both physical and chemical processes. What happens to weathered material? Let's look at an example.

INVESTIGATION

Bye-Bye Beach

Examine how this beach changes from one photo to the next below.

1. How did this beach change over time?

The beach has become narrower. The space between the water and the buildings has decreased over time.

2. What do you think caused these changes?

As waves crashed onto the beach, sand was removed by the water and carried to new locations.

Erosion and Deposition As you just investigated, weathered material can be moved or transported to new locations. Geologists use the term **erosion** to describe the moving of weathered material, or sediment, from one location to another. **Deposition** is the laying down or settling of eroded material.

Together, the processes of weathering, erosion, and deposition change the surface of Earth. These processes can occur at spatial scales ranging from large to microscopic, over time periods ranging from seconds to millions or billions of years.

COLLECT EVIDENCE

What processes change Earth's surface over time? Record your evidence (A) in the chart at the beginning of the lesson.

5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes Compare between chemical & physical change	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92 73

Paper part - الأسئلة المقالية

Analyze and Conclude

15. Make a claim about how water can change a stream over time.

Water weathers, erodes, and deposits sediment in a stream over time.

16. What evidence from the investigation supports your claim?

that the rate of weathering, erosion, and deposition is affected by an increase in stream gradient (slope) and water speed, and is also affected by the shape of the stream. Students should cite specific evidence from their experience.

Water Erosion and Deposition As you just modeled, streams are active systems that weather and erode land and deposit sediment. The erosion produced by a stream depends on the stream's energy. This energy is usually greatest in steep, mountainous areas where young streams flow rapidly downhill. The rushing water often carves V-shaped valleys. Water in a stream slows as it reaches gentler slopes. Slower moving water erodes the sides of a stream channel more than its bottom, and the stream develops curves. Over time, the stream meanders, or curves, changing shape.

Erosion occurs on the outside of bends where water flows faster. Deposition occurs on the inside of bends where water flows slower. Flowing water deposits sediment as the water slows. A loss of speed reduces the amount of energy that the water has to carry sediment. Deposition by a stream can occur anywhere along its path where the water's speed decreases.

Wind Erosion and Deposition Strong winds also can erode and deposit weathered sediment. In some places, wind and water work together to weather and erode rocks and make them look so smooth and polished. The erosion and deposition of materials by wind can form different types of features on Earth's surface.

Land Features	
Sand Dunes The shapes of dunes are mostly controlled by whether wind blows consistently in one direction or is more variable in direction. Some dunes can be many kilometers long. Grain by grain, sand dunes migrate in the direction the wind blows. Dunes can take on irregular shapes and are constantly changing.	
Loess Wind-deposited silt and clay is called loess. One type of loess forms from rock that was ground up and deposited by glaciers. Wind picks up this fine-grain sediment and redeposits it as thick layers of dust called loess.	
Arches As wind carries weathered sediment along, the sediment cuts and polishes exposed rock. Abrasion is the grinding away of rock or other surfaces as weathered particles carried by wind, water, or ice scrape against them.	
Scoured and Sandblasted Rocks Wind can bombard rocks on the surface with windblown sand, silt, or even ice, essentially sandblasting them. Many such rocks take on a smooth, polished appearance as sharp, rough spots are smoothed by debris. Others take on odd shapes like the rock shown here.	

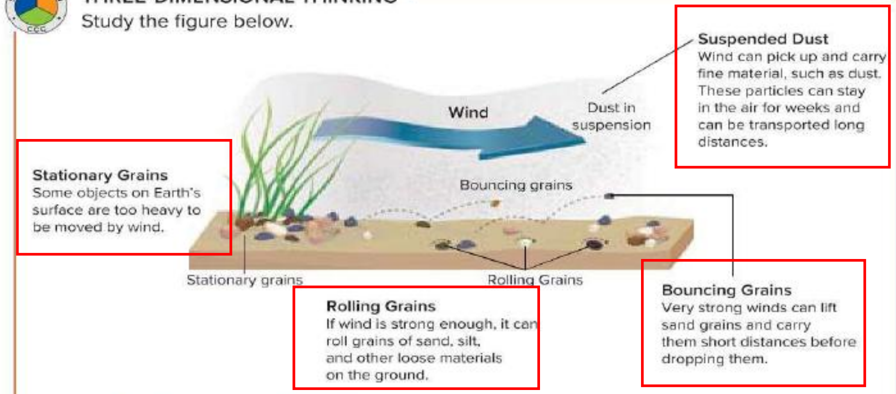
5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92
	Compare between chemical & physical change		73

Paper part - الأسئلة المقالية

Sediment Transport and Wind In deserts, erosion by wind can be the most important process that changes landforms. Wind can weather rock, and it can erode and deposit sediment. The effects of wind vary, depending on the size of the sediment particles.

Wind is capable of moving sand and finer sediment, as well as pieces of plants and other materials lying on the surface. A microscopic grain of sand can be moved easily and over long distances in a fairly short period of time. However, the movement of larger sediment pieces would take a longer amount of time and require more force.

THREE-DIMENSIONAL THINKING
Study the figure below.



1. **Construct an explanation** about how grain size could affect the movement of a sand dune from one location to another.
It is more difficult for wind to move larger grains than smaller grains. Stronger wind is needed to move large grains. Dunes made of smaller grains can move locations more easily.

2. Compare and contrast the spatial **scales** over which wind impacts the movement of sand.
Areas with greater wind exposure and smaller, lighter sediment sizes are more likely to change more over time and spatial scales than areas with larger, heavier grain sizes and less wind exposure.

Erosion by Ice As you just observed, the ice cube glacier transported and deposited some of the colored sand as it moved downhill. Glaciers erode Earth's surface as they slide over it. Let's investigate the types of materials that glaciers transport and how glaciers change Earth's surface.

INVESTIGATION

Glacial Shaping

GO ONLINE Watch the video *Glacial Landscapes*.

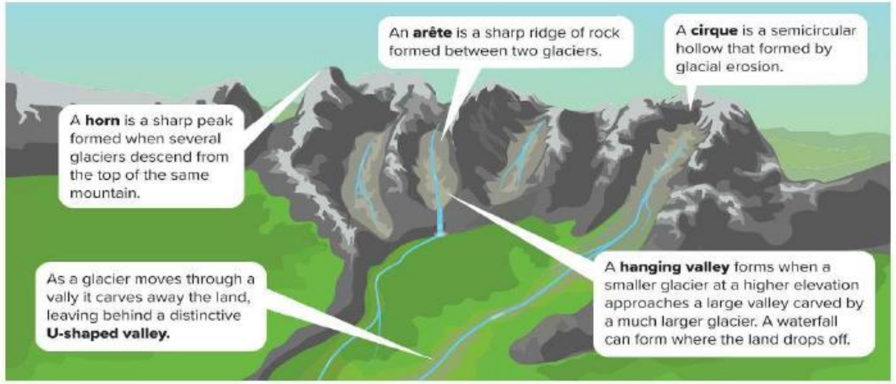
1. What evidence did you gather that glaciers transport materials on Earth's surface?
: As glaciers move, they pick up rocks and boulders. These rocks scrape and chip away at the rocks below. Boulders, pebbles, silt, and even the color of the water deposited from the glacier are the result of materials being moved by ice.

2. How might glaciers change the landscape over time?
As glacial ice picks up rocks, it scrapes the surface of Earth below. The glacier acts like an enormous piece of sandpaper, carving out valleys and lakebeds. Over time glaciers carve deep valleys into mountains.

Glacial Debris Glaciers carry an unsorted collection of large, commonly angular rocks to pulverized, fine-grained sediment. The sides of most glaciers contain especially abundant sediment because they receive loose materials from the slopes of hills and mountains that flank the glacier. This sediment is eroded as the ice pushes forward. Rocks and grit frozen within the ice create grooves and scratches on underlying rocks as they are transported downhill. When glaciers melt, the water produced by the melting ice does not flow fast enough to carry sediment. The sediment is deposited where the ice melts. Till is a mixture of various sizes of sediment deposited by a glacier. Deposits of till are poorly sorted.

5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes Compare between chemical & physical change	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92 73

Paper part - الأسئلة المقالية



Glacier Features Glaciers act as giant bulldozers. Glacial features are formed as a glacier moves through an area and carves away the land. Some of the distinct features produced by glaciers are identified in the image above.

THREE-DIMENSIONAL THINKING

Explain how the mountains and the valley in the image above would be different if a glacier had not passed through.

: The valley would likely be V-shaped (formed by a river) instead of U-shaped (formed by a glacier). There would not be ridges carved into the mountains, so you would not see features such as horns, arêtes, cirques, and hanging valleys.

GO ONLINE for an additional opportunity to explore!

Examine how glaciers change Earth's surface by performing the following activity.

- [ ] **Read** the **Scientific Text** *Glaciers and Landforms* to learn about how glaciers have impacted North America.

COLLECT EVIDENCE

How can a glacier change a mountainous landscape? Record your evidence (D) in the chart at the beginning of the lesson.

THREE-DIMENSIONAL THINKING

Examine the photo below. Use the concepts you have learned in the lesson to answer the questions that follow.

1. How might weathering, erosion, and deposition **change** the landscape over a short-term time **scale,** such as fractions of a second, weeks, or decades?

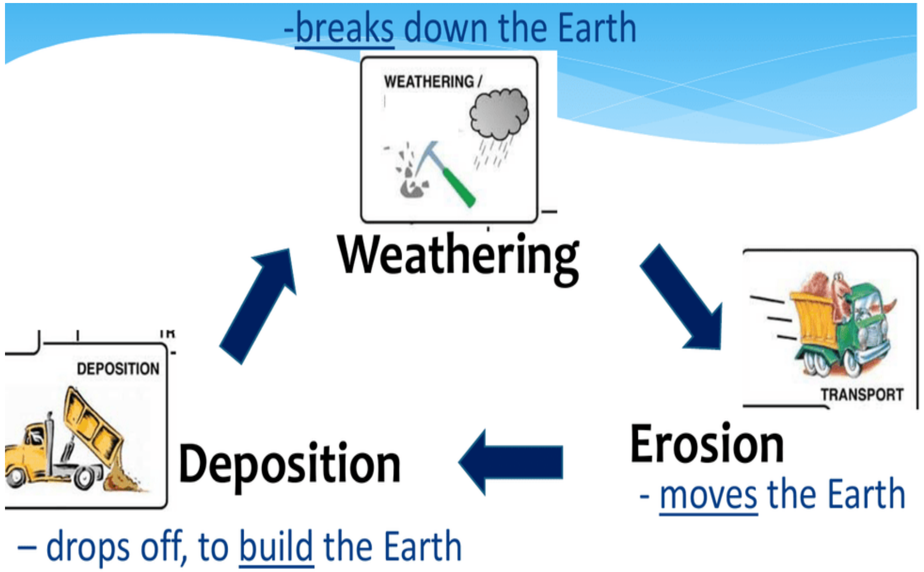
The chemical reactions that take place during chemical weathering are rapid changes. Erosion and deposition by water, wind and ice can also occur on small time scales. Flash floods, for example, can increase the rate of erosion on the banks of a mountain stream quickly.

2. How might the landscape appear in thousands or millions of years? **Explain** your reasoning.

Gradually, over thousands or millions of years, the processes of weathering and erosion will wear down the landscape. The sharp mountain peaks will become rounder and the mountains will become shorter.

5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92
	Compare between chemical & physical change		73

Paper part - الأسئلة المقالية



LESSON 4
Review

Summarize It!

1. **Describe** how water, wind, and ice can change Earth's surface through the processes of weathering, erosion, and deposition.

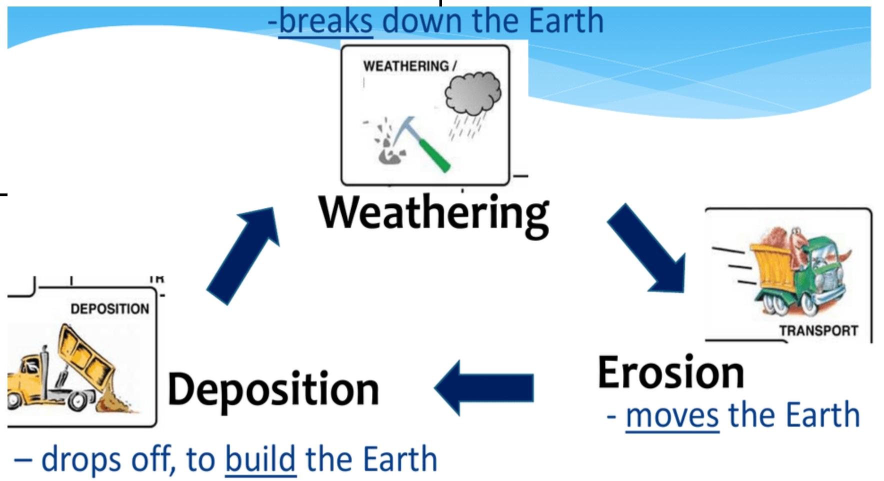
Water	causes physical and chemical weathering both above and below Earth's surface; causes most erosion and deposition; fast-moving water erodes more than slow-moving water; slow-moving water deposits more than fast-moving water
Wind	when strong enough, can cause erosion; can change desert landscapes; can pick-up, transport, and suspend small grain materials
Ice	can carve features on Earth's surface; erode the land over which it moves; when glaciers melt they deposit rocks and other sediment

5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes Compare between chemical & physical change	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92 73

Paper part - الأسئلة المقالية

What processes are responsible for changing Earth’s surface?

process	weathering	erosion	deposition
Definition	any natural process that changes objects on earth’s surface over time	the moving of weathered, or sediment, from one location to another	the laying down or settling of eroded material



5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92
	Compare between chemical & physical change		73

Paper part - الأسئلة المقالية

Briefly explain the factors that change the Earth’s surface in the following figures.

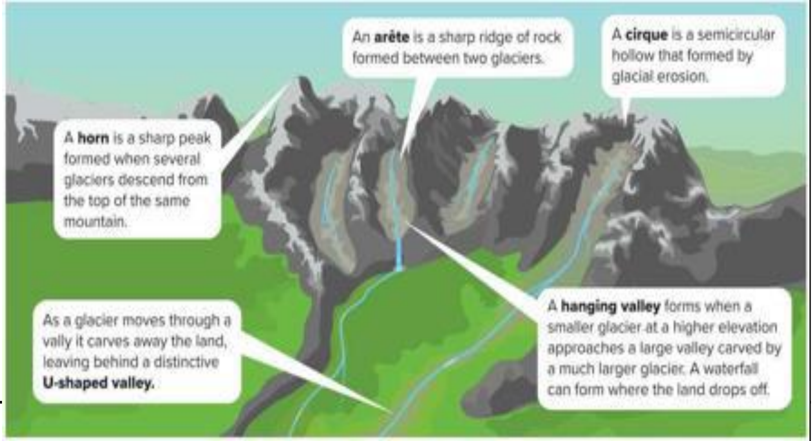
-Water erosion and deposition

-Slow moving water erodes the sides of a stream channel more than its bottom, and the steam develops curves. Over time, the stream meanders, or curves, changing shape,

- Wind erosion and deposition
- The shape of sand dunes are controlled by whether wing blows consistently in one direction or is more variable in direction

Paper part - الأسئلة المقالية

Land features of erosion and deposition

Erosion factor	water	Wind	glacier
Land features by erosion	V-shaped valley meanders 	Arches  Scoured and sandblasted rock Abrasion 	Grooves- Horn- U-shaped valley Arete- Cirque- Hanging valley 
Land features by deposition	Delta	Sand dunes  Loess 	Till

5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92
	Compare between chemical & physical change		73

Paper part - الأسئلة المقالية

- Compare between chemical & physical change
- textbook, figures, investigation
- 73

Analyze and Conclude

7. Compare and contrast the "rocks" from each cup.

the rocks are alike in that they are still rocks. They differ in that they are smoother, smaller, and more broken the more they are shaken.

