

Mountain Building

ESSENTIAL QUESTION

How do mountains form?

By the end of this lesson, you should be able to describe how the movement of Earth's tectonic plates causes mountain building.

The highest peak in the Alps mountain range is Mont Blanc at just over 4,800 m tall.

Lesson Labs

Quick Labs

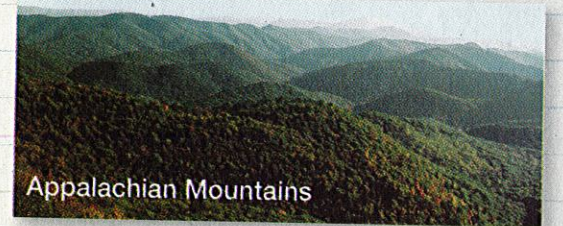
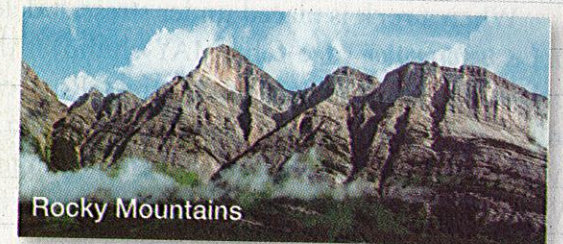
- What Happens When Objects Collide?
- Modeling Mountains
- Modeling Geological Processes

Engage Your Brain

1 Predict Check T or F to show whether you think each statement is true or false.

- | T | F |
|--------------------------|--------------------------|
| <input type="checkbox"/> | <input type="checkbox"/> |
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- Mountains can originate from a level surface that is folded upward.
- Rocks can be pulled apart by the movement of tectonic plates.
- All mountains are created by volcanoes.
- A mountain range can form only at the edge of a tectonic plate.

2 Hypothesize The Appalachian Mountains were once taller than the Rocky Mountains. What do you think happened to the mountains? Explain.



Active Reading

3 Compare The terms *compression* and *tension* have opposite meanings. Compare the two sentences below, then write your own definition for *compression* and *tension*.

Vocabulary	Sentence
compression	The stack of books on Jon's desk caused the bottom book to be flattened by <u>compression</u> .
tension	Keisha pulled the piece of string so hard, the <u>tension</u> caused the string to break.

compression:

tension:

Vocabulary Terms

- deformation
- folding
- fault
- shear stress
- tension
- compression

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

Stressed Out

How can tectonic plate motion cause deformation?

The movement of tectonic plates places stress on rocks. A tectonic plate is a block of lithosphere that consists of crust and the rigid outermost part of the mantle. **Stress** is the amount of force per unit area that is placed on an object. Rocks can bend or break under stress. In addition, low temperatures make materials more brittle, or easily broken. High temperatures can allow rock to bend.

When a rock is placed under stress, it deforms, or changes shape. **Deformation** (dee•fohr•MAY•shuhn) is the process by which rocks change shape when under stress. Rock can bend if it is placed under high temperature and pressure for long periods of time. If the stress becomes too great, or is applied quickly, rock can break. When rocks bend, folds form. When rocks break, faults form.

Active Reading

5 Identify As you read, list some objects near you that can bend or break from deformation.

By applying stress, the boy is causing the spaghetti to deform. Similarly, stress over a long period of time can cause rock to bend.



Like the spaghetti, stress over a short period of time or great amounts of stress can cause rock to break.



Visualize It!

6 Correlate How can the same material bend in one situation but break in another?

What are two kinds of folds?

Folded rock layers appear bent or buckled. **Folding** occurs when rock layers bend under stress. The bends are called **folds**. Scientists assume that all rock layers start out as horizontal layers deposited on top of each other over time. Sometimes, different layers of rocks can still be seen even after the rocks have been folded. When scientists see a fold, they know that deformation has happened. Two common types of folds are synclines and anticlines.

