

4-1 What are rocks?

4-1 What are rocks?

Lesson Review

Match each term in Column B with its description in Column A. Write the correct letter in the space provided.

Column A

- _____ 1. rock formed from melted minerals
- _____ 2. grouping of things that are alike
- _____ 3. scientist who studies rocks and minerals
- _____ 4. rock formed when another rock is changed by heat and pressure
- _____ 5. rock formed from the remains of living things
- _____ 6. substances that make up rocks

Column B

- a. metamorphic
- b. petrologist
- c. minerals
- d. igneous
- e. classification
- f. sedimentary

Classification The grouping of things that are alike is called classification (klay-uh-fib-KAY-shuh). Scientists often classify things to make them easier to study. Biologists classify things as living or nonliving. Chemists classify elements as metals or nonmetals. A petrologist (puh-TRAHL-uh-jist) is a scientist who studies rocks and minerals. Petrologists classify the rocks of the earth's crust.

Define: What is classification?

Classes of Rocks Petrologists classify rocks according to the way the rocks form. Some rocks form when melted minerals cool and harden. These rocks are classified as **igneous** (IG-nee-us) rocks. Rocks that form when pieces of minerals and rocks become cemented together, or from the remains of living things, are classified as **sedimentary** (sed-uh-MEN-tuh-ree) rocks. Other rocks form when existing rocks are slowly changed by heat and pressure. These rocks are classified as **metamorphic** (met-uh-MOR-fee) rocks.

Identify: What are the three classes of rocks?

Objective ▶ Identify and describe the three classes of rocks.

TechTerms

- ▶ **igneous** (IG-nee-us) **rock:** rock that forms from melted minerals
- ▶ **metamorphic** (met-uh-MOR-fee) **rock:** rock that forms when existing rocks are changed by heat and pressure
- ▶ **sedimentary** (sed-uh-MEN-tuh-ree) **rock:** rock that forms from pieces of other rocks or the remains of once-living things

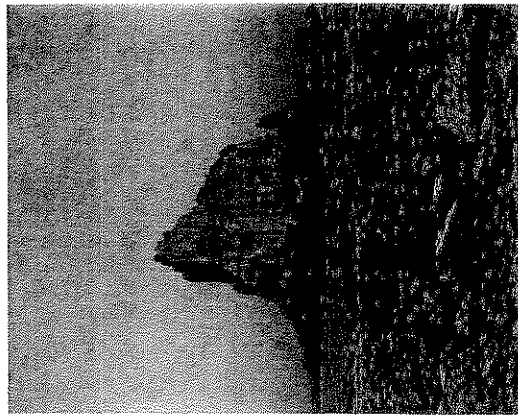


Figure 1

Rocks The earth's crust is made up of many kinds of rocks. All of these different rocks are made up of one or more minerals. There are more than 2000 different minerals in the earth's crust. However, fewer than 20 of these minerals are found in most rocks.

Identify: What are rocks made up of?



Figure 2 Petrologists study rocks and minerals.

Skill Challenge

Skills: applying concepts, classifying
Decide whether each rock described in the table is igneous, sedimentary, or metamorphic. Place a check mark in the correct column.

Table 1 Classification of Rocks

Rock	Igneous	Sedimentary	Metamorphic
1. Shell limestone—made up of pieces of shells that are cemented together			
2. Marble—formed when limestone is put under heat and pressure			
3. Granite—formed when the melted minerals quartz, feldspar, and mica cool and harden			
4. Shale—formed when particles of mud and clay are pressed and cemented together			
5. Slate—formed when shale is put under great pressure			

4-2 How are igneous rocks formed?

formed?

Objective ▶ Identify two ways that igneous rocks are formed.

TechTerms

- ▶ **lava** (LAH-vuh): magma that reaches the earth's surface
- ▶ **magma** (MAG-muh): molten rock inside the earth
- ▶ **molten** (MOHL-tun) rock: melted minerals

Heat inside the Earth The temperature of the earth becomes hotter as you dig deeper into the earth. Two meters beneath the earth's surface, the temperature is about 10 °C. The deepest oil wells have been drilled about 6 km into the earth. Here, the temperature is more than 60 °C. Between the earth's crust and the mantle (MAN-tul), the temperature is between 600 and 700 °C. The mantle is the layer of the earth below the crust.