8. Are rocks on Earth's surface stable? What might cause rocks to change? Explain your reasoning.

er: Rocks seem stable, however they can change over time. For example, as rocks hit against each other, they can break into smaller pieces.

Weathering Any natural process that changes objects on Earth's surface over time is called **weathering**. Two types of weathering can occur: physical and chemical. Physical weathering breaks rocks into small pieces without changing the composition or chemical make-up of the rock.

LIFE SCIENCE Connection Plants and animals can physically weather rocks. Animals that live in soil create holes in the soil where water enters and causes weathering. Animals burrowing through loose rock, like this mole, can also help to break down rocks as they dig.

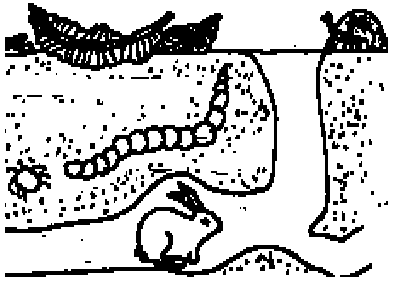
The roots of plants can grow into cracks in rocks, as shown on the previous page. The force from the growing roots can pry the rock open.

What happens to a rock when it is exposed to chemical weathering?

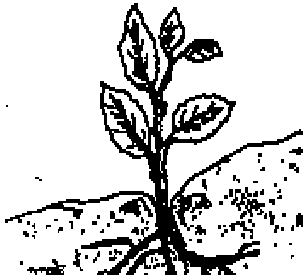
Want more information?
Go online to read more about how weathering, erosion, and deposition change Earth's surface over time.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

6.04 Weathering



Organisms in the soil



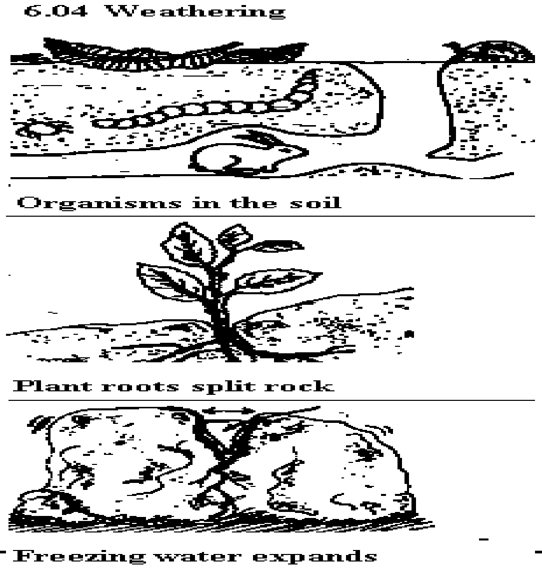
Plant roots split rock

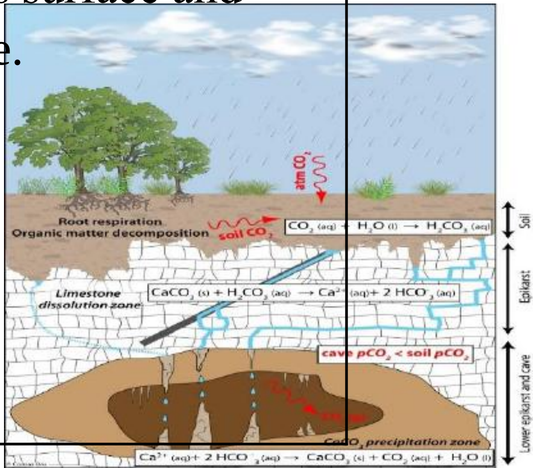
Freezing water expands

5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92
	Compare between chemical & physical change		73

Paper part - الأسئلة المقالية

	Physical weathering	Chemical weathering
Definition	breaks rock into small pieces without changing the composition or chemical make up of the rock	Break rock into small pieces with changing the composition or chemical make up of the rock
Examples	Plants roots grow into cracks in rocks. Animal live in soil create holes where water enters and causes weathering Water in cracks freeze and expand.	Chemical weathering can be caused by reactions between rock and the chemicals in air and water. Carbon dioxide in the air reacts with water to form a weak acid. This acid reacts with rocks (limestone) on Earth's surface and underground forming a cave.

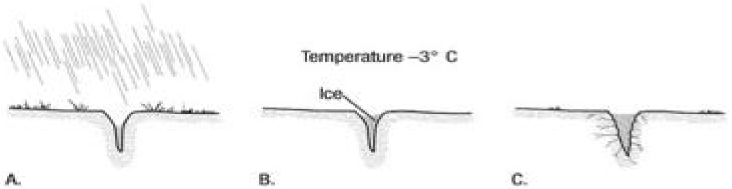




Paper part - الأسئلة المقالية

5	List the processes that change Earth's surface (Weathering, erosion, deposition) and conclude how water and wind play a significant role in changing the Earth's surface and assgin examples of land features resulted from these processes Compare between chemical & physical change	textbook, figures, investigation	76, 80, 84, 85, 87, 88, 90, 92 73

Which best explain the process occurring in the figure below?



Outcomes Covered

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l.2.3.02.001

It is a chemical change from the plant’s roots

It is a chemical change from changing the water to ice

It is a physical change for the soil chemical composition

It is a physical change in Earth’s surface

6	Explain Earth's constant motion	Textbook, figures	5, 19

الأسئلة الموضوعية MCQ

- Explain Earth's constant motion
- Textbook, figures
- 5, 19

What was missing?

Alfred Wegener continued to support the continental drift hypothesis until his death in 1930. His ideas, however, were not widely accepted until nearly four decades later. Why were scientists skeptical of Wegener's hypothesis?

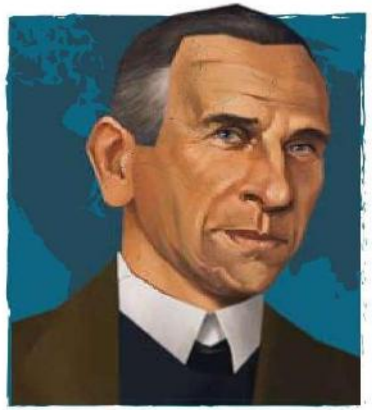
INVESTIGATION

Wegener's Thorn

GO ONLINE Watch the video *What was missing?*

Why did scientists argue against continental drift?

While Alfred Wegener had a cache of geologic and fossil evidence supporting his hypothesis of continental drift, Wegener could not explain how the continents moved across the solid rock of the ocean floor.



Alfred Wegener

Wegener needed more scientific evidence to prove his hypothesis of continental drift. This evidence, however, was hidden on the seafloor between the drifting continents and was not discovered until long after Wegener's death.

GO ONLINE for additional opportunites to explore!

Want to learn more about Wegener and continental drift? Then perform one of the following activities.

- [ ] **Watch the Video** *Close the Atlantic Ocean* to see examples of rock and fossil evidence for continental drift.

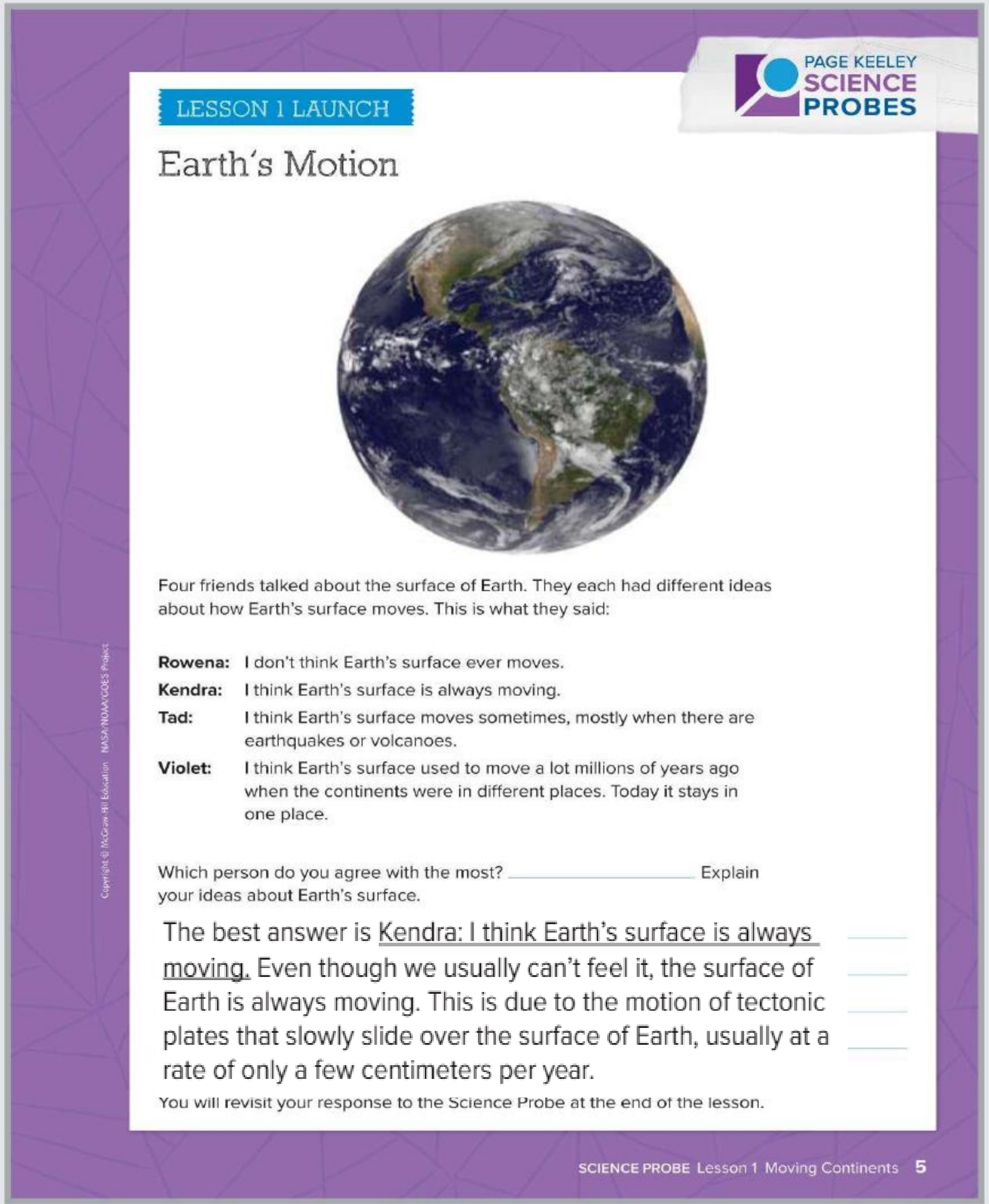
OR

- [ ] **Demonstrate** how fossil clues are useful in reconstructing continents in the **Lab** *Interpreting Fossil Data.*

6	Explain Earth's constant motion	Textbook, figures	5, 19

الأسئلة الموضوعية MCQ

- Explain Earth's constant motion?
- even through we usually can't feel it, the surface of earth is always moving.
- This is due to the motion of tectonic plates that slowly slide over the surface of earth, usually at a rate of only few centimeters per year.


PAGE KEELEY SCIENCE PROBES

LESSON 1 LAUNCH

Earth's Motion

Four friends talked about the surface of Earth. They each had different ideas about how Earth's surface moves. This is what they said:

Rowena: I don't think Earth's surface ever moves.

Kendra: I think Earth's surface is always moving.

Tad: I think Earth's surface moves sometimes, mostly when there are earthquakes or volcanoes.

Violet: I think Earth's surface used to move a lot millions of years ago when the continents were in different places. Today it stays in one place.

Which person do you agree with the most? ____________ Explain your ideas about Earth's surface.

The best answer is Kendra: I think Earth's surface is always moving. Even though we usually can't feel it, the surface of Earth is always moving. This is due to the motion of tectonic plates that slowly slide over the surface of Earth, usually at a rate of only a few centimeters per year.

You will revisit your response to the Science Probe at the end of the lesson.

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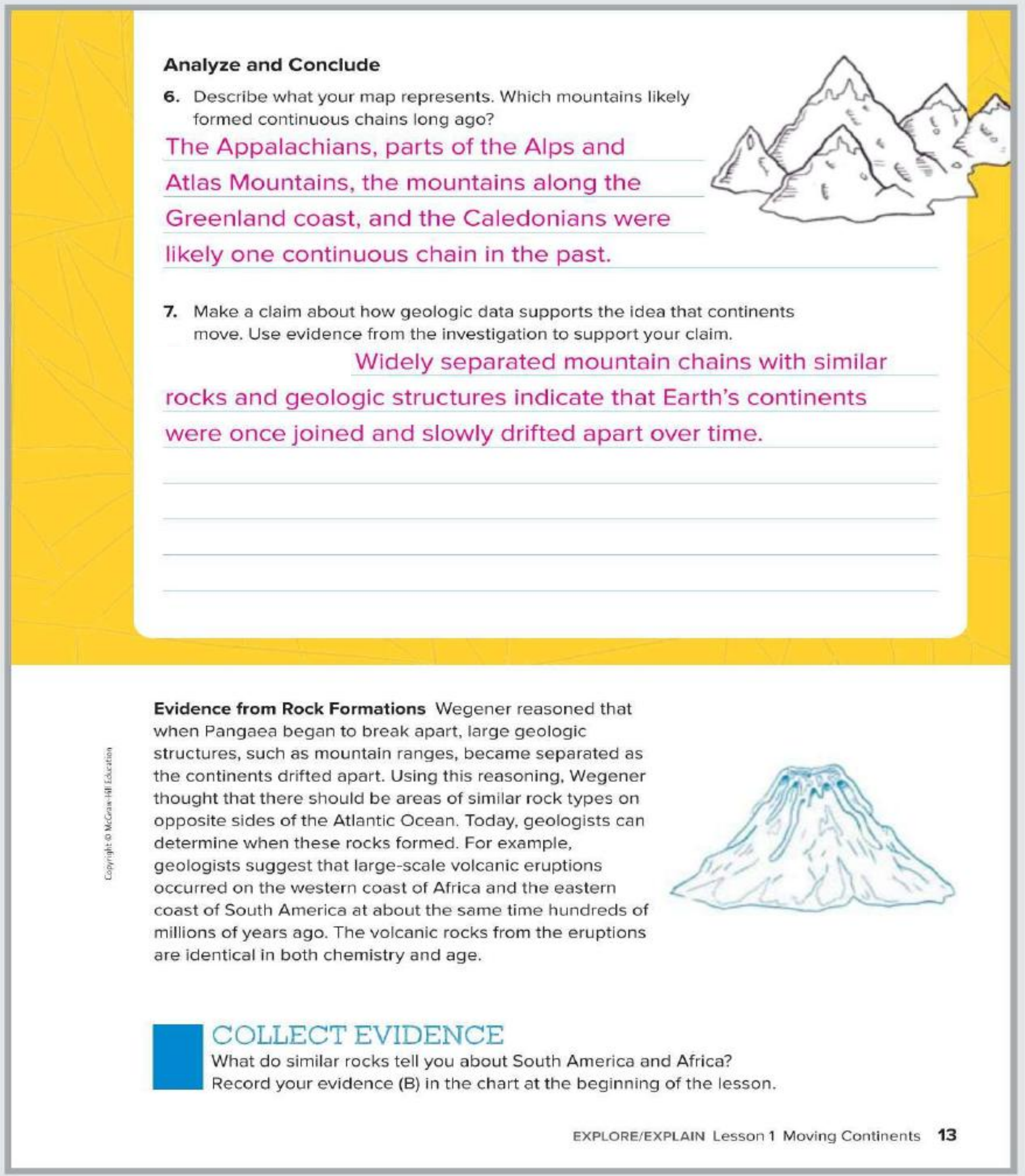
SCIENCE PROBE Lesson 1 Moving Continents 5

7	Explain the evidence and clues that support the continental drift theory: Glacial features & coal deposits	textbook, figures, 3D	13, 14

الأسئلة الموضوعية MCQ

- Explain the evidence and clues that support the continental drift theory: Glacial features & coal deposits
- textbook, figures, 3D
- 13, 14



Analyze and Conclude

6. Describe what your map represents. Which mountains likely formed continuous chains long ago?

The Appalachians, parts of the Alps and Atlas Mountains, the mountains along the Greenland coast, and the Caledonians were likely one continuous chain in the past.