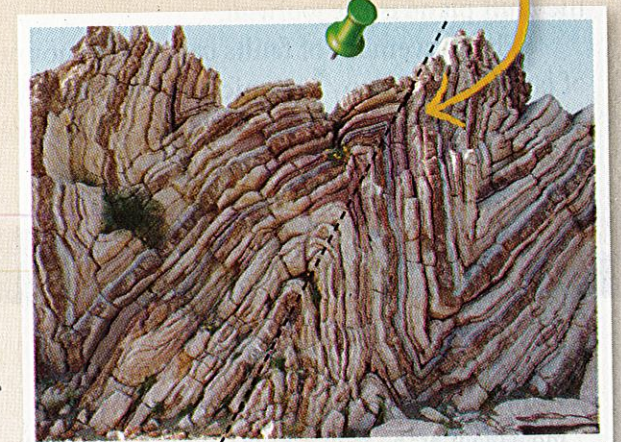
Synclines and Anticlines

Folds are classified based on the age of the rock layers. In a **syncline** (SIN•klyn), the youngest layers of rock are found at the core of a fold. The oldest layers are found on the outside of the fold. Synclines usually look like rock layers that are arched upward, like a bowl. In an **anticline** (AN•tih•klyn), the oldest layers of rock are found at the core of the fold. The youngest layers are found on the outside of the fold. Anticlines often look like rock layers that are arched downwards and high in the middle. Often, both types of folds will be visible in the same rock layers, as shown below.

Think Outside the Book

7 Model Stack several sheets of paper together. Apply stress to the sides of the paper to create a model of a syncline and an anticline. Share your model with your teacher.

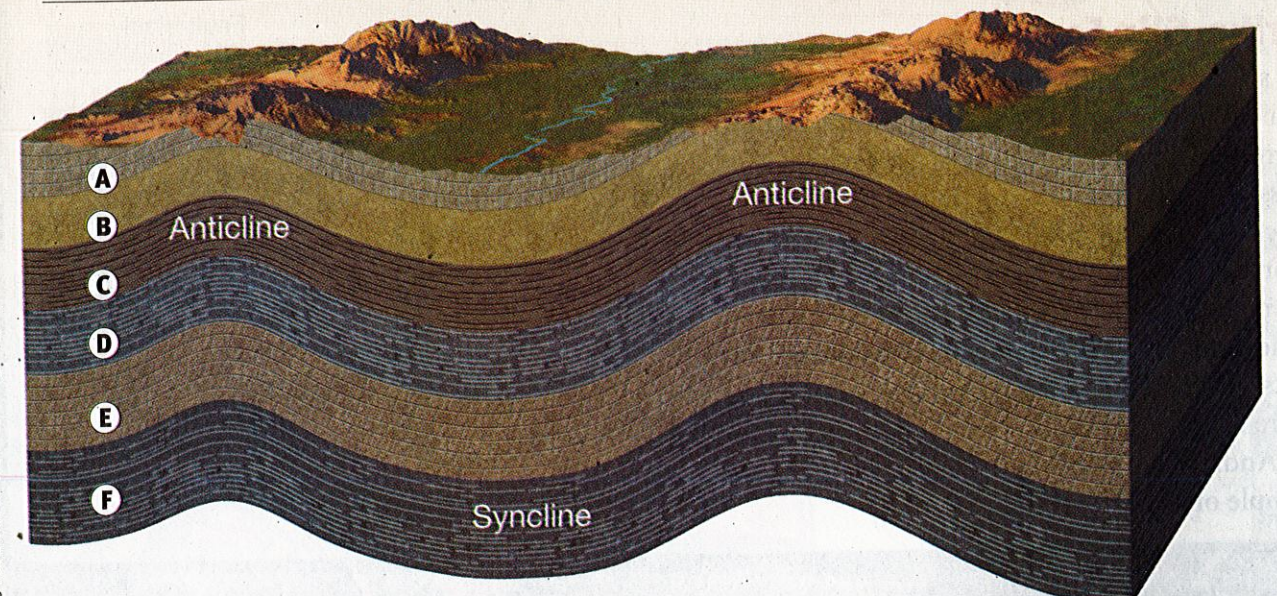
The hinge is the middle point of the bend in a syncline or anticline.



Visualize It!

8 Identify Rock layers are labeled on the image below. Which rock layers are the youngest and oldest?

How do you know? _____



Faulted

What are the three kinds of faults?

Rock can be under so much stress that it cannot bend and may break. The crack that forms when large blocks of rock break and move past each other is called a **fault**. The blocks of rock on either side of the fault are called **fault blocks**. The sudden movement of fault blocks can cause earthquakes.

Any time there is a fault in Earth's crust, rocks tend to move in predictable ways. Earth has three main kinds of faults: strike-slip faults, normal faults, and reverse faults. Scientists classify faults based on the way fault blocks move relative to each other. The location where two fault blocks meet is called the **fault plane**. A fault plane can be oriented horizontally, vertically, or at any angle in between. For any fault except a perfectly vertical fault, the block above the fault plane is called the **hanging wall**. The block below the fault plane is the **footwall**.