The temperature between the crust and the mantle is high enough to melt minerals. Melted minerals are called **molten** (MOHL-tun) rock. When molten rock cools, igneous rocks form. Igneous rocks are sometimes called "fire-formed" rocks. Although fire does not form igneous rocks, tremendous heat melts rock.

Explain: How do igneous rocks form?

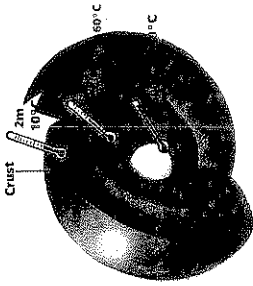


Figure 2

Magma and igneous rocks Molten rock inside the earth is called **magma** (MAG-muh). There are large pools of magma deep inside the earth. Sometimes, magma rises through cracks between rocks into the upper part of the earth's crust. Here, the temperature is much cooler than deep inside the earth. As magma rises through cracks in the earth's crust, the magma cools and hardens. Igneous rock is formed. Igneous rock can take thousands of years to cool from magma.

Define: What is magma?

Lava and igneous rocks Sometimes magma rises through cracks in rocks and reaches the earth's surface. Magma that reaches the earth's surface is called **lava** (LAH-vuh). Lava cools upon contact with air or water. Cooling makes lava harden into igneous rock. Igneous rocks form from lava in a short period of time.

Describe: How does lava rise to the earth's surface?

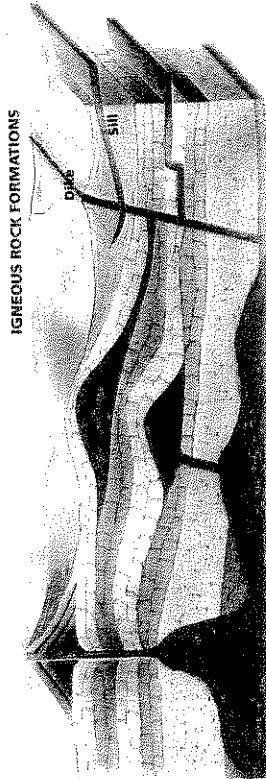


Figure 1 igneous rock formation

4-2 How are igneous rocks formed?

Lesson Review

In the space provided, write the term that best completes each statement.

1. The temperature of the earth becomes _____ as you go deeper into the earth.
2. The _____ is the layer of the earth below the crust.
3. Melted minerals are called _____ rock.
4. When molten rock cools, _____ rocks form.
5. Molten rock below the earth's surface is called _____.
6. Molten rock can reach the earth's surface through _____ in rocks.
7. Magma that pours onto the earth's surface is called _____.
8. Lava that cools and hardens becomes _____ rock.

Skill Challenge

Skills: interpreting, identifying, applying definitions

Use the labels on the diagram to identify each structure described. Write your answer in the space with the same number as each description.

1. Molten rock on earth's surface
2. Outer layer of the earth
3. Layer below the earth's outer layer
4. Molten rock below the earth's surface
5. Rock formed from molten rock on the earth's surface
6. Rock formed from molten rock inside the earth

4-3 How are igneous rocks classified?

Objective ▶ Identify and describe igneous rocks by their minerals and textures.

Term

▶ **texture** (TEKS-char): size of the crystals in an igneous rock

A Mixture of Minerals Igneous rocks are made up of different kinds of minerals. There are six minerals that are commonly seen in igneous rocks. These six minerals are listed in Table 1.

quartz	olivine
feldspar	amphibole
mica	pyroxene

Igneous rocks can be identified by their minerals. Granite (GRAN-it) is an igneous rock made up of quartz, feldspar, and mica. Look at the photograph of granite. You can see each mineral.