7. Make a claim about how geologic data supports the idea that continents move. Use evidence from the investigation to support your claim.

Widely separated mountain chains with similar rocks and geologic structures indicate that Earth's continents were once joined and slowly drifted apart over time.

Evidence from Rock Formations Wegener reasoned that when Pangaea began to break apart, large geologic structures, such as mountain ranges, became separated as the continents drifted apart. Using this reasoning, Wegener thought that there should be areas of similar rock types on opposite sides of the Atlantic Ocean. Today, geologists can determine when these rocks formed. For example, geologists suggest that large-scale volcanic eruptions occurred on the western coast of Africa and the eastern coast of South America at about the same time hundreds of millions of years ago. The volcanic rocks from the eruptions are identical in both chemistry and age.

COLLECT EVIDENCE

What do similar rocks tell you about South America and Africa? Record your evidence (B) in the chart at the beginning of the lesson.

7	Explain the evidence and clues that support the continental drift theory: Glacial features & coal deposits	textbook, figures, 3D	13, 14

الأسئلة الموضوعية MCQ

Evidence from Glacial Features When Wegener was trying to piece Pangaea together, he studied sediments in South America, Africa, India, and Australia. Beneath these sediments, Wegener discovered 290-million-year old glacial grooves, or deep scratches in rocks made as glaciers moved across land.

THREE-DIMENSIONAL THINKING

Analyze the map below. The white areas show the locations of glacial grooves.

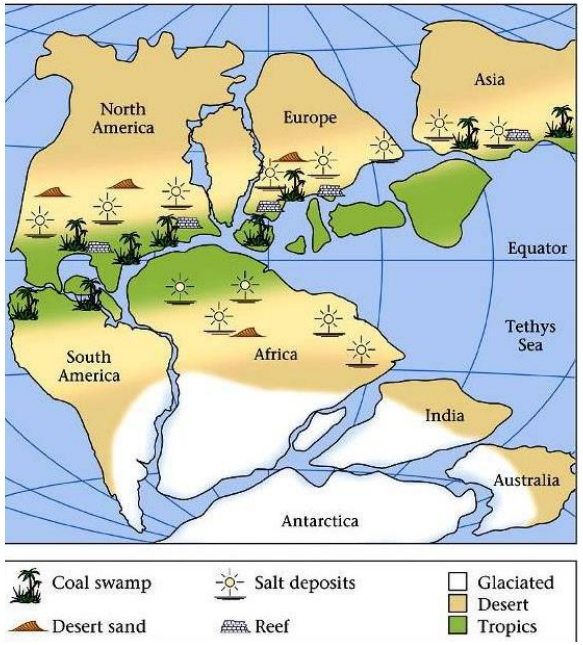
Interpret the map. Could ice caps, similar to the one that covers Antarctica today, exist on these continents in their present locations? How do **patterns** of glacial features provide evidence of continental drift?

These areas are too warm to have massive ice sheets today. If the Southern Hemisphere continents could be reassembled into Pangaea, the presence of an ice sheet would explain the glacial features on these continents today.

Evidence from Coal Deposits Wegener found additional evidence in rocks that the climates of some continents had changed drastically. For example, coal deposits have been found in Antarctica. Coal forms from the compaction of ancient swamp plants that grew in warm, wet regions. The presence of coal beds in Antarctica indicated that this frozen land once had a tropical climate. Wegener used this evidence to conclude that Antarctica must have been much closer to the equator sometime in the geologic past.

COLLECT EVIDENCE

Do South America and Africa share other geologic similarities? Record your evidence (C) in the chart at the beginning of the lesson.



8	Explain the evidence and clues that support the continental drift theory: fossils	textbook, figures, 3D	15, 16, 17, 21

الأسئلة الموضوعية MCQ

- explain the evidence and clues that support the continental drift theory: fossils
- textbook, figures, 3D
- 15, 16, 17, 21

How do fossils provide evidence that continents move?

LIFE SCIENCE Connection Animals and plants that live on different continents can be unique to that continent alone. Lions live in Africa but not in South America. Kangaroos live in Australia but not on any other continent. Because oceans separate continents, these animals cannot travel from one continent to another by natural means. However, fossils of similar organisms have been found on several continents separated by oceans.

Can you reconstruct the configuration of Gondwana, a large ancient continent that was made of many continents, using fossil evidence?

LAB Reconstructing Gondwana

Safety

Materials

fossil evidence handout
colored pencils
glue stick
scissors

Procedure

1. Read and complete a lab safety form.
2. Obtain a fossil evidence handout from your teacher. Determine what color or symbol represents each fossil.
3. With scissors, carefully cut out each landmass.
4. Use the puzzle pieces of Earth's landmasses to construct a model of how the continents were once configured in the past.
5. When you are sure of your arrangement, glue your model into your Science Notebook. Create a sketch of your Gondwana in the Data and Observations section.

Data and Observations

Check students' sketches for accuracy.

الأسئلة الموضوعية MCQ

8	Explain the evidence and clues that support the continental drift theory: fossils	textbook, figures, 3D	15, 16, 17, 21

Analyze and Conclude

6. Which fossils have been found on the landmasses that made up Gondwana? On which present-day continents are they located?

Glossopteris fossils have been found on all of the landmasses. *Kannemeyerid* fossils have been found in South America and Africa. *Lystrosaurus* fossils have been found in Africa, India, and Antarctica. *Mesosaurus* fossils have been found in South America and Africa.

7. **READING Connection** Now, read the text on the following page. How does this information compare and contrast to the information gained from this lab?

Comparisons may include the types of fossils used as evidence and the configuration of the continents. Students might note that the text provides Wegener's reasoning, while the lab does not.

8. Make a claim about how fossil evidence supports the idea that continents move. Use evidence from the lab to support your claim.

Sample answer: The types and locations of fossils found on multiple continents now separated by vast oceans support the hypothesis that these continents were once joined but have moved away from each other.

Evidence from Fossils As you just discovered in the Lab *Reconstructing Gondwana*, fossils provide compelling evidence for continental drift. Fossils of *Glossopteris*, shown below, have been discovered in rocks from South America, Africa, India, Australia, and Antarctica. These continents are far apart today. Wegener reasoned that the area separating these fossils was too large to have a single climate. Also, because *Glossopteris* grew in temperate climates, these places must have been closer to the equator.

Which of the continents would not support *Glossopteris* growth today?

In addition to *Glossopteris* fossils, Wegener also used fossils of various reptiles to support his hypothesis. Fossils of a coastal reptile, *Mesosaurus*—shown to the right—and two terrestrial reptiles, *Cynognathus* and *Lystrosaurus*, have been found on continents that are now separated by vast oceans. Wegener reasoned that these creatures could not have swam the distances that now separate the fossil locations, which added to his cache of evidence.

The similarity of rocks and fossils on continents now several thousand kilometers apart and separated by wide oceans suggests that the continents have not always been in their present positions. They must have been joined in the past.

COLLECT EVIDENCE

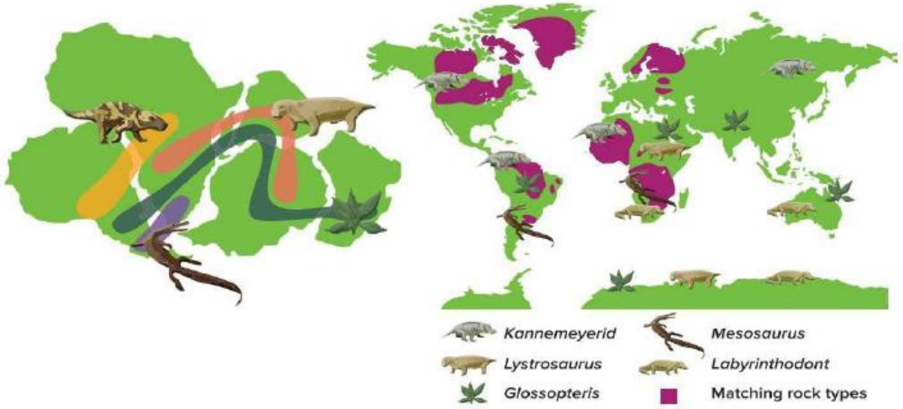
What fossil evidence is similar between South America and Africa? Record your evidence (D) in the chart at the beginning of the lesson.

8	Explain the evidence and clues that support the continental drift theory: fossils	textbook, figures, 3D	15, 16, 17, 21

الأسئلة الموضوعية MCQ

Three-Dimensional Thinking

Alfred Wegener found different types of evidence to help support the hypothesis of continental drift. He found fossils of a reptile called *Mesosaurus* on land areas that were once part of Pangaea. The locations where the fossils are found are shown in the figure below.



2. Which statement below describes how the presence of *Mesosaurus* fossils in South America and Africa helps support the hypothesis of continental drift?

A A reptile would not have been able to swim across an entire ocean, so the landmasses must have been closer together.

B It shows that the climates of both continents were different during the time that *Mesosaurus* lived.

C This suggests that South America and Africa moved apart, but India, Antarctica, and Australia remained stationary.

D It shows that *Mesosaurus* could only exist on South America and Africa because all other continents were covered in ice.

Alfred Wegener found different types of evidence to help support his hypothesis, studying the map below, Which of the following statements describe how the presence of Mesosaurus fossils in South America and Africa helps support his hypothesis?

Dutcomes Covered

I.2.3.05.005

A reptile would not have been able to swim across an entire ocean, so the landmasses must have been closer together

It shows that the climates of both continents were different during the time that Mesosaurus lived

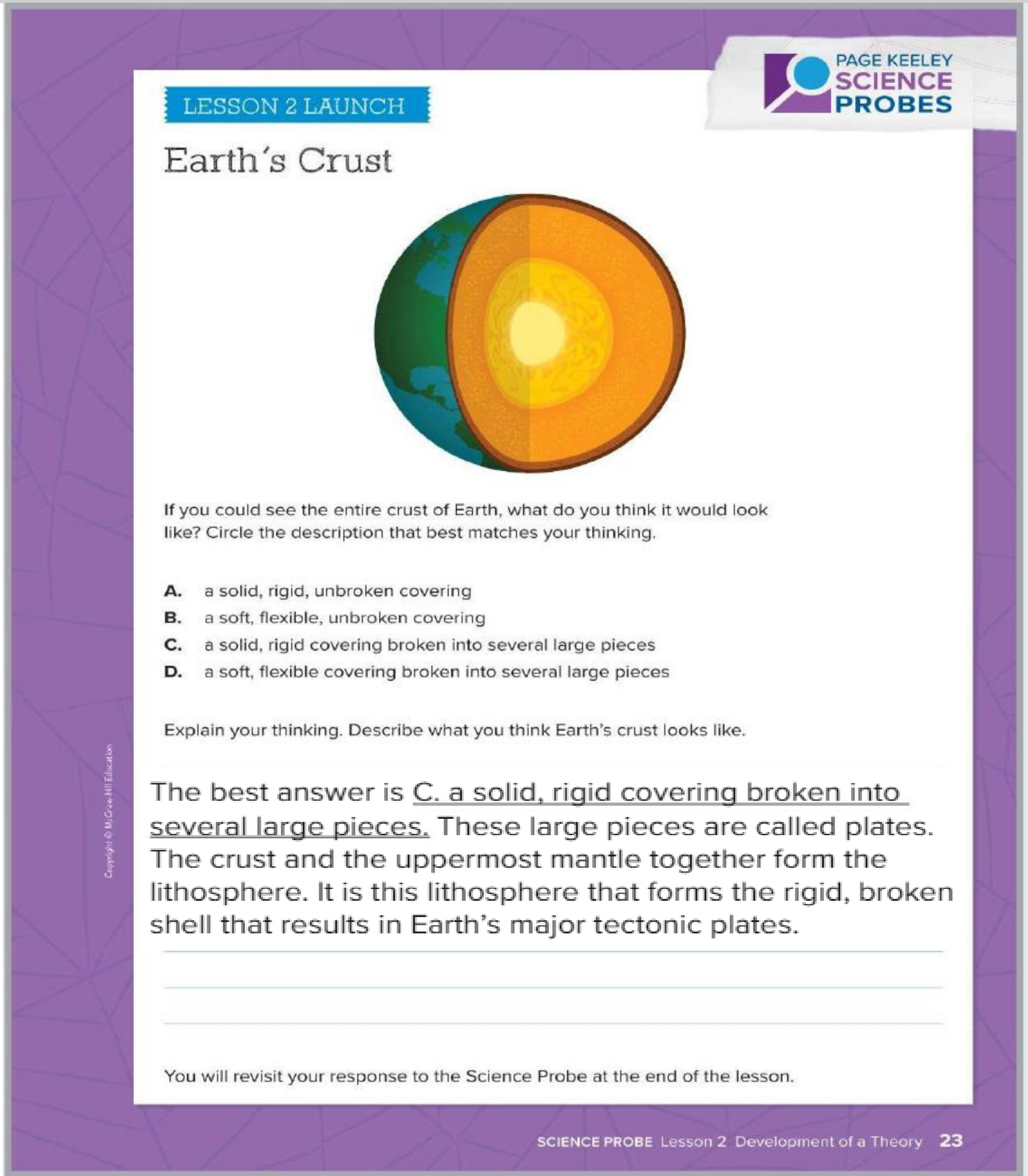
This suggests that all continents moved apart, except India and Antarctica remained stationary

It shows that Mesosaurus could only exist on South America and Africa because all the other continents were covered in ice

9	Describe Earth's crust and components	textbook, figures, investigation	23, 34

الأسئلة الموضوعية MCQ

- Describe Earth's crust and components
- textbook, figures, investigation
- 23, 34



PAGE KEELEY SCIENCE PROBES

LESSON 2 LAUNCH

Earth's Crust

If you could see the entire crust of Earth, what do you think it would look like? Circle the description that best matches your thinking.

A. a solid, rigid, unbroken covering
B. a soft, flexible, unbroken covering
C. a solid, rigid covering broken into several large pieces
D. a soft, flexible covering broken into several large pieces

Explain your thinking. Describe what you think Earth's crust looks like.

The best answer is C. a solid, rigid covering broken into several large pieces. These large pieces are called plates. The crust and the uppermost mantle together form the lithosphere. It is this lithosphere that forms the rigid, broken shell that results in Earth's major tectonic plates.

You will revisit your response to the Science Probe at the end of the lesson.

