

CHAPTER 4 Rocks: Mineral Mixtures

SECTION 2 **Igneous Rock**

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- How do igneous rocks form?
- What factors affect the texture of igneous rock?

National Science Education Standards
ES 1c, 1d

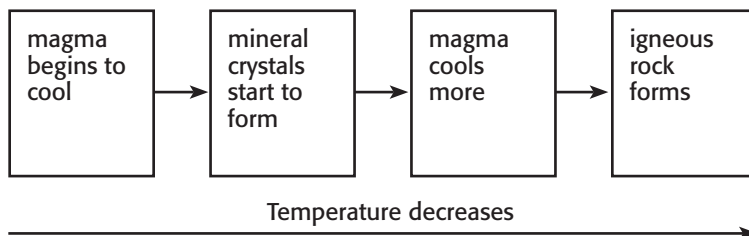
How Does Igneous Rock Form?

Igneous rocks form when hot, liquid rock, or *magma*, cools and hardens. There are three main ways that magma can form.

- An *increase in temperature*: when temperature increases, the minerals in a rock can melt.
- A *decrease in pressure*: hot rock can remain solid if it is under high pressure deep within the Earth. When the hot rock rises to the surface, the pressure goes down, and the rock can melt.
- An *addition of fluids*: when fluids, such as water, mix with rock, the melting temperature of the rock decreases and the rock can melt. ✓

When magma cools enough, mineral crystals form. This is similar to how water freezes. When you put water into the freezer, the water cools. When its temperature gets low enough, crystals of ice form. In the same way, crystals of different minerals can form as magma cools.

Water is made of a single compound. Therefore, all water freezes at the same temperature (0°C). However, magma is made of many different compounds. These compounds can combine to form different minerals. Each mineral becomes solid at a different temperature. Therefore, as magma cools, different parts of it become solid at different temperatures. Magma can become solid, or freeze, between 700°C and 1,250°C. ✓



STUDY TIP

Compare After you read this section, make a table comparing the properties of intrusive igneous rock and extrusive igneous rock.

READING CHECK

1. Identify Give three ways that magma can form.

READING CHECK

2. Explain Why do different parts of magma become solid at different times?

SECTION 2 Igneous Rock *continued*

How Do Geologists Classify Igneous Rocks?

Geologists group igneous rocks by how they form. Geologists use clues from the rocks' compositions and textures to guess how they formed.

COMPOSITION

Based on composition, there are two main groups of igneous rocks—felsic rocks and mafic rocks. *Felsic* igneous rocks are rich in elements such as sodium, potassium, and aluminum. These elements combine to form light-colored minerals. Therefore, most felsic igneous rocks are light-colored. Granite and rhyolite are examples of felsic rocks.

Mafic igneous rocks are rich in elements such as iron, magnesium, and calcium. These elements combine to form dark-colored minerals. Therefore, most mafic igneous rocks are dark-colored. Gabbro and basalt are examples of mafic rocks.

TEXTURE

Remember that the texture of a rock is determined by the sizes of the grains in the rock. The texture of an igneous rock depends on how fast the magma cooled.

When magma cools quickly, mineral crystals do not have time to grow very large. Therefore, the rock that forms has a fine-grained texture. When magma cools slowly, large mineral crystals can form. Therefore, the rock that forms has a coarse-grained texture.

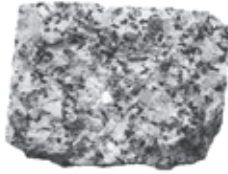

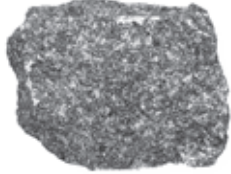

Critical Thinking

3. Compare Give two differences between felsic and mafic igneous rocks.

TAKE A LOOK

4. Identify Give an example of a felsic, fine-grained igneous rock.

5. Identify Give an example of a mafic, coarse-grained igneous rock.

	Coarse-grained	Fine-grained
Felsic	 Granite	 Rhyolite
Mafic	 Gabbro	 Basalt

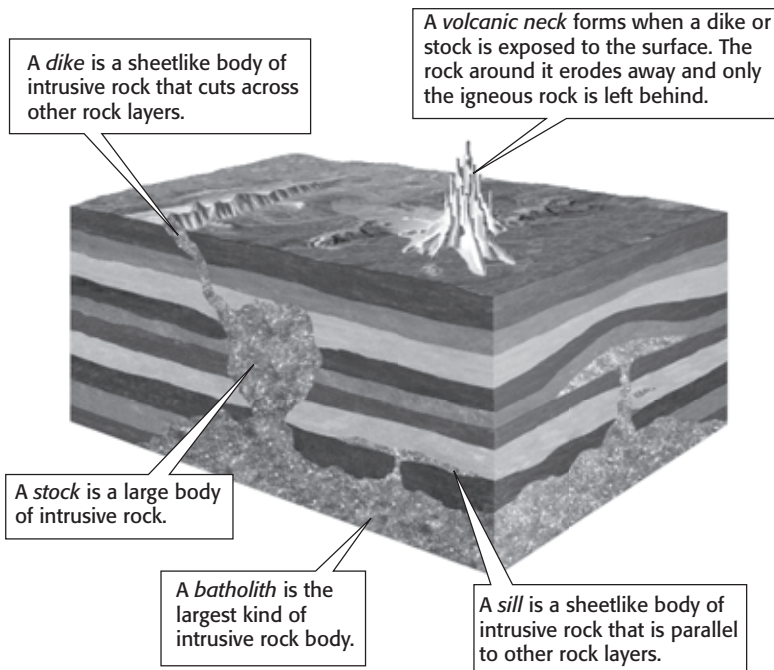
SECTION 2 Igneous Rock *continued*

Rock's Texture?