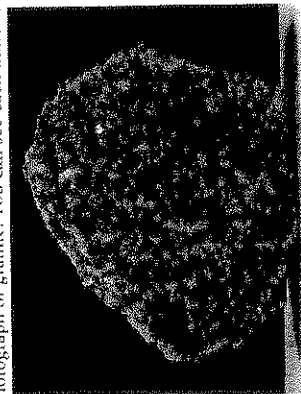


Figure 1 Granite

Observe: Look at the photograph of granite. How do the colors of the quartz and feldspar crystals in granite differ?

Crystal Size Igneous rocks have crystals of different sizes. Crystal size depends upon the amount of time it takes the magma in a rock to cool. Large crystals take a long time to form. Igneous rocks

formed from magma have large mineral crystals. Small crystals take a short time to form. Most igneous rocks formed from lava have very small crystals. Sometimes lava cools so quickly that no crystals form. For this reason, a few igneous rocks do not have any crystals. Obsidian is an igneous rock that does not have any crystals.



Figure 2 Obsidian

Relate: How are cooling rate and crystal size related?

Texture The size of the crystals in an igneous rock is called its texture (TEKS-char). Texture can be used to identify different igneous rocks that are made up of the same minerals. Granite and rhyolite (RY-oh-lite) are igneous rocks that are made up of the same minerals. You can tell if a rock is granite or rhyolite by looking at its texture. Granite has large crystals that you can see and feel. Rhyolite has very small crystals that cannot be seen.

Igneous rocks are classified according to their textures. Igneous rocks with large crystals have a coarse texture. Igneous rocks with small crystals have a fine texture. Igneous rocks that do not have crystals have a glassy texture.

Classify: Classify granite, obsidian, and rhyolite according to their textures.

4-3 How are igneous rocks classified?

Lesson Review

Part A Write true if the statement is true. If the statement is false, change the underlined term to make the statement true. Write your answers in the spaces provided.

- Igneous rocks can be identified by their minerals.
- Texture refers to the shape of the crystals in an igneous rock.
- Granite has small mineral crystals.
- Large crystals form in igneous rocks that take a long time to cool.
- Most igneous rocks that formed from magma have small mineral crystals.
- An igneous rock with a coarse texture has very small mineral crystals.
- Igneous rocks with no mineral crystals were formed from lava that cooled very quickly.
- An example of an igneous rock with no mineral crystals is rhyolite.

Part B In the spaces provided, list the six minerals that make up most igneous rocks.

- _____ 3. _____ 5. _____
- _____ 4. _____ 6. _____

Skill Challenge

Skills: inferring, identifying, classifying

Use the information in the table to fill in the blank spaces in the table.

Table 1 Classifying Igneous Rocks

Rock	Formed from	Cooling rate	Crystal size	Texture
Felsite	lava	1.	small	2.
Gabbro	3.	slow	4.	coarse
Basalt	5.	fast	6.	fine
Pumice	lava	7.	no crystals	8.
Obsidian	9.	very fast	10.	glassy
Granite	magma	11.	large	12.

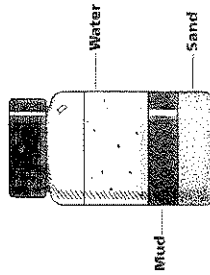
4-4 How are sedimentary rocks formed?

Objective Describe two ways that sedimentary rocks are formed.

Term

► **sediment** (SED-uh-munt): rock particles that settle in a liquid

Sediments What happens when you mix mud and sand in a jar of water? The particles of mud and sand settle to the bottom of the jar. The mud and sand settle in layers. The sand settles first because it is heavier than the mud. The mud settles on top of the sand. Mud and sand are examples of **sediments** (SED-uh-munt). Sediments are rock and mineral particles that settle in a liquid.



► **Restate:** Define sediment in your own words.

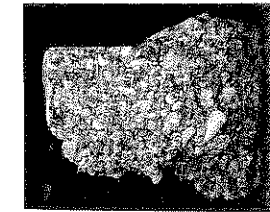
Natural Concrete Many sedimentary rocks form in much the same way as concrete. Concrete is made up of sand and gravel. Have you ever seen the trucks that pour concrete for a building? Inside these trucks, sand, gravel, cement, and water are mixed. After the mixture is poured out, the water evaporates. When the water evaporates, the sand and gravel become cemented together to form solid concrete.