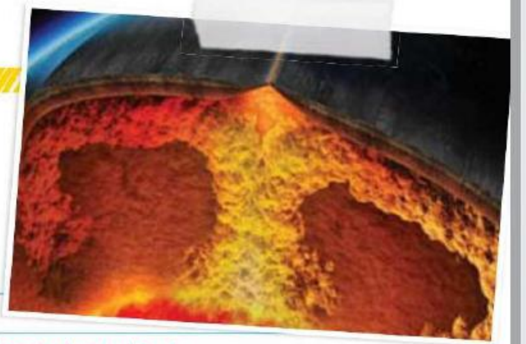
9	Describe Earth's crust and components	textbook, figures, investigation	23, 34

الأسئلة الموضوعية MCQ

- Describe Earth's crust and components?
- solid, rigid covering broken into several large pieces.
- These large pieces are called plates.
- The crust and the uppermost mantle together form the lithosphere.
- It is this lithosphere that forms the rigid, broken shell that results in earth's major tectonic plates.

So how do continents "drift?"

Why would the seafloor age as you move further away from mid-ocean ridges? In the 1960s, scientists proposed a new process that helped explain ocean-floor features, ages, and continental drift. This process is called seafloor spreading. **Seafloor spreading** is the process by which new oceanic crust continuously forms along mid-ocean ridges and is destroyed at ocean trenches. Why does this process occur?



INVESTIGATION

Seafloor Spreading

GO ONLINE Watch the video *Seafloor Spreading.*

What causes Earth's crust to spread?

Hot rock rises, heated by Earth's core. Near the surface, the rock spreads in two directions and goes sideways. It begins to lose heat. Eventually the much cooler rock sink backs down. Through this spreading process Earth's crust is very slowly dragged apart.

The Conveyor Belt Rock under Earth's surface is heated by Earth's hot interior. When the seafloor spreads, the rock below the seafloor becomes molten. Molten rock below Earth's surface is called **magma.** Magma is less dense than the surrounding rock and rises upward through cracks in Earth's crust along the mid-ocean ridge. When magma erupts onto Earth's surface it is called **lava.** As lava cools and crystallizes, it forms new oceanic crust. Two halves of the oceanic crust spread apart slowly, and move apart like a conveyor belt. As the seafloor continues to spread apart, the older oceanic crust moves away from the mid-ocean ridge and sinks at ocean trenches.

A mechanism to explain continental drift was finally discovered long after Wegener proposed his hypothesis. Continents do not plow through the solid rock on the seafloor. Instead, continents move as the seafloor spreads along a mid-ocean ridge!

COLLECT EVIDENCE

What is the relationship between seafloor spreading, mid-ocean ridges, and ocean trenches? Record your evidence (C) in the chart at the beginning of the lesson.

10	Explain ocean features formation	textbook, figures, investigation	30, 32

الأسئلة الموضوعية MCQ

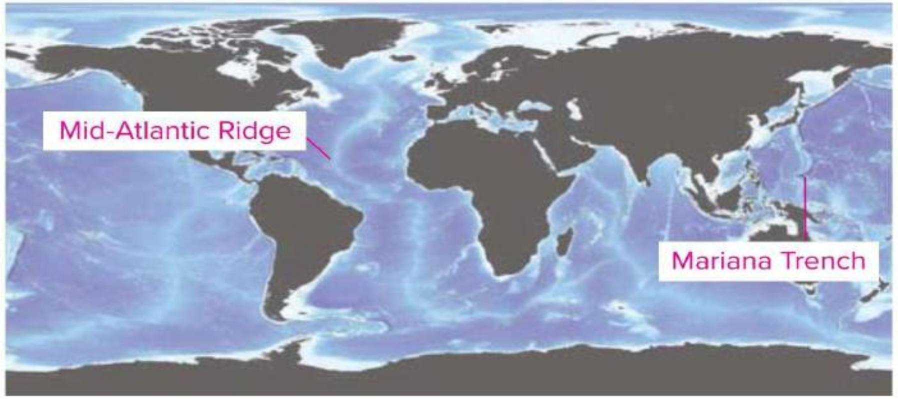
- Explain ocean features formation
- textbook, figures, investigation
- 30,32

Ocean Floor Topography Once ocean depths were determined using sonar, scientists used these data to create a topographic map of the seafloor, much like you did in the *Simulating Sonar* lab. These new topographic maps uncovered a few surprising landforms. Let's dive in!

INVESTIGATION

Under the Sea

Examine the map below. The different colors indicate changes in water depths. Light blue indicates shallower depths; dark blue indicates deeper depths. The land regions are shaded in black.

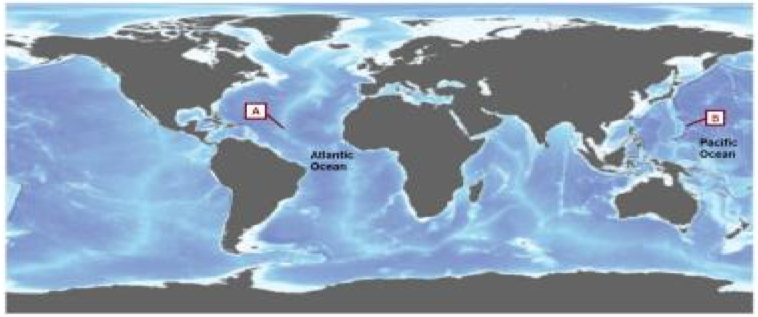


1. Notice the light blue linear features that run along the ocean floors? These are vast mountain ranges deep below the ocean's surface called **mid-ocean ridges.** One such mountain range—the Mid-Atlantic Ridge—runs through the center of the Atlantic Ocean. Can you locate the Mid-Atlantic Ridge on the map above? Label it on the map.
2. The maps also revealed that underwater mountain chains had counterparts called ocean trenches. **Ocean trenches** are deep, underwater troughs on the seafloor. The Mariana Trench in the Pacific Ocean is the deepest landform on Earth. It is so deep it could fit Mount Everest with six Empire State buildings stacked on top! Can you identify an ocean trench on the map above? Label it on the map.
3. Return to the profile you created in the *Simulating Sonar* lab. Can you identify a mid-ocean ridge on your seafloor? Label it on your profile.

10	Explain ocean features formation	textbook, figures, investigation	30, 32

الأسئلة الموضوعية MCQ

Study the map below, which of the following is correct?



arning Outcomes Covered

- SCI.2.3.05.002
- SCI.2.3.05.005

A is an example of the ocean trenches

B is a vast mountain ranges deep below the ocean's surface called mid-ocean ridges

B is the marina trench which is the deepest landform on Earth

A is a shallow-water ocean features and landforms

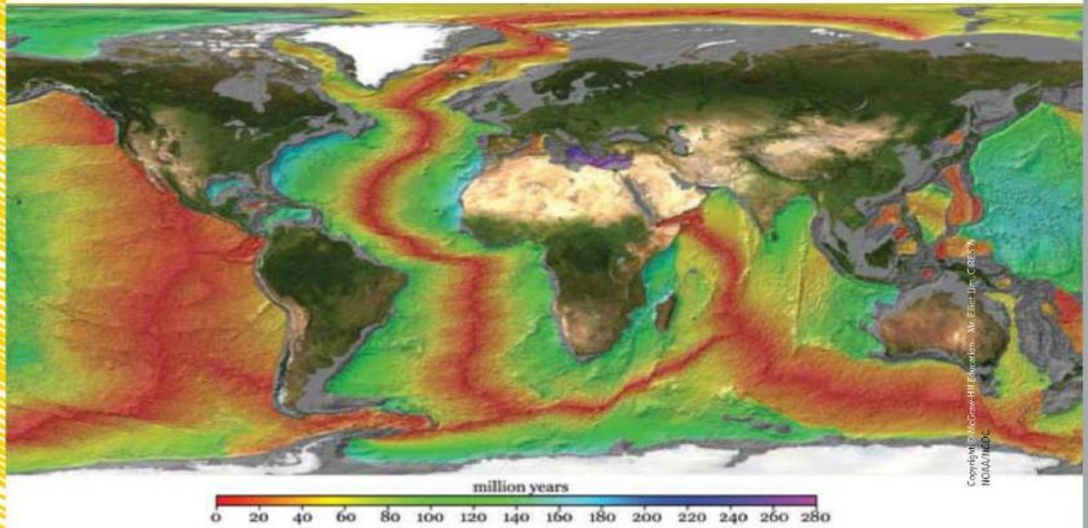
What pattern can be found on the seafloor?

Rock samples from the seafloor also revealed a surprise. Scientists were able to determine the age of the ocean floor and create isochron maps. An isochron is an imaginary line on a map that shows points that have the same age—that is, they formed at the same time. These isochron maps revealed an interesting pattern.

INVESTIGATION

Stripes on the Seafloor

Study the isochron map of the seafloor. Each colored band on this isochron map represents the age of that strip of crust.



1. What pattern do you observe?
Students should note that the colored bands are symmetrical on either side of a mid-ocean ridge.

11	Construct and explain the patterns of plate tectonics and their movement speed	textbook, figures, 3D	36, 39

الأسئلة الموضوعية MCQ

- Construct and explain the patterns of plate tectonics and their movement speed
- textbook, figures, 3D
- 36, 39

What is the theory of plate tectonics?

By the late 1960s, the concepts of continental drift and seafloor spreading led to a more complete theory called plate tectonics. The theory of **plate tectonics** states that Earth's surface is made of rigid slabs of rock, or plates, that move with respect to each other.

THREE-DIMENSIONAL THINKING

Analyze the tectonic plate map below. Compare this map with the topographic map in the *Under the Sea* investigation and the isochron map in the *Stripes on the Seafloor* investigation.

What **patterns** do you notice between the three maps? Using the concepts you've learned in this lesson, **construct an explanation** for these patterns in your Science Notebook.

Over billions of years, continents have moved great distances, collided, and spread apart. Tectonic plates move slowly, only 1–9 cm per year. But these massive plates have so much force they can build tall mountains, form deep valleys, and rip Earth's surface apart. Because tectonic plates move very slowly, most changes to Earth's surface take a long time. But some changes, like earthquakes and volcanic eruptions, occur very quickly and violently. You will learn about these changes in the following lesson.

COLLECT EVIDENCE

How is seafloor topography evidence of plate tectonics? Record your evidence (D) in the chart at the beginning of the lesson.

11	Construct and explain the patterns of plate tectonics and their movement speed	textbook, figures, 3D	36, 39

الأسئلة الموضوعية MCQ

$$\text{rate} = \frac{\text{distance}}{\text{time}}$$

$$\text{rate} = \frac{\text{distance}}{\text{time}}$$

$$0.006 = \frac{100\,m}{\text{time}}$$

$$\text{time} = \frac{100}{0.006}$$

$$= 16667 \text{ years}$$

Three-Dimensional Thinking

For many years, scientists thought that the ocean floor was flat. During World War II, U.S. Navy ships patrolled the oceans. A captain of one of the ships, Harry Hess, was also a geologist. He used a new device called an echo sounder to map the ocean floor. The echo sounder data showed that the ocean floor had mountains and volcanoes in addition to flat areas.

When scientists took samples of the rocks that made up the ocean floor, they discovered something surprising. The rocks closer to the mid-ocean ridge were younger in age than the rocks far away from the mid-ocean ridge. They concluded that this difference in age was another way to support the theory of plate tectonics.

2. **HISTORY Connection** Which best describes how the scientists could explain their observations?

- **A** They thought that sediment washing in from the shore formed the ocean floor, and continued to build out from the shore.
- **B** They thought that strong ocean waves pushed the younger rock material toward the middle of the ocean.
- **C** They thought that wave erosion at the shore removed the younger rock layers that were on top of the older rock layers.
- **D** They thought the young rock formed at the mid-ocean ridge and pushed the older rock toward the shore.

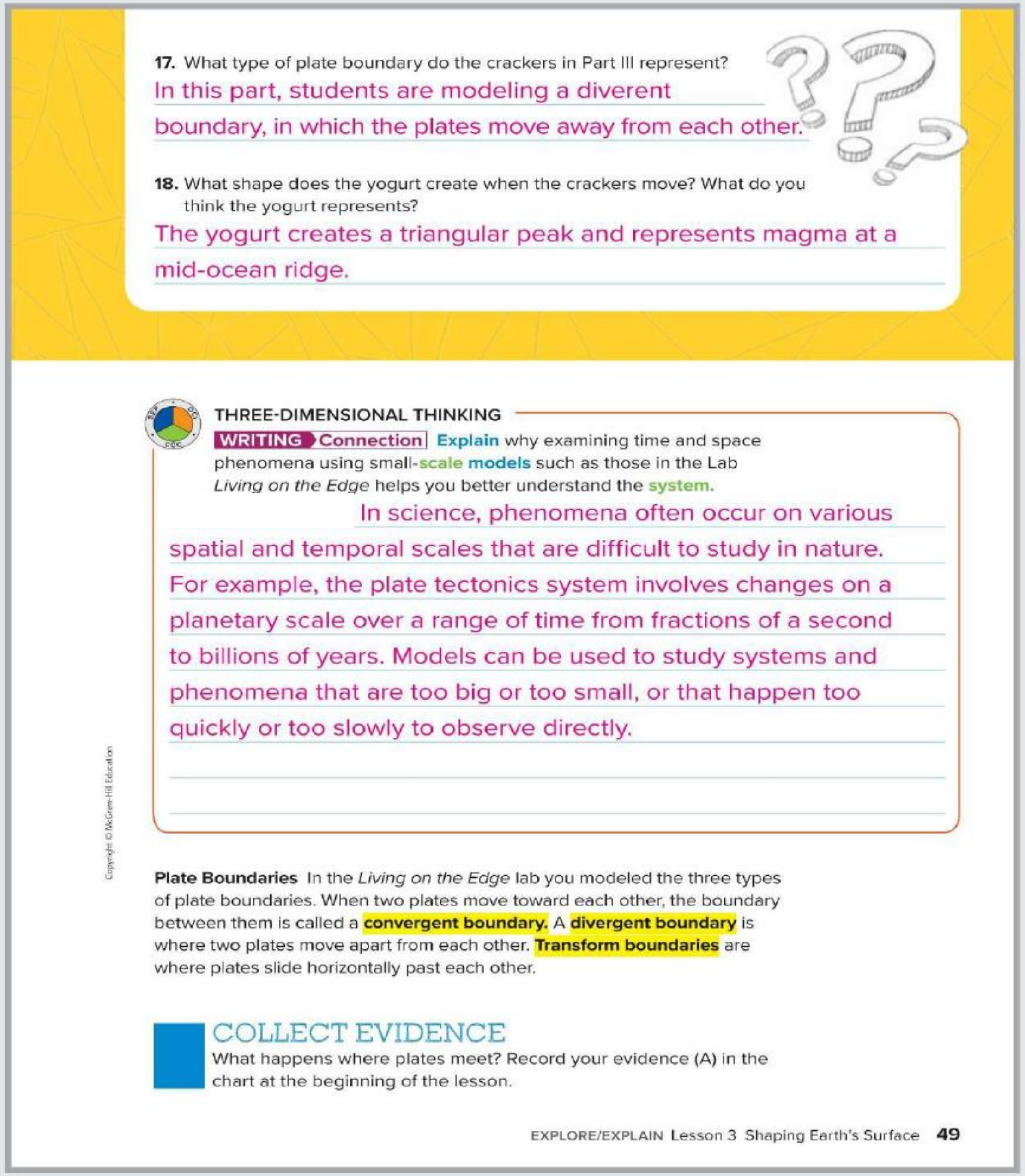
3. **MATH Connection** A continent travels 0.006 m/year. How long would it take the continent to travel 100 m?