The movement of faults can create mountains and other types of landforms. At any tectonic plate boundary, the amount of stress on rock is complex. Therefore, any of the three types of faults can occur at almost all plate boundaries.

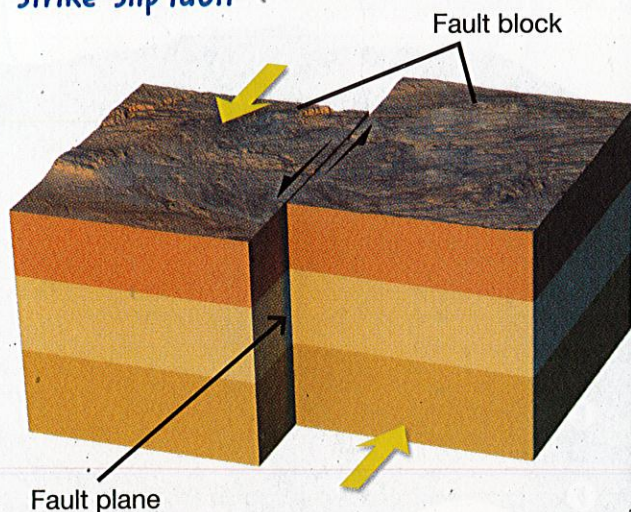
Active Reading

9 Identify As you read, underline the direction of movement of the fault blocks in each type of fault.

Strike-Slip Faults

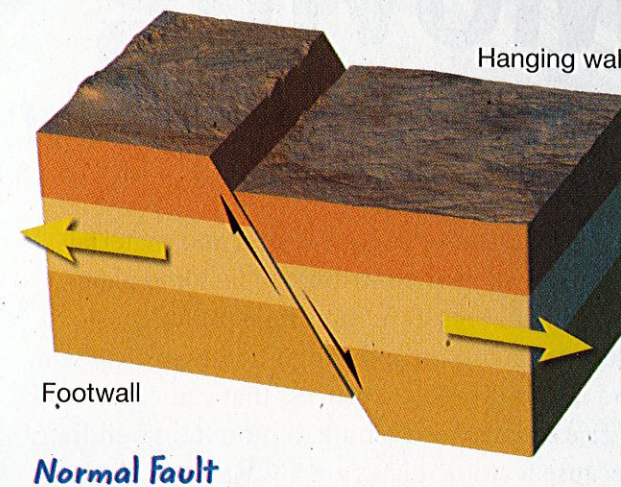
In a strike-slip fault, the fault blocks move past each other horizontally. Strike-slip faults form when rock is under shear stress. **Shear stress** is stress that pushes rocks in parallel but opposite directions as seen in the image. As rocks are deformed deep in Earth's crust, energy builds. The release of this energy can cause earthquakes as the rocks slide past each other. Strike-slip faults are common along transform boundaries, where tectonic plates move past each other. The San Andreas fault system in California is an example of a strike-slip fault.

Strike-Slip Fault



Normal Faults

In the normal fault shown on the right, the hanging wall moves down relative to the footwall. The faults are called normal because the blocks move in a way that you would *normally* expect as a result of gravity. Normal faults form when the rock is under tension. **Tension** (TEN•shun) is stress that stretches or pulls rock apart. Therefore, normal faults are common along divergent boundaries. Earth's crust can also stretch in the middle of a tectonic plate. The Basin and Range area of the southwestern United States is an example of a location with many normal fault structures.

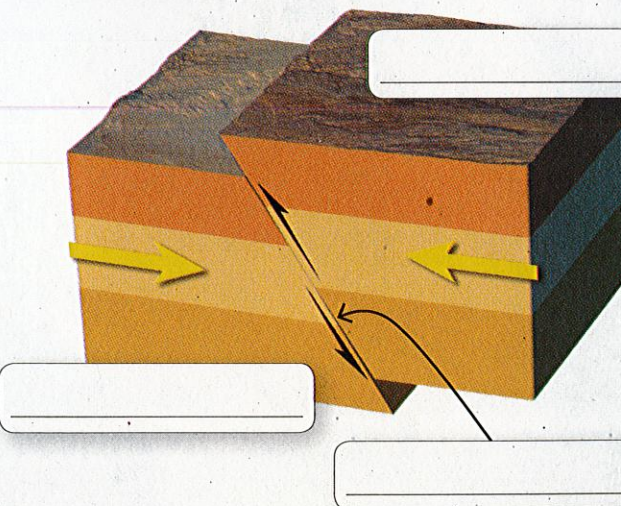


Normal Fault

Reverse Faults

In the reverse fault shown on the right, the hanging wall moves up relative to the footwall. The faults are called reverse because the hanging blocks move up, which is the reverse of what you would expect as a result of gravity. Reverse faults form when rocks undergo compression. **Compression** (kuhm•PRESH•uhn) is stress that squeezes or pushes rock together. Reverse faults are common along convergent boundaries, where two plates collide. The San Gabriel Mountains in the United States are caused by reverse faults.