How do sedimentary rocks form? Most sedimentary rocks are formed in water. These rocks form from sediments that settle to the bottoms of

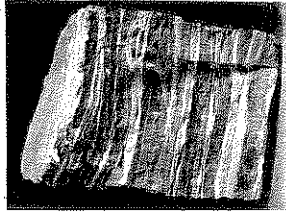
lakes, rivers, or oceans. Over millions of years, the sediments pile up in layers. The layers of sediment may be hundreds of meters thick. As more sediment is added to the layers, the lower layers of sediment become tightly packed under the weight of the new layers. The older sediments become solid rock when water and air are squeezed out from between the sediment layers. The sediments also may become rock as dissolved minerals in the water cement the sediments together.

► **Describe:** When does sediment become solid rock?

Sedimentary Rock From Living Things Some sedimentary rocks form from the remains of living things. For example, some sedimentary rocks form from the shells of sea animals. When clams and snails die, their shells are left on the bottom of the ocean. The shells pile up in layers. Minerals in the water cement the shells together. **Coquina** (koh-KEE-nuh) is a sedimentary rock formed from cemented shells. Shell limestone also forms from shells. However, you cannot see the shells in shell limestone. The shells were smashed into small pieces by ocean waves.



Coquina



Shell limestone

► **Identify:** How do the shells of coquina stick together?

4-4 How are sedimentary rocks formed?

Lesson Review

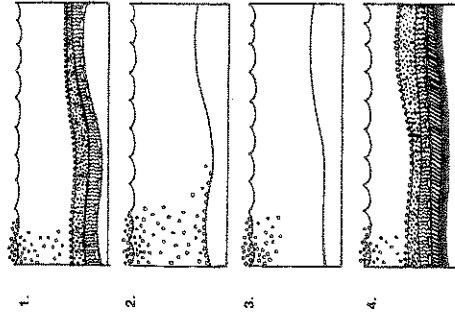
In the space provided, write the letter of the term or phrase that best completes each statement.

- Each of the following could be a sediment, *except*
 - gravel.
 - sand.
 - water.
 - sea shells.
- Most sedimentary rocks are formed in
 - volcanoes.
 - the mantle.
 - mountains.
 - water.
- One way that sediments become solid rock is when
 - they are mixed with other sediments.
 - water mixes with the sediments.
 - sand is mixed with the sediments.
 - water and air are squeezed from between sediment layers.
- Sediments in water often become solid rock when
 - air is added to the sediments.
 - minerals cement the sediments together.
 - sand cements the sediments together.
 - more sediments are added to the sediments.
- Sea shells become sedimentary rock when they are cemented together by
 - minerals.
 - sand.
 - limestone.
 - water.

Skill Challenge

Skills: Interpreting diagrams, sequencing

Match each diagram with its caption by writing the letter of the correct caption in the space beside each diagram. Then, in the space provided, write the correct order of the diagrams.



1.

Figure 1
Caption _____

2.

Figure 2
Caption _____

3.

Figure 3
Caption _____

4.

Figure 4
Caption _____

Captions

- More layers of sediment form.
 - Older sediment becomes rock under the weight of the upper layers which squeeze out water and air.
 - The sediment settles to the ocean bottom.
 - Sediment is added to ocean water.
5. The correct order of the diagrams is:

4-5 How are sedimentary rocks classified?

Objective ▶ Identify and describe the two main groups of sedimentary rock.

Key Terms

- ▶ **clastics** (KLAS-iks): sedimentary rocks made up of pieces of rock
- ▶ **nonclastics**: sedimentary rocks made up of dissolved minerals, or the remains of living things

Groups of Sedimentary Rocks There are two groups of sedimentary rocks. One group is made up of sediments that have been cemented and pressed together. These sedimentary rocks are called **clastics** (KLAS-iks). Another group of sedimentary rock is made up of dissolved minerals, or the remains of plants and animals. These sedimentary rocks are **nonclastics**.