- **A** 600 years
- **B** 16,667 years
- **C** 60,000 years
- **D** 167 years

12	Explain how features on Earth's surface occur: (land or seafloor)	textbook, figures, investigation	49, 50, 52

الأسئلة الموضوعية MCQ

- Explain how features on Earth's surface occur: (land or seafloor)
- textbook, figures, investigation
- 49, 50, 52
- Explain how features on Earth's surface occur land?
- Majestic mountain ranges are one feature produced by the slow and large-scale motion of earth's plates.
- Fold mountains create by compressional force such as the Himalayas.



17. What type of plate boundary do the crackers in Part III represent?

In this part, students are modeling a diverent boundary, in which the plates move away from each other.

18. What shape does the yogurt create when the crackers move? What do you think the yogurt represents?

The yogurt creates a triangular peak and represents magma at a mid-ocean ridge.

THREE-DIMENSIONAL THINKING

WRITING Connection **Explain** why examining time and space phenomena using small-**scale** **models** such as those in the Lab *Living on the Edge* helps you better understand the **system.**

In science, phenomena often occur on various spatial and temporal scales that are difficult to study in nature. For example, the plate tectonics system involves changes on a planetary scale over a range of time from fractions of a second to billions of years. Models can be used to study systems and phenomena that are too big or too small, or that happen too quickly or too slowly to observe directly.

Plate Boundaries In the *Living on the Edge* lab you modeled the three types of plate boundaries. When two plates move toward each other, the boundary between them is called a **convergent boundary.** A **divergent boundary** is where two plates move apart from each other. **Transform boundaries** are where plates slide horizontally past each other.

COLLECT EVIDENCE

What happens where plates meet? Record your evidence (A) in the chart at the beginning of the lesson.

12	Explain how features on Earth's surface occur: (land or seafloor)	textbook, figures, investigation	49, 50, 52

الأسئلة الموضوعية MCQ

How do large mountain ranges form on land?

The direction of motion of Earth's plates creates a variety of features at the boundaries between the plates. Majestic mountain ranges are one feature produced by the slow and large-scale motion of Earth's plates. In the following activities you will model the formation of two types of mountains—fold mountains and fault-block mountains.

LAB Fold Mountains

Brainstorm

Before you begin the lab, predict what type of plate motion might produce these features. Record your thoughts below.

: Colliding plates at a convergent plate boundary produce fold mountains as the plates crumple into each other.

Safety

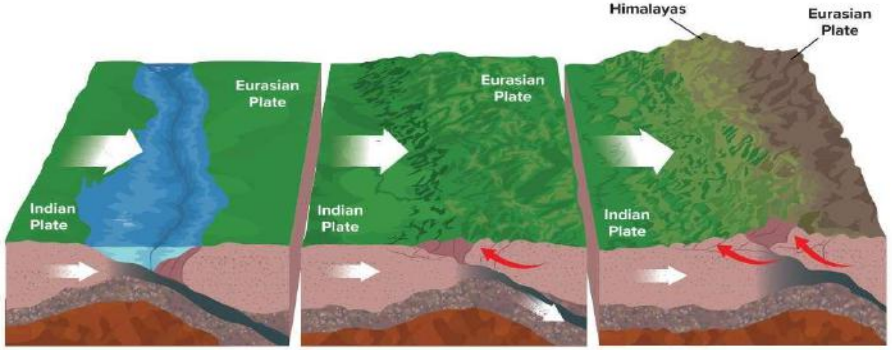
Materials

waxed paper
colored dough
plastic knife

Procedure

1. Read and complete a lab safety form.
2. On a piece of waxed paper, shape four balls of different colored dough into rectangles about 1 cm thick.

Fold Mountains As you just modeled in the *Fold Mountains* lab, squeezing—or compressional—forces can create mountains. When two continental plates collide at a convergent boundary large mountain ranges form. The tectonic plates are under extreme pressure and fold or crumple upward, forming fold mountains. But the mountains form slowly and in stages over millions of years. The Himalayas, for example, formed as the Indian Plate converged with the Eurasian Plate, as shown in the figure below. The Himalayas are the largest and highest mountain range in the world, and they are still growing!



The Andes are also an example of fold mountains. As the denser Nazca Plate collides with the South American Plate, it is forced under the South American Plate in a process called **subduction.** This causes the leading edge of the South American Plate to fold upward. The Andes, shown to the right, are the longest mountain range on Earth.

Not all of Earth's mountains are fold mountains. You have probably heard of faults. A **fault** is a break in Earth's crust along which movement occurs. What you might not be aware of is that faults can create mountains.

COLLECT EVIDENCE

How did the Andes form? Record your evidence (B) in the chart at the beginning of the lesson.

13	List the effects of: time, weathering, and erosion on mountain ranges shapes and sizes	textbook, figures, investigation	54, 55

الأسئلة الموضوعية MCQ

- List the effects of: time, weathering, and erosion on mountain ranges shapes and sizes
- textbook, figures, investigation
- 54, 55

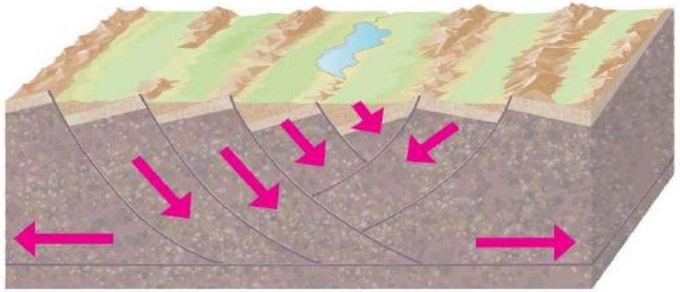
Analyze and Conclude

7. How does the thickness of the crust relate to the height of the mountains?
In general, as crust thickens mountains grow higher. Fault-block mountains are an exception to this rule.

8. Make a claim about how you think fault-block mountains are produced. Use evidence from the experiment to support your claim.
Fault-block mountains form as tension pulls apart the crust. Gravity causes the "blocks" to slide over onto their side. The high parts that remain extending up are the mountains, and the low parts between the books are the valleys between the mountains.

Fault-Block Mountains Where plates move apart, tension stresses stretch Earth's crust. Sometimes tension stresses within a continent create mountains. As tension pulls crust apart, faults form. At the faults, some blocks of crust fall and the others rise. The Basin and Range Province in Nevada, Utah, California, Arizona, and northwestern Mexico consists of dozens of parallel fault-block mountains that are oriented north to south. The tension that created the mountains pulled in the east-west directions.

THREE-DIMENSIONAL THINKING
Draw arrows on the image below to model the cause of fault-block mountains and the movement of crust along the faults.



13	List the effects of: time, weathering, and erosion on mountain ranges shapes and sizes	textbook, figures, investigation	54, 55

الأسئلة الموضوعية MCQ

- List the effects of: time, weathering, and erosion on mountain ranges shapes and sizes?
- Weathering and erosion gradually wear the mountains over time.
- The Appalachian mountains are shorter and smoother than the rocky mountains because they are older.

INVESTIGATION

A Tale of Two Mountain Ranges

Mountains are important structures of the North American landscape. Compare the Appalachian Mountains (left) to the Rocky Mountains (right) below. Both are fold mountains, formed when continental plates collided.

1. How do the shapes and sizes of the mountains ranges compare?
The Appalachians are low and gently rounded. The Rocky Mountains are high and have sharp peaks.

2. Which mountain range do you think is older? Why?
The Appalachian Mountains are older than the Rocky Mountains. They have been worn down over time.

Weathering and Erosion Mountains do not last forever. Weathering and erosion gradually wear them down over time. The Appalachian Mountains are shorter and smoother than the Rocky Mountains because they are older. They formed hundreds of millions of years ago. The Rockies formed just 50 to 100 million years ago. You'll learn more about how weathering and erosion gradually change Earth's surface in the next lesson.

GO ONLINE for an additional opportunity to explore!

Want to learn more about mountain ranges in North America? Then perform the following activity.

☐ **Create** a presentation about a mountain range of your choice in the **Lab** *What tectonic processes are most responsible for shaping North America?*

14	Understand the effects quick changes can have on Earth's surface from earthquakes (e.g.: landslides, fault zones, tsunamis), and others like meteoroid strikes that create impact craters	textbook, figures, table	62, 63

الأسئلة الموضوعية MCQ

- Understand the effects quick changes can have on Earth's surface from earthquakes (e.g.: landslides, fault zones, tsunamis), and others like meteoroid strikes that create impact crater
- textbook, figures, table
- 62,63

When the Ground Shakes An **earthquake** is the rupture and sudden movement of rocks along a break or a crack in Earth's crust. Earthquakes result from the buildup and rapid release of stress along active plate boundaries. An earthquake can change Earth's surface quickly and dramatically. We see the results of earthquakes in faults, landslides, and tsunamis.

Faults associated with earthquakes can be visible at Earth's surface. Natural and human-made features that cross the fault, such as streams and railroads, are shifted by earthquakes. Some faults, such as the San Andreas Fault in California, can be more than 1,000 km long. The San Andreas Fault is not a single fault. Many smaller faults exist in the area around the San Andreas Fault. An area of many fractured pieces of crust along a large fault is called a **fault zone.** ▶

◀ Earthquakes can also trigger landslides, quickly changing Earth's surface. A **landslide** is the rapid downhill movement of soil, loose rocks, and boulders. The vibrations of an earthquake can cause large amounts of Earth materials to separate from a slope. Gravity quickly causes materials to come crashing downhill. The 2016 Kumamoto earthquakes in Japan triggered numerous landslides, including the one shown in the photograph to the left.

Underwater earthquakes can cause catastrophic tsunamis. A **tsunami** is a wave that forms when an ocean disturbance suddenly moves a large volume of water. As blocks of crust move up along a fault, the water above is displaced and forms a gigantic wave. Tsunamis can quickly destroy coastlines. This photo was taken five years after the 2004 Indian Ocean earthquake and tsunami, and the destruction is still clearly visible. ▶

COLLECT EVIDENCE

Why does the western coast of South America experience earthquakes? Record your evidence (D) in the chart at the beginning of the lesson.

14	Understand the effects quick changes can have on Earth's surface from earthquakes (e.g.: landslides, fault zones, tsunamis), and others like meteoroid strikes that create impact craters	textbook, figures, table	62, 63

الأسئلة الموضوعية MCQ

Which of the following is the correct name for the Earth's feature shown in the figure below due to the impact of meteoroid?

ning Outcomes Covered

- SCI.2.3.05.002
- SCI.2.3.05.004

Impact craters

Impact holes

Impact fracture

Impact canyon

Besides plate motion, what else creates major features on Earth?

Not all major features on Earth's surface are caused by plate motion. For example, craters are not formed by the movement of tectonic plates. Instead, they form when a meteoroid from space strikes Earth's surface. These impacts leave giant, circular depressions in Earth's surface, called **impact craters.** There are more than 170 impact craters on Earth.

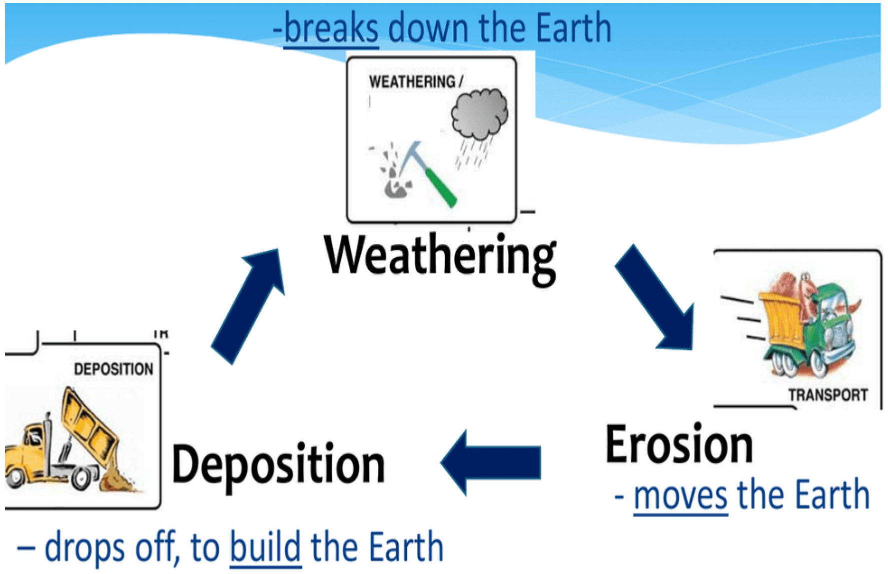
Like volcanic eruptions and earthquakes, meteoroid impacts are catastrophic changes that create surface features over a very short period of time. And just like mountains and other landforms on Earth, impact craters are subject to further changes over time. The Barringer Crater, shown above, is estimated to have lost between 15–20 m in height due to erosion and weathering processes on Earth.

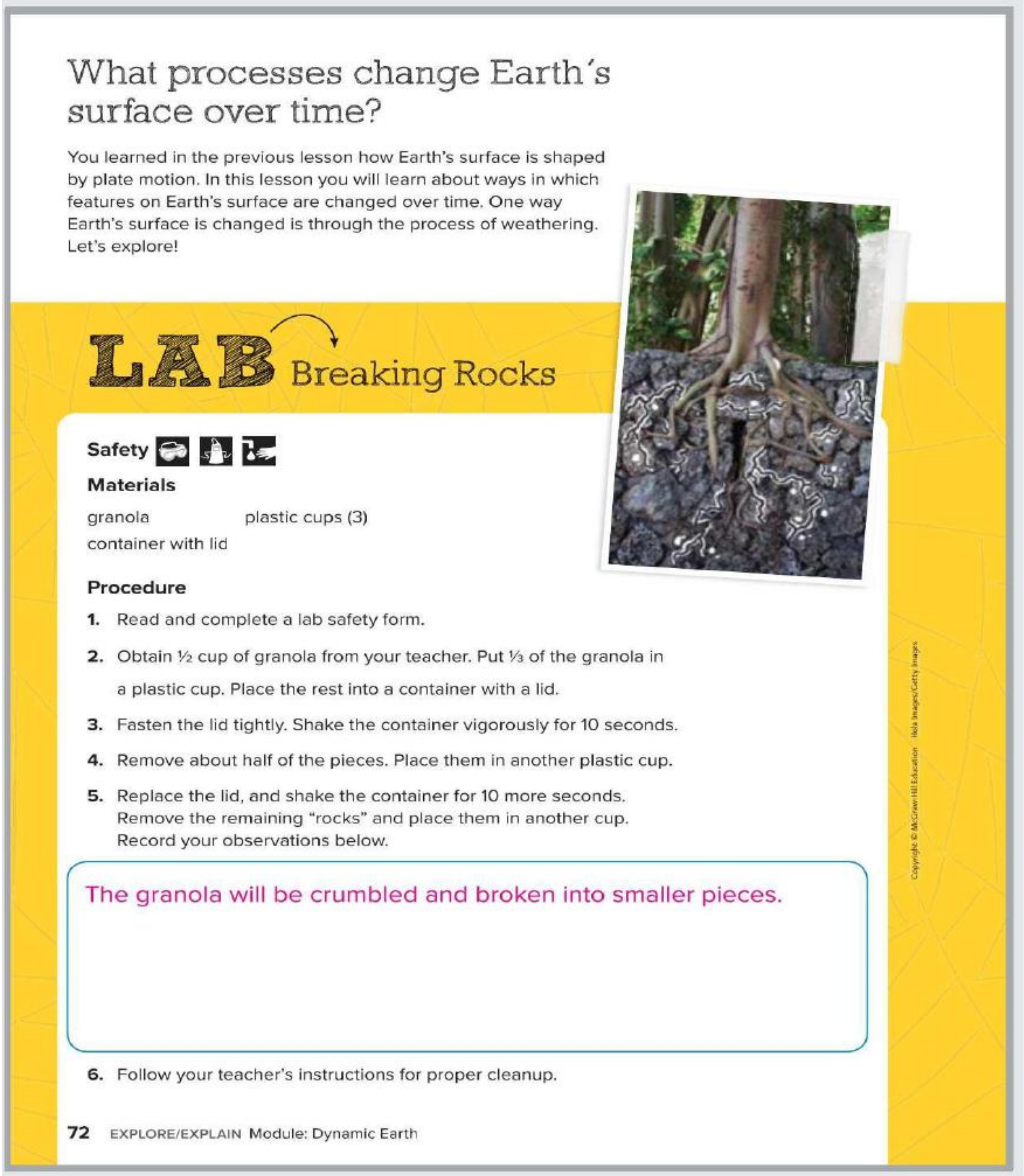
Canyons, such as the Fish River Canyon shown below, are also not a result of plate motion. These landforms are created by weathering and erosion over time. You will learn more about these features and the processes that create and shape them in the next lesson.