Many people know that volcanoes form from melted rock. Therefore, they may think that igneous rocks only form at volcanoes on the Earth's surface. However, some igneous rocks form deep within the Earth's crust.

INTRUSIVE IGNEOUS ROCKS

Intrusive igneous rock forms when magma cools below the Earth's surface. Because the magma cools slowly, intrusive igneous rock usually has a coarse-grained texture. The minerals can grow into large, visible crystals. Bodies of intrusive igneous rock are grouped by their sizes and shapes. ✓



✓ **READING CHECK**

6. Define Write your own definition for intrusive igneous rock.

TAKE A LOOK

7. Identify Give four kinds of intrusive rock bodies.

EXTRUSIVE IGNEOUS ROCKS

Magma that reaches the Earth's surface is called *lava*. **Extrusive igneous rock** forms when lava cools. Extrusive igneous rock is common around volcanoes. Because extrusive rock cools quickly, it contains very small crystals or no crystals. ✓

When lava erupts from a volcano, it forms a *lava flow*. Lava flows can cover the land and bury objects on the Earth's surface.

Sometimes, lava erupts and flows along long cracks in Earth's crust called *fissures*. Many fissures are found on the ocean floor. Lava can also flow out of fissures onto land and form a *lava plateau*.

✓ **READING CHECK**

8. Explain Why do extrusive rocks have very small crystals or no crystals?

Section 2 Review

NSES ES 1c, 1d

SECTION VOCABULARY

extrusive igneous rock rock that forms from the cooling and solidification of lava at the Earth's surface

intrusive igneous rock rock formed from the cooling and solidification of magma beneath the Earth's surface

1. Compare How are intrusive and extrusive igneous rocks different?

2. Identify Give two examples of fine-grained igneous rocks.

3. Describe How does a volcanic neck form?

4. Compare What is the difference between a dike and a sill?

5. Predict An igneous rock forms from slowly cooled magma deep beneath the surface of the Earth. Is the rock intrusive or extrusive? What type of texture does the rock probably have? Explain your answer.

6. Apply Concepts Complete the table below. (Hint: What is the texture of each rock?)

Rock Name	Composition	Intrusive or Extrusive?
basalt	mafic	
gabbro	mafic	
granite	felsic	
rhyolite	felsic	

- In the box: sediment
Above the arrow: pressure
- texture, composition
- how fast the magma cools
- Different minerals form under different conditions. The minerals in a rock determine its composition.

SECTION 2 IGNEOUS ROCK

- increasing temperature, decreasing pressure, addition of fluids
- Magma contains many minerals that solidify at different temperatures.
- Most felsic rocks are light-colored and rich in Na, K, and Al. Most mafic rocks are dark-colored and rich in Fe, Mg, and Ca.
- rhyolite
- gabbro
- rock that forms when melted rock cools slowly underground
- dike, stock, sill, batholith
- The lava cools very quickly.

Review

- Intrusive rock forms below the surface and has a coarse-grained texture. Extrusive rock forms above the surface and has a fine-grained texture.
- basalt, rhyolite
- A stock or dike forms. Then, the rock around it erodes away. The igneous rock is left over as a volcanic neck.
- A dike cuts across rock layers, but a sill is parallel to other, previous layers.
- It probably has a coarse-grained texture because it cooled slowly (or because it is an intrusive rock).
- extrusive, intrusive, intrusive, extrusive

SECTION 3 SEDIMENTARY ROCK

- at or near the Earth's surface
- calcite, quartz
- coarse-grained
- Minerals crystallize from water.
- Rock made from the shells of sea creatures.
- Sediment is deposited in layers.

Review

- the arrangement of rocks in layers

- sandstone, shale, siltstone, conglomerate
- Clastic sedimentary rock forms when rock or mineral fragments are cemented together. Organic sedimentary rock forms from the remains of once-living organisms.
- Evaporite forms when halite and gypsum crystallize as water evaporates.
- Fossiliferous limestone forms from the fossils of animals in the ocean. Skeletons of sea animals collect on the ocean floor. These animal remains become cemented together to form limestone.
- The sediment was probably deposited in an area with steady winds or running water. Wind and water produce ripples in sediment. These ripples can be preserved as ripple marks in sedimentary rock.

SECTION 4 METAMORPHIC ROCK

- Minerals react to produce new minerals.
- Mineral molecules moved together during metamorphism.
- metamorphism that happens when rock is heated by nearby magma
- where rock is deeply buried or where pieces of crust collide
- squeezing
- Sillimanite is more likely to be found in a metamorphic rock because it forms under high temperatures and pressures.
- Minerals like quartz form under a range of temperatures and pressures.
- chlorite
- a metamorphic rock in which the minerals are arranged in bands
- gneiss
- They can change.

Type of metamorphic rock	Description	Example
Foliated	Minerals are arranged in bands or stripes.	gneiss
Nonfoliated	Minerals are not arranged in bands or stripes.	quartzite

Review

- Foliated rocks have minerals arranged in bands. Nonfoliated rocks do not.
- Regional metamorphism happens when high temperatures and pressures cause rock in a large area to change.