Define: What are clastics?

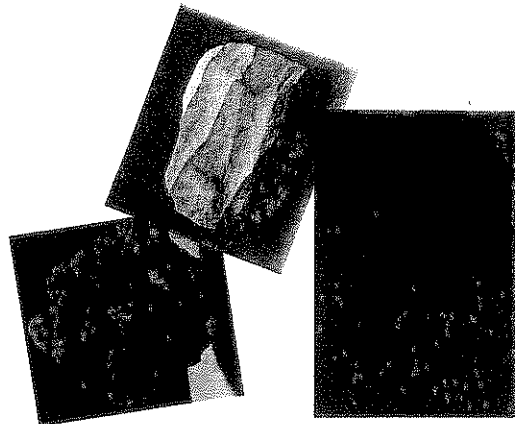


Figure 1 Clastic sedimentary rocks

Particle Size Clastics are classified according to the sizes and shapes of their sediments. Conglomerates (kun-GLAHM-uh-zayts) are clastic rocks made up of rounded pebbles and gravel. Sandstones are made up of small grains of sand. Shales are a group of clastic rocks made up of mud and clay. Mud and clay are the smallest kinds of sediment.

Identify: Name three groups of clastic sedimentary rocks.

Dissolved Minerals Most nonclastics form from dissolved minerals. Rocks formed in this way are chemical rocks. When water evaporates from salt lakes and shallow seas, the salts are left behind. These salts form a mineral called halite (HAY-lit). Rock salt is a sedimentary rock made up of halite. Some kinds of limestone also form from dissolved minerals. The dissolved mineral that forms some kinds of limestone is calcite.

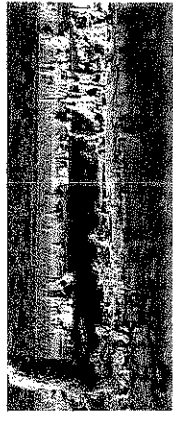


Figure 2 Mono Lake

Name: What mineral makes up rock salt?

Plants and Animals Some nonclastics form from the remains of plants and animals. Rocks formed from the remains of living things are organic (or-GAN-ik) rocks. Coals are nonclastic rocks formed from the remains of plants. Coal forms when the remains of plants are pressed together for a long time. Coquina (koh-KEE-nuh) is a nonclastic made up of the skeletons of sea animals. Chalk is a kind of limestone made up of the shells of very small one-celled organisms.

Describe: How is coal formed?

4-5 How are sedimentary rocks classified?

Lesson Review

Circle the word or term in each group that does not belong.

1. conglomerate clastic sandstone animals
2. clay pebbles conglomerate gravel
3. conglomerate halite shale sandstone
4. mud clay shale halite
5. nonclastic organic rocks chemical rocks sandstone
6. coal conglomerate coquina chalk
7. rock salt shale limestone chemical rocks
8. coal plants clastic organic rock
9. chalk calcite shells one-celled organisms
10. chemical rocks organic rocks clastic rocks nonclastic rocks

Skill Challenge

Skills: Classifying, identifying

For each sedimentary rock in the table, decide whether it is a clastic or a nonclastic. Place a check mark in the correct column. In the last column of the table write the word sediment, living things, or chemical to identify how the rock formed.

Table 1 Classifying Sedimentary Rocks

Rock	Clastic	Nonclastic	Forms from
1. Coal			
2. Sandstone			
3. Rock salt			
4. Shale			
5. Coquina			
6. Chalk			
7. Conglomerate			

4-6 How are metamorphic rocks formed?

Objective Describe three ways in which metamorphic rocks form.