15	Differentiate between weathering, erosion, and deposition	Textbook, figures, investigation, lab	72, 73, 74, 75, 76

الأسئلة الموضوعية MCQ

- Differentiate between weathering, erosion, and deposition
- Textbook, figures, investigation, lab
- 72, 73, 74, 75, 76





What processes change Earth's surface over time?

You learned in the previous lesson how Earth's surface is shaped by plate motion. In this lesson you will learn about ways in which features on Earth's surface are changed over time. One way Earth's surface is changed is through the process of weathering. Let's explore!

LAB Breaking Rocks

Safety

Materials

granola
container with lid
plastic cups (3)

Procedure

1. Read and complete a lab safety form.
2. Obtain ½ cup of granola from your teacher. Put ⅓ of the granola in a plastic cup. Place the rest into a container with a lid.
3. Fasten the lid tightly. Shake the container vigorously for 10 seconds.
4. Remove about half of the pieces. Place them in another plastic cup.
5. Replace the lid, and shake the container for 10 more seconds. Remove the remaining "rocks" and place them in another cup. Record your observations below.

The granola will be crumbled and broken into smaller pieces.

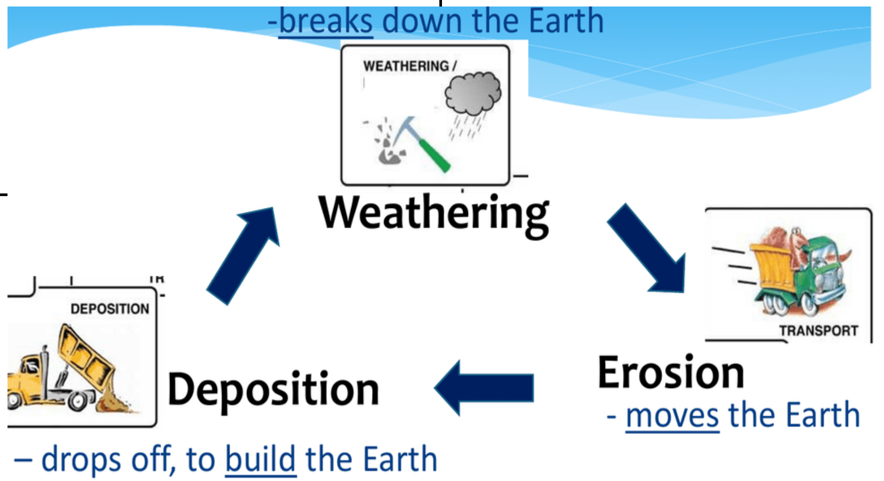
6. Follow your teacher's instructions for proper cleanup.

15	Differentiate between weathering, erosion, and deposition	Textbook, figures, investigation, lab	72, 73, 74, 75, 76

الأسئلة الموضوعية MCQ

Differentiate between weathering, erosion, and deposition?

process	weathering	erosion	deposition
Definition	any natural process that changes objects on earth's surface over time	the moving of weathered, or sediment, from one location to another	the laying down or settling of eroded material



الأسئلة الموضوعية MCQ

15	Differentiate between weathering, erosion, and deposition	Textbook, figures, investigation, lab	72, 73, 74, 75, 76

Analyze and Conclude

7. Compare and contrast the "rocks" from each cup.

the rocks are alike in that they are still rocks. They differ in that they are smoother, smaller, and more broken the more they are shaken.

8. Are rocks on Earth's surface stable? What might cause rocks to change? Explain your reasoning.

Rocks seem stable, however they can change over time. For example, as rocks hit against each other, they can break into smaller pieces.

Weathering Any natural process that changes objects on Earth's surface over time is called **weathering.** Two types of weathering can occur: physical and chemical. Physical weathering breaks rocks into small pieces without changing the composition or chemical make-up of the rock.

LIFE SCIENCE Connection Plants and animals can physically weather rocks. Animals that live in soil create holes in the soil where water enters and causes weathering. Animals burrowing through loose rock, like this mole, can also help to break down rocks as they dig.

The roots of plants can grow into cracks in rocks, as shown on the previous page. The force from the growing roots can pry the rock open.

What happens to a rock when it is exposed to chemical weathering?

Want more information?
Go online to read more about how weathering, erosion, and deposition change Earth's surface over time.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

LAB Rock Reactions

Safety

Materials

- magnifying lens
- rocks
- droppers (2)
- water
- hydrochloric acid
- watch glasses (3)

Procedure

1. Read and complete a lab safety form.
2. Use a magnifying lens to carefully examine the rocks provided by your teacher. Note details such as color, texture, and size of grains.
3. Place each rock on a watch glass. Use a dropper to place several drops of water on each rock.
4. Observe what happens to each rock. Record your observations in the Data and Observations section below.
5. Use a different dropper to place several drops of dilute hydrochloric acid on each rock. Again, record your observations.
6. Follow your teacher's instructions for proper cleanup.

Data and Observations

When water is placed on the rocks, no reaction occurs. When hydrochloric acid is placed on one of the rocks (limestone), bubbles form. When hydrochloric acid is placed on the other two rocks (basalt and gneiss), no reaction occurs.

15	Differentiate between weathering, erosion, and deposition	Textbook, figures, investigation, lab	72, 73, 74, 75, 76

الأسئلة الموضوعية MCQ

Analyze and Conclude

7. Did either substance react with one or more of the rocks? If so, which substance? And, how did you know a reaction occurred?

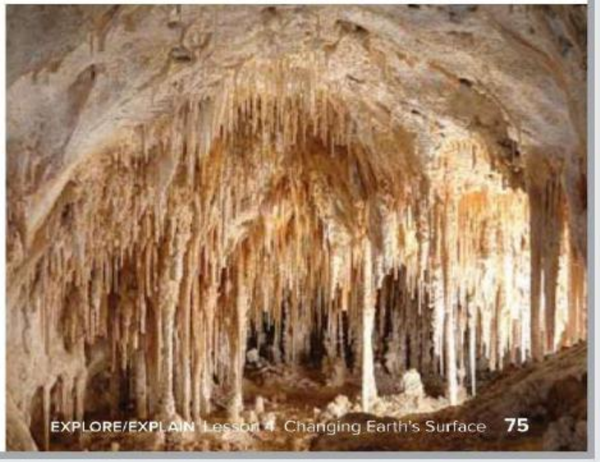
The hydrochloric acid reacted with one of the rocks (limestone). Bubbles on the rock indicated that a chemical reaction occurred.

8. Predict what might happen to rocks exposed to such a substance in the environment over time.

The rocks would undergo chemical weathering. Over time, parts of the rocks (calcium carbonate in limestone) would dissolve and the remaining parts of the rocks would turn into sediment.

PHYSICAL SCIENCE Connection Chemical weathering can be caused by reactions between rock and the chemicals in air and water. Water is important in chemical weathering because most substances dissolve in water. The minerals that make up most rocks dissolve very slowly in water. Sometimes the amount that dissolves over several years is so small that it seems as though the mineral does not dissolve at all.

For a rock, the process of dissolving happens when minerals in the rock break into smaller parts in solution. Have you ever wondered how caves form? When carbon dioxide in the air mixes with rainwater, a weak acid forms. Some of this rainwater becomes groundwater. As acidic groundwater seeps through rocks and soil, it can pass through layers of limestone. Acidic water dissolves and washes away the limestone, forming a cave, as shown to the right. The formation of a cave can take tens of thousands to millions of years.



After Weathering... You just discovered that materials on Earth are slowly weathered over time through both physical and chemical processes. What happens to weathered material? Let's look at an example.

INVESTIGATION

Bye-Bye Beach

Examine how this beach changes from one photo to the next below.

1. How did this beach change over time?

Sample answer: The beach has become narrower. The space between the water and the buildings has decreased over time.

2. What do you think caused these changes?

Sample answer: As waves crashed onto the beach, sand was removed by the water and carried to new locations.

Erosion and Deposition As you just investigated, weathered material can be moved or transported to new locations. Geologists use the term **erosion** to describe the moving of weathered material, or sediment, from one location to another. **Deposition** is the laying down or settling of eroded material.

Together, the processes of weathering, erosion, and deposition change the surface of Earth. These processes can occur at spatial scales ranging from large to microscopic, over time periods ranging from seconds to millions or billions of years.

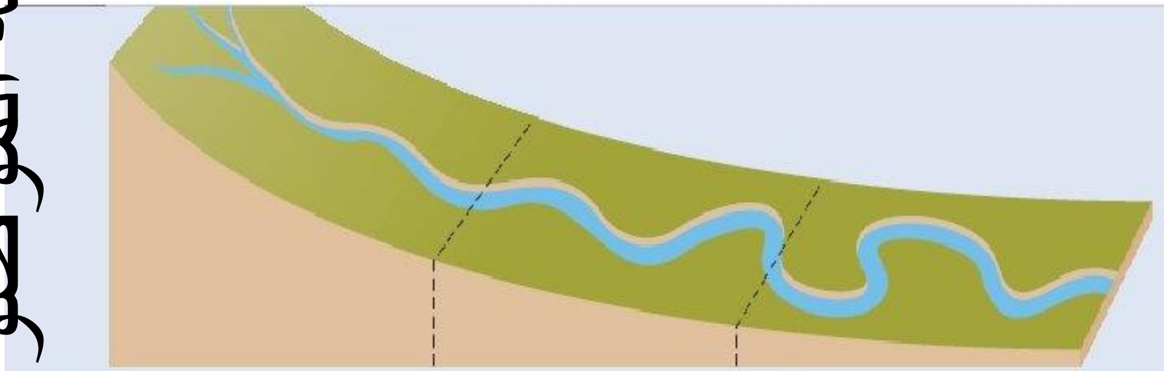
COLLECT EVIDENCE

What processes change Earth's surface over time? Record your evidence (A) in the chart at the beginning of the lesson.

16	Predict the effect of water on changing the Earth's surface	textbook, figures, lab	77, 78, 79, 80, 81

الأسئلة الموضوعية MCQ

- Predict the effect of water on changing the Earth's surface
- textbook, figures, lab
- 77, 78, 79, 80, 81



Steep so river flows very fast

Fast water **erodes** easier

Features are Waterfalls, V Shaped Valley Interlocking Spurs

More gradual gradient so river slows down

Features are Meanders

Much slower river.

As river slows down it drops the material it carries Called **Deposition**

Features are Deltas,

How does water change Earth's surface?

As you investigated in *Bye-Bye Beach*, as water moves over Earth's surface, it can cause changes to Earth's features. Sometimes these changes occur on too large or too small of a scale and are best observed using a model. When you analyze an event using a model you can observe the different processes that occur. You can also consider the effects of changes. In this activity, you will analyze different ways that erosion and deposition occur along a stream and shape the landscape.

LAB Go with the Flow

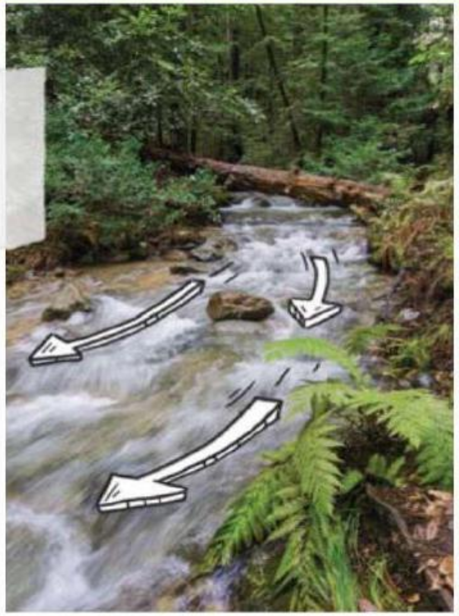
Safety

Materials

sand
gravel
tub
stream table
craft sticks
water

Procedure

1. Read and complete a lab safety form.
2. Set up the stream table as directed by your teacher.
3. You will test several factors that impact a stream:
   - slope (stream gradient),
   - flow rate of water, and
   - stream path.
4. Make sure to rebuild the stream table between each trial and test.
5. After completing the lab, follow your teacher's instructions for proper cleanup.



16	Predict the effect of water on changing the Earth's surface	textbook, figures, lab	77, 78, 79, 80, 81

الأسئلة الموضوعية MCQ

Slope Test

6. Test three different stream gradients (slopes) as directed by your teacher. The amount and rate of water discharged into the stream table should be the same for all three tests. Analyze the movement of sand and sediments along the channel as the stream gradient is changed. Record your observations in your Science Notebook.
7. How does the velocity of the water flow change as the gradient increases?

As the gradient increases, the velocity of the water will increase.

8. What evidence did you gather that determines if erosion and deposition along the stream varies as the gradient changes?

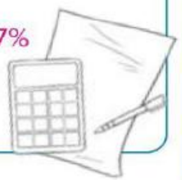
Evidence may include depth of the stream channel (depth will increase with an increase in gradient as the water flows faster) or the amount of sediment eroded in the channel (more sediment erodes with an increase in gradient as the water flows faster).

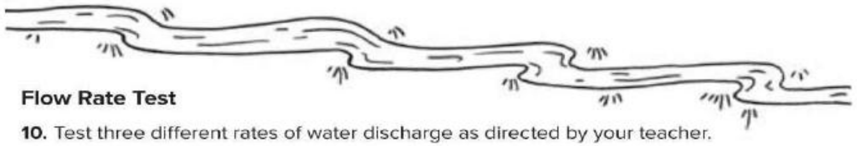
9. **MATH Connection** The height of a mountain changes from 380 m to 590 m over a horizontal distance of 3,000 m. Calculate the percent slope of a stream coming down the mountain.

Slope is the ratio of the change in vertical height over the change in horizontal distance.

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{Y_2 - Y_1}{X_2 - X_1} \qquad \text{slope} = \frac{590 - 380}{3000 - 0}$$

$$\text{slope} = \frac{210}{3000} = 0.07 \qquad \text{percent slope} = 0.07 \times 100 = 7\%$$





Flow Rate Test

10. Test three different rates of water discharge as directed by your teacher. The slope of the stream table will remain the same for all three trials. Place different sized sediments along the path of the stream. Analyze the movement of sand along the channel as the discharge rate is changed. Record your observations in your Science Notebook.
11. Do erosion and deposition along the stream vary as the amount of water exposed to the stream is changed?