Term

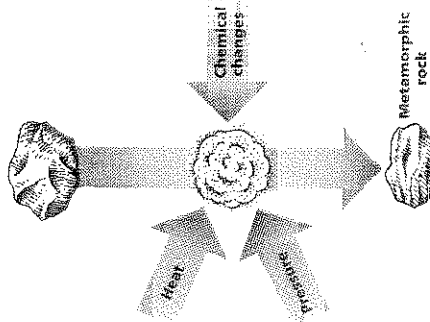
pressure (PRESH-up): force that pushes against an object

Changed Rock You can make bread from eggs, milk, flour, and salt. First, you mix the ingredients. Then, you bake the mixture in an oven. After baking the mixture, you cannot recognize any of the ingredients. The heat of the oven changes the eggs, milk, flour, and salt. The inside of the earth is like an oven. Heat inside the earth "bakes" rocks and changes the minerals in them. These changed rocks are metamorphic rocks.

Explain: Why are metamorphic rocks called changed rocks?

Heat and Pressure Minerals in rocks go through a chemical change when rocks are heated. Minerals change chemically at temperatures

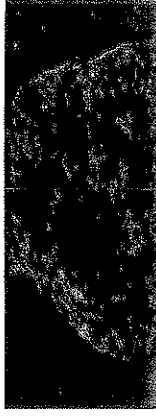
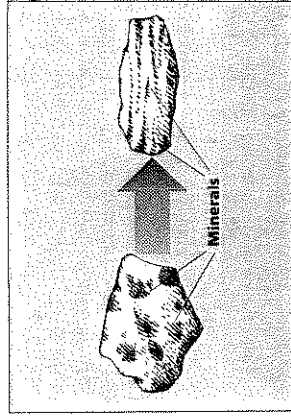
igneous, sedimentary, or metamorphic rock



between 100 °C and 800 °C. Minerals do not change when the temperature is below 100 °C. Above 800 °C, minerals melt into magma.

Rocks buried deep inside the earth also are affected by **pressure (PRESH-up)**. Pressure is a force that pushes against an object. Pressure deep inside the earth's crust, changes the form of minerals. A lot of pressure makes minerals flatten out into bands.

Define: What is pressure?



Magma and Metamorphic Rocks Some metamorphic rocks are formed when existing rocks come in contact with magma. Magma can move into cracks in deeply buried sedimentary rocks. Magma may also flow between the layers of sedimentary rocks. The heat and chemical solutions in the magma change the minerals inside the sedimentary rocks. Magma also changes minerals in igneous rocks and other metamorphic rocks.

Identify: How are rocks changed by magma?

Name _____ Class _____ Date _____

4-6 How are metamorphic rocks formed?

Lesson Review

In the space provided, write the term that best completes each statement.

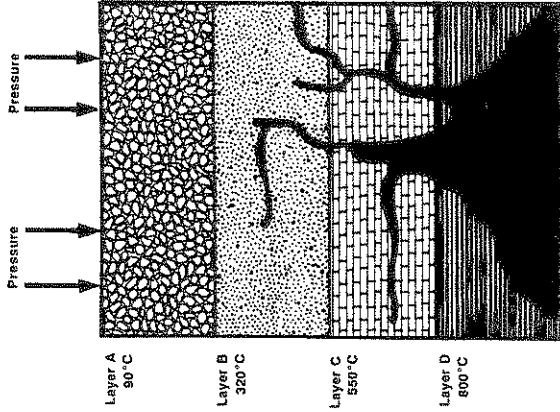
1. When an existing rock is changed by great heat and pressure, a _____ rock is formed.
2. The minerals in rocks undergo a _____ change when the rocks are heated.
3. When temperatures inside the earth go above 800 °C, minerals melt into _____.
4. Pressure is a _____ that pushes against an object.
5. Magma can move between layers of _____ rock.
6. Metamorphic rocks are formed when heat, pressure, or magma changes the _____ that make up a rock.

Skill Challenge

Skills: analyzing, applying concepts

Use the diagram to answer the questions.

1. Could the temperature alone in Layer A change the rocks here into metamorphic rocks? Explain. _____
Layer A 90 °C
2. What could cause a rock in Layer C to change into a metamorphic rock? _____
Layer B 320 °C
Layer C 550 °C
3. What kind of rock would be formed by the magma in Layer C? _____
4. What happens to a mineral that falls below Layer D? _____
Layer D 800 °C
5. What three factors shown in the diagram can cause metamorphic rocks to form? _____



Magma