As the speed of the water increased so did the rate at which weathering and erosion occurred. The water transported and deposited a greater quantity of material faster as the quantity of the water increased.

12. How is the flow rate of a stream related to the size of the sediments it deposits?

When the water was moving slowly, it transported only sand. As the water moves quickly, it may move some of the gravel downstream.

Stream Path Test

13. Carve two meanders into the stream path. The slope and rate of flow will remain the same for this trial. Analyze the movement of sand along the channel for each path. Record your observations in your Science Notebook.
14. How was the shape of the meander affected by the flowing water?

Water flowing slowly through the meander caused the channel to deepen. Sand piled up on the inside of curves where the water flowed slowly and the meander tended to have bigger curves. More erosion occurs on the outside of bends where water flows faster. More deposition occurs on the inside of bends where water flows slower. When the water flowed faster, it cut off some curves and flowed straight across the land, forming crescent-shaped lakes.

الأسئلة الموضوعية MCQ

16	Predict the effect of water on changing the Earth's surface	textbook, figures, lab	77, 78, 79, 80, 81

Analyze and Conclude

15. Make a claim about how water can change a stream over time.

Water weathers, erodes, and deposits sediment in a stream over time.

16. What evidence from the investigation supports your claim?

that the rate of weathering, erosion, and deposition is affected by an increase in stream gradient (slope) and water speed, and is also affected by the shape of the stream. Students should cite specific evidence from their experience.

Water Erosion and Deposition As you just modeled, streams are active systems that weather and erode land and deposit sediment. The erosion produced by a stream depends on the stream's energy. This energy is usually greatest in steep, mountainous areas where young streams flow rapidly downhill. The rushing water often carves V-shaped valleys. Water in a stream slows as it reaches gentler slopes. Slower moving water erodes the sides of a stream channel more than its bottom, and the stream develops curves. Over time, the stream meanders, or curves, changing shape.

Erosion occurs on the outside of bends where water flows faster. Deposition occurs on the inside of bends where water flows slower. Flowing water deposits sediment as the water slows. A loss of speed reduces the amount of energy that the water has to carry sediment. Deposition by a stream can occur anywhere along its path where the water's speed decreases.

THREE-DIMENSIONAL THINKING

Analyze the photos and then read the scenario below.

A stream begins flowing down a mountain side. As the stream picks up speed, the water becomes muddy. When it reaches a flatter area, the stream moves more slowly, and the water clears.

Explain why the stream changes in appearance.

The fast-moving water carries sediments, making it appear muddy. The river is muddy because of the sediment it carries. As water enters a flatter area, it loses energy, slows, and drops much of its sediment, making the water appear clearer.

COLLECT EVIDENCE

How does water change features on Earth's surface? Record your evidence (B) in the chart at the beginning of the lesson.

17	Predict the effect of wind and ice on changing the Earth's surface	Textbook, figures, 3D	84, 87, 88, 93

الأسئلة الموضوعية MCQ

- Predict the effect of wind and ice on changing the Earth's surface
- Textbook, figures, 3D
- 84, 87, 88, 93

Wind Erosion and Deposition Strong winds also can erode and deposit weathered sediment. In some places, wind and water work together to weather and erode rocks and make them look so smooth and polished. The erosion and deposition of materials by wind can form different types of features on Earth's surface.

Land Features	
Sand Dunes The shapes of dunes are mostly controlled by whether wind blows consistently in one direction or is more variable in direction. Some dunes can be many kilometers long. Grain by grain, sand dunes migrate in the direction the wind blows. Dunes can take on irregular shapes and are constantly changing.	
Loess Wind-deposited silt and clay is called loess. One type of loess forms from rock that was ground up and deposited by glaciers. Wind picks up this fine-grain sediment and redeposits it as thick layers of dust called loess.	
Arches As wind carries weathered sediment along, the sediment cuts and polishes exposed rock. Abrasion is the grinding away of rock or other surfaces as weathered particles carried by wind, water, or ice scrape against them.	
Scoured and Sandblasted Rocks Wind can bombard rocks on the surface with windblown sand, silt, or even ice, essentially sandblasting them. Many such rocks take on a smooth, polished appearance as sharp, rough spots are smoothed by debris. Others take on odd shapes like the rock shown here.	

17	Predict the effect of wind and ice on changing the Earth's surface	Textbook, figures, 3D	84, 87, 88, 93

الأسئلة الموضوعية MCQ

Erosion by Ice As you just observed, the ice cube glacier transported and deposited some of the colored sand as it moved downhill. Glaciers erode Earth's surface as they slide over it. Let's investigate the types of materials that glaciers transport and how glaciers change Earth's surface.

INVESTIGATION

Glacial Shaping

GO ONLINE Watch the video *Glacial Landscapes.*

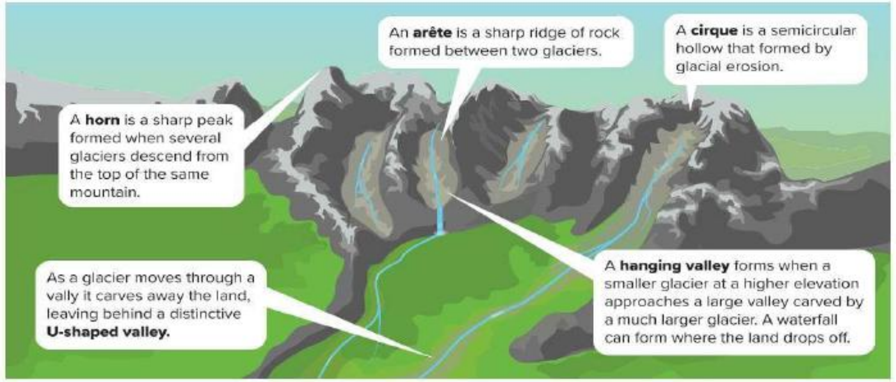
1. What evidence did you gather that glaciers transport materials on Earth's surface?

: As glaciers move, they pick up rocks and boulders. These rocks scrape and chip away at the rocks below. Boulders, pebbles, silt, and even the color of the water deposited from the glacier are the result of materials being moved by ice.

2. How might glaciers change the landscape over time?

As glacial ice picks up rocks, it scrapes the surface of Earth below. The glacier acts like an enormous piece of sandpaper, carving out valleys and lakebeds. Over time glaciers carve deep valleys into mountains.

Glacial Debris Glaciers carry an unsorted collection of large, commonly angular rocks to pulverized, fine-grained sediment. The sides of most glaciers contain especially abundant sediment because they receive loose materials from the slopes of hills and mountains that flank the glacier. This sediment is eroded as the ice pushes forward. Rocks and grit frozen within the ice create grooves and scratches on underlying rocks as they are transported downhill. When glaciers melt, the water produced by the melting ice does not flow fast enough to carry sediment. The sediment is deposited where the ice melts. Till is a mixture of various sizes of sediment deposited by a glacier. Deposits of till are poorly sorted.



Glacier Features Glaciers act as giant bulldozers. Glacial features are formed as a glacier moves through an area and carves away the land. Some of the distinct features produced by glaciers are identified in the image above.

THREE-DIMENSIONAL THINKING

Explain how the mountains and the valley in the image above would be different if a glacier had not passed through.

: The valley would likely be V-shaped (formed by a river) instead of U-shaped (formed by a glacier). There would not be ridges carved into the mountains, so you would not see features such as horns, arêtes, cirques, and hanging valleys.

GO ONLINE for an additional opportunity to explore!

Examine how glaciers change Earth's surface by performing the following activity.

- [ ] **Read** the **Scientific Text** *Glaciers and Landforms* to learn about how glaciers have impacted North America.

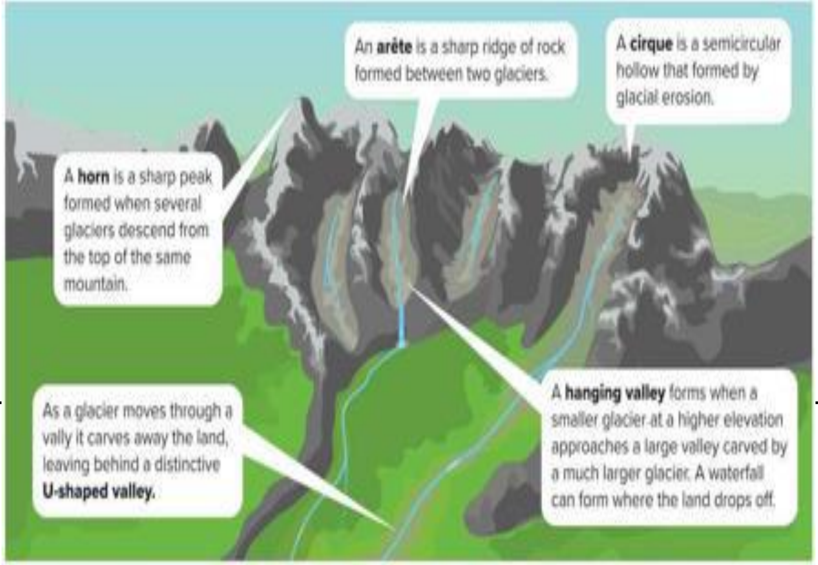
COLLECT EVIDENCE

How can a glacier change a mountainous landscape? Record your evidence (D) in the chart at the beginning of the lesson.

17	Predict the effect of wind and ice on changing the Earth's surface	Textbook, figures, 3D	84, 87, 88, 93

Land features of erosion and deposition

الأسئلة الموضوعية MCQ

Erosion factor	Wind	glacier
Land features by erosion	Arches  Scoured and sandblasted rock Abrasion 	Grooves- Horn- U-shaped valley Arete- Cirque- Hanging valley 
Land features by deposition	Sand dunes  Loess 	Till

17	Predict the effect of wind and ice on changing the Earth's surface	Textbook, figures, 3D	84, 87, 88, 93

الأسئلة الموضوعية MCQ

Three-Dimensional Thinking

The Lighthouse of Palo Duro Canyon State Park is a famous rock formation in Texas. Examine the photo of the Lighthouse below.

2. Which statement best explains how this rock formation likely formed over time?

A The Lighthouse formed as water erosion carved away the softer rock around the structure over time.

B The Lighthouse formed from multiple episodes of wind erosion and deposition over time.

C The Lighthouse formed as repeated flash floods deposited sediments and rocks on the structure over time.

D The Lighthouse formed as desert plants protected some of the rock layers from erosion over time.

18	Define crystallization and differentiate between igneous rocks (extrusive and intrusive)	Textbook, figure, 3D	104, 105

الأسئلة الموضوعية MCQ

- Define crystallization and differentiate between igneous rocks (extrusive and intrusive)
- Textbook, figure, 3D
- 104-105
- Crystallization occurs when particles dissolved in a liquid, such as lava or magma, solidify and form crystals.

Igneous Rock Formation Melted rock material is present both on and below Earth's surface. Recall that molten rock is called magma when it is inside Earth. Molten rock that erupts onto Earth's surface is called lava. As magma or lava cools, mineral crystals begin to form. All minerals form through a process called crystallization. The process of **crystallization** occurs when particles dissolved in a liquid, such as lava or magma, solidify and form crystals. Minerals can crystallize as molten rock cools. Earth's internal heat energy drives the processes of melting and crystallization by changing the atomic arrangement of elements in rocks, a chemical change.

PHYSICAL SCIENCE Connection Each pure substance has characteristic physical and chemical properties. A chemical change is a change in matter in which the substances change into other substances with new physical and chemical properties. The arrangement of elements determines the properties of the rock. The substances that undergo a change have different properties because they no longer have the same atomic arrangement.

THREE-DIMENSIONAL THINKING
How does the flow of **energy** from Earth's hot interior drive the formation of igneous rocks?

: Earth's hot interior allows for rock, deep inside of Earth, to melt. For igneous rocks to form, molten rock, above and below Earth's surface, must cool and crystallize.

COLLECT EVIDENCE

How does lava flowing out of a volcano relate to the formation of igneous rock? Record your evidence (A) in the chart at the beginning of the lesson.

18	Define crystallization and differentiate between igneous rocks (extrusive and intrusive)	Textbook, figure, 3D	104, 105

الأسئلة الموضوعية MCQ

Study the table below, which of the following is correct?

1	2
	
Molten rocks cool slowly	Molten rocks cool so quickly

Learning Outcomes Covered

- SCI.2.3.05.002

a. 1 is called intrusive rock, their mineral crystals are very small in size

b. 2 is called extrusive rock, their mineral crystals are very small in size

c. 1 is called extrusive rock, their mineral crystals are large in size

d. Both 1 and 2 cools on the Earth's crust, where its lower temperature than its core

Where do igneous rocks form?

When lava cools and crystallizes on Earth's surface, the igneous rock that forms is called **extrusive rock.** Lava at Earth's surface cools so quickly, that mineral crystals either have no time to grow, as in the obsidian to the right, or are very small in size. Geologists describe the texture of igneous rocks with small crystals as fine-grained. ▶

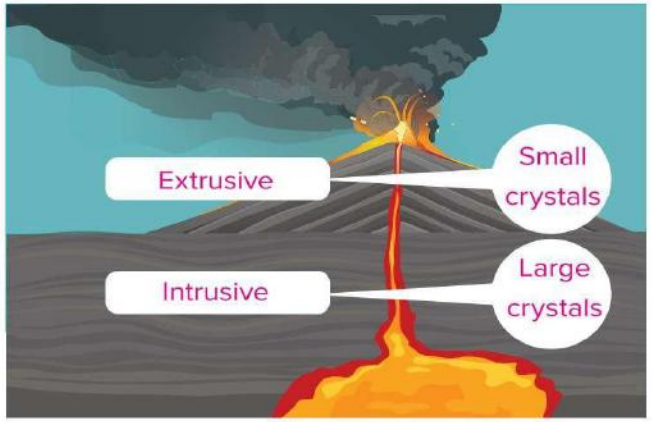
Extrusive rock

Intrusive rock

◀ When magma cools and crystallizes inside Earth, the igneous rock that forms is called **intrusive rock.** Deep below Earth's surface, magma is insulated by solid rock and therefore cools slowly. The crystals have more time to grow and are larger, as shown in the diorite rock to the left. Geologists describe the texture of igneous rocks with large crystals as coarse-grained.

THREE-DIMENSIONAL THINKING

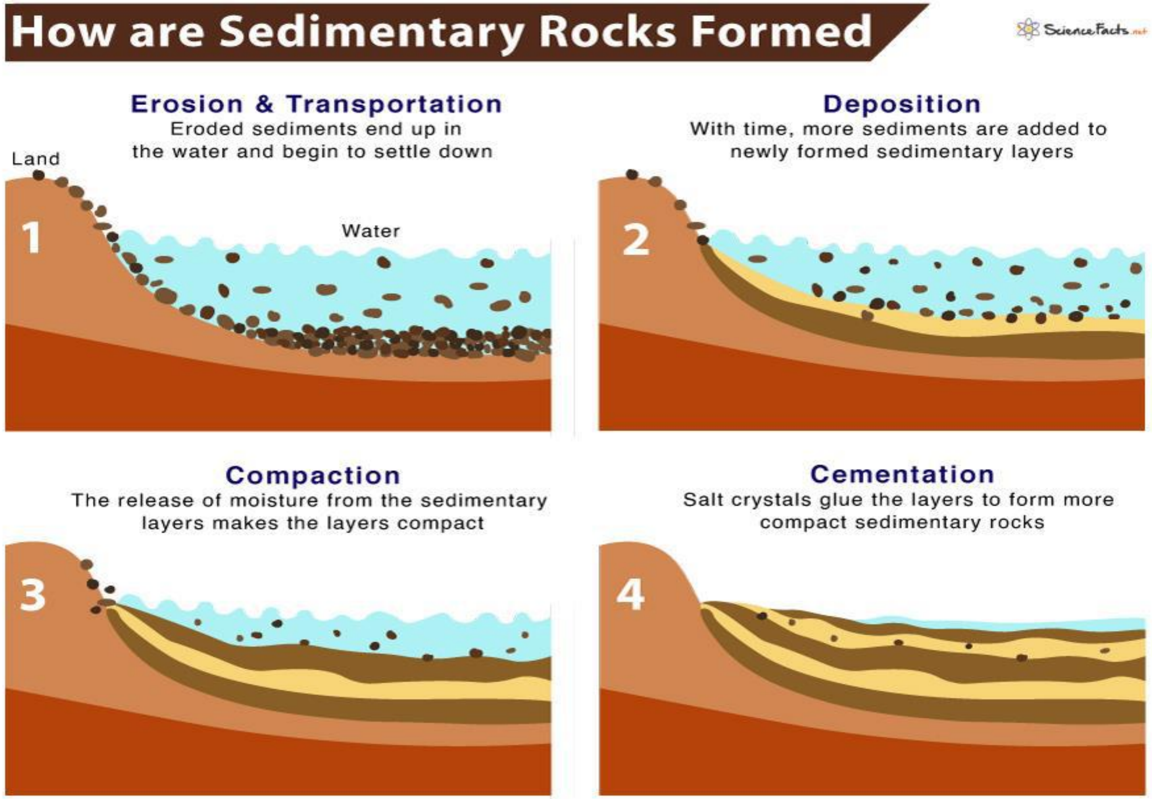
What is the **effect** of location on crystal size? Label the location of intrusive and extrusive igneous rocks on the diagram below. Then, illustrate the crystal size of the rock formed at that location in the appropriate callout circles.



19	Describe the processes of lithification, compaction and cementation	textbook, investigation, 3D	106, 109, 110, 112

MCQ الأسئلة الموضوعية

- Describe the processes of lithification, compaction and cementation
- textbook, investigation, 3D
- 106. 109. 110. 112



What happens to rocks at Earth's surface?

Recall that sediment is rock material that forms where rocks are broken down into smaller pieces or dissolved in water. These materials, which include rock fragments, mineral crystals, or the remains of certain plants and animals, and range in size from very fine clay to large boulders, are the building blocks of sedimentary rocks. The same forces that weather rocks also transport sediment to new locations by the process of erosion. Weathering and erosion processes can happen simultaneously.

PHYSICAL SCIENCE Connection The forces that are driven by energy from the Sun, such as wind and water, along with the activities of some organisms, interact with rocks on Earth's surface. As a result, rocks are physically broken apart or altered by chemical reactions through the process of weathering. Physical weathering, a physical change, breaks rock into pieces, but does not change the chemical composition of rock. Chemical weathering, a chemical change, changes the atomic arrangement of the elements in the rock.

THREE-DIMENSIONAL THINKING
How does the flow of **energy** from the Sun drive the formation of sediment?

: Energy from the Sun drives the movement of wind and the cycling of water on Earth's surface. These forces drive the process of weathering, which breaks rocks into smaller pieces of sediment.

What happens to eroded sediment?

Models allow scientists to observe things in nature that are too big or too small to observe naturally. Let's model what happens to sediment if it reaches a body of water, such as a lake or ocean.

19	Describe the processes of lithification, compaction and cementation	textbook, investigation, 3D	106, 109, 110, 112

الأسئلة الموضوعية MCQ

12. Why is the water cloudy after you shake it?

The smallest sediment particles remain suspended in the water.

13. Do you think the water will become clear over time? Explain your reasoning.

Students should predict, yes, the water will eventually clear. The sediments will sink to the bottom over time.

14. How does this activity model what happens in a real-world scenario, such as when a river or stream reaches a lake or ocean?

As water from a river or stream reaches a lake or ocean the water slows down. This allows for sediments to settle out of the water. Heavier sediments will settle out first at the mouth of the river or stream, followed by lighter sediments extending further into the open water environment.

Deposition One of the most important factors in the formation of sedimentary rocks is the place where the sediment is left to settle. Recall that the layering down or settling of eroded material is called deposition. Energy from the Sun drives the movement of wind and water that causes the erosion and deposition of weathered Earth materials. Eventually, glaciers, wind, and water slow down enough that they can no longer transport the sediment and the process of sedimentation begins. Deposition of these sediments forms layers.

PHYSICAL SCIENCE Connection Sedimentation results when gravity removes suspended solids from water, or wind, a physical change. This process does not change the identity of the particles of rock.

THREE-DIMENSIONAL THINKING

A river delta is a landform that forms from deposition of sediment carried by a river as the flow leaves its mouth and enters slower-moving or standing water. Examine the locations indicated in the photo of a delta below.

1. At which location would the largest grains of sediment be located? The smallest? **Explain** your reasoning.

: The largest grains of sediment would be located at the mouth of the river, location A. The smallest grains of sediment would be concentrated further out into the ocean, location C. Heavier sediments will fall out of the water first as it begins to slow down. Only small, fine sediments will make it further out into the ocean.

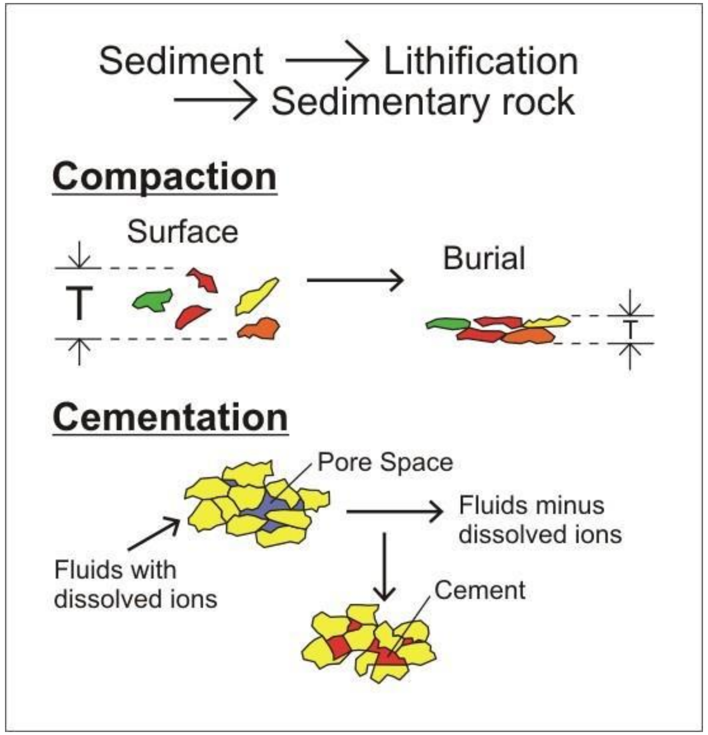
2. Deposition, also called sedimentation, cycles matter through which type of **change**, physical or chemical? Explain your reasoning.

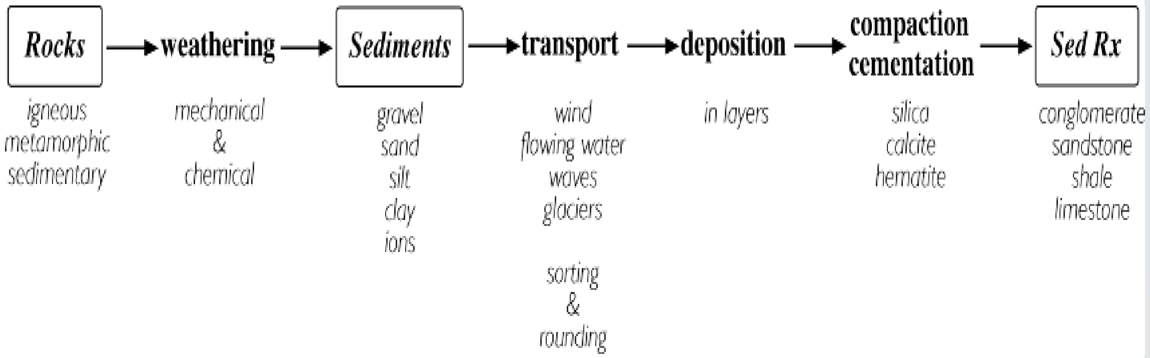
The deposition of sediment does not change the atomic arrangement of the sediment. Therefore, it is a physical change.

3. Develop a **model** that could describe why deposition occurs. Record details and descriptions about your model in your Science Notebook.

19	Describe the processes of lithification, compaction and cementation	textbook, investigation, 3D	106, 109, 110, 112

الأسئلة الموضوعية MCQ





4. What role does the sugar have in the formation of the "rock"?
the sugar is holding the sand together to create the "rock".

5. Why is a cementing material needed to hold sedimentary rocks together?
Pressure alone can't make grains stick together. A cementing material acts to hold them together.

6. What do you think is the "glue" holding sediments together in a sedimentary rock such as sandstone?
: the "glue" is minerals or other deposits left after the water evaporates.

Cementing Rock Together **Lithification** is the process through which sediment turns into rock. Imagine sediment deposits becoming thicker over time. Younger sediment layers bury older sediment layers. As time passes, more and more layers are deposited and the old and young layers of sediment are buried by even younger sediment deposits. The weight from the layers of sediment forces out fluids and decreases the space between grains during a process called **compaction.**

Compaction is often followed by a process called cementation. When minerals dissolved in surrounding water crystallize between grains of sediment, **cementation** occurs. Mineral cement holds the grains together, as shown to the left.

COLLECT EVIDENCE

How do sedimentary rocks form from sediment? Record your evidence (B) in the chart at the beginning of the lesson.

20	Describe how sedimentary and metamorphic rocks are classified and list the common sedimentary rock types ,	textbook, table, figures, 3D	114, 117

الأسئلة الموضوعية MCQ

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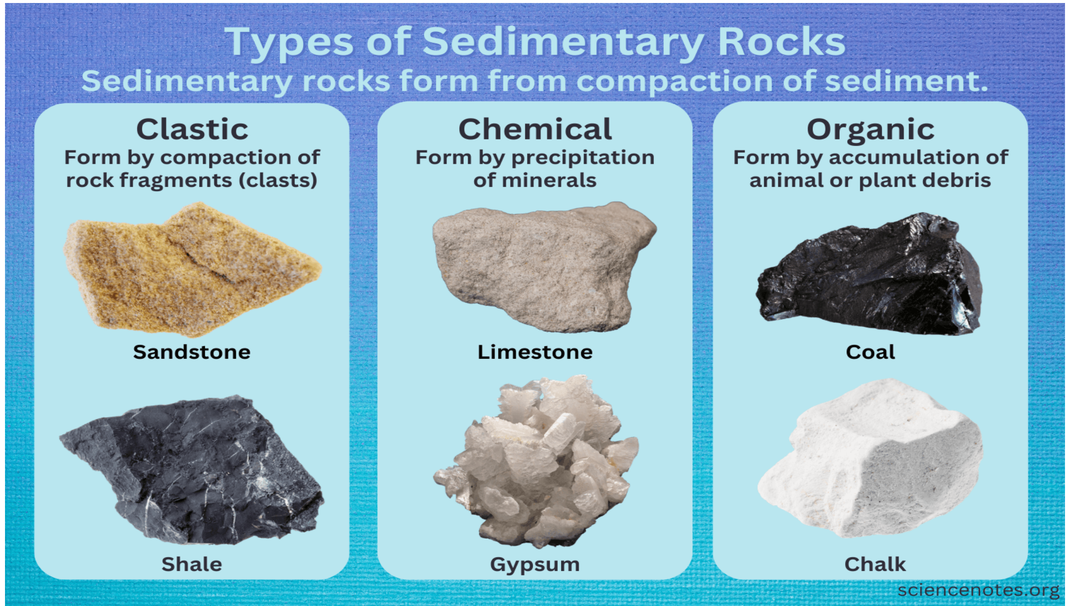

What are the different types of sedimentary rocks?

All sedimentary rocks form from the cementing of different types of sediment. Types of sedimentary rocks include clastic sedimentary rocks, chemical sedimentary rocks, and biochemical sedimentary rocks.

Types of Sedimentary Rocks	
Clastic Sedimentary Rocks Sedimentary rocks that are made up of broken pieces of minerals and rock fragments are known as clastic (KLAH stik) sedimentary rocks. The broken pieces and fragments are called clasts.	
Chemical Sedimentary Rocks Chemical sedimentary rocks form when minerals crystallize from water. Water can only hold a certain amount of dissolved solids. During dry conditions, as water evaporates, solids crystallize out of the water and form minerals.	
Biochemical Sedimentary Rocks Biochemical rock is a sedimentary rock that was formed by organisms or contains the remains of organisms. Some marine organisms such as mussels, clams, corals, and snails make their shells from dissolved minerals in the ocean. When these organisms die, their shells settle onto the seafloor. This sediment is compacted and cemented together. The most common biochemical sedimentary rock is limestone.	

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The following figure shows a type of sedimentary rocks that is formed when minerals crystallize from water during dry conditions, under which of the following types it belongs to?

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Clastic

Chemical

Biochemical

Gneiss

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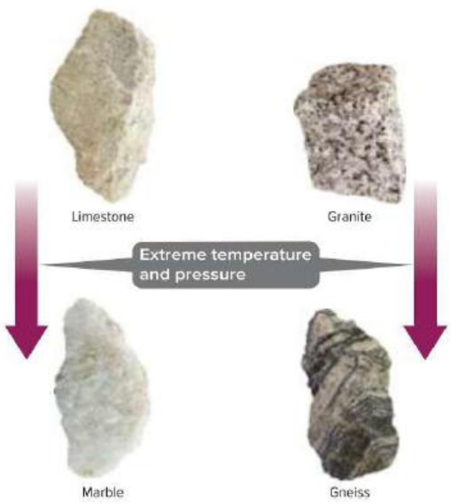
Metamorphic Rocks

Granite igneous rock

Gneiss metamorphic rock

Metamorphic Rocks When temperature and pressure combine and change the texture, mineral composition, or chemical composition of a rock without melting it, a metamorphic rock forms. The addition of hot chemical fluids can also cause rocks to become metamorphic. The high temperatures required for metamorphism are ultimately derived from Earth's internal heat, either through deep burial such as at a subduction zone, or from nearby igneous intrusions. The high pressures required for metamorphism come from deep burial or from compressional forces where Earth's tectonic plates meet. During metamorphism, the minerals that make up the rock's composition change as well as the texture, or arrangement, of the individual mineral grains.



PHYSICAL SCIENCE Connection How do minerals change without melting? During metamorphism, the minerals in a rock change into new minerals that are stable under the new temperature and pressure conditions. Minerals that change in this way are said to undergo solid-state alterations.

THREE-DIMENSIONAL THINKING
How does the flow of energy from Earth's hot interior drive the formation of metamorphic rock?

Earth's internal heat is responsible for the movement of plates along Earth's surface. When rocks are exposed to extreme temperature and pressure, such as along plate boundaries, they can change to metamorphic rocks.

COLLECT EVIDENCE

What conditions in Earth cause metamorphic rocks to form? Record your evidence (C) in the chart at the beginning of the lesson.