Reverse Fault



Visualize It!

10 Identify Label the fault plane, hanging wall, and footwall on the reverse fault to the right.

Think Outside the Book Inquiry

11 Compile Create a memory matching game of the types of faults. Create as many cards as you can with different photos, drawings, or written details about the types of faults. Use the cards to quiz yourself and your classmates.

Moving On Up

What are the three kinds of mountains?

The movement of energy as heat and material in Earth's interior contribute to tectonic plate motions that result in mountain building. Mountains can form through folding, volcanism, and faulting. *Uplift*, a process that can cause land to rise can also contribute to mountain building. Because tectonic plates are always in motion, some mountains are constantly being uplifted.

Active Reading 12 Identify As you read, underline examples of folded, volcanic, and fault-block mountains.

Folded Mountains

Folded mountains form when rock layers are squeezed together and pushed upward. They usually form at convergent boundaries, where plates collide. For example, the Appalachian Mountains (ap•uh•LAY•chun) formed from folding and faulting when the North American plate collided with the Eurasian and African plates millions of years ago.

In Europe, the Pyrenees (PIR•uh•neez) are another range of folded mountains, as shown below. They are folded over an older, pre-existing mountain range. Today, the highest peaks are over 3,000 m tall.

Visualize It!

13 Identify What evidence do you see that the Pyrenees Mountains are folded mountains?

The Pyrenees Mountains are folded mountains that separate France from Spain.

Volcanic Mountains

Volcanic mountains form when melted rock erupts onto Earth's surface. Many major volcanic mountains are located at convergent boundaries. Volcanic mountains can form on land or on the ocean floor. Volcanoes on the ocean floor can grow so tall that they rise above the surface of the ocean, forming islands. Most of Earth's active volcanoes are concentrated around the edge of the Pacific Ocean. This area is known as the Ring of Fire. Many volcanoes, including Mt. Griggs in the image to the right, are located on the Northern rim of the Pacific plate in Alaska.

Mt. Griggs volcano on the Alaskan Peninsula is 2,317 m high.

Fault-Block Mountains

Fault-block mountains form when tension makes the lithosphere break into many normal faults. Along the faults, pieces of the lithosphere drop down compared with other pieces. The pieces left standing form fault-block mountains. The Teton Mountains (TEE•tuhn) and the Sierra Nevadas are fault-block mountains.

The Teton Mountains in Wyoming are fault-block mountains.

14 Identify Draw a simple version of each type of mountain below.

Folded	Volcanic	Faulted

Visual Summary

To complete this summary, fill in the blanks with the correct word or phrase. Then use the key below to check your answers. You can use this page to review the main concepts of the lesson.

Mountain Building

Rocks can bend or break under stress.



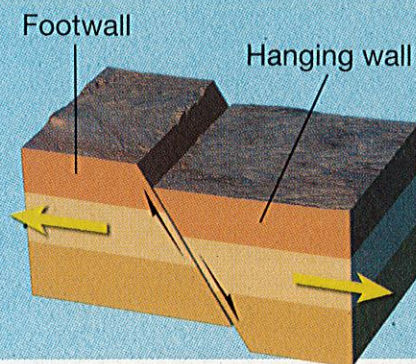
15 The process by which rocks change shape under stress is called _____.

Folds occur when rock layers bend.



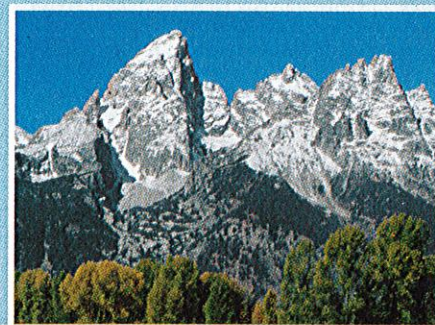
16 A rock structure with the oldest rocks at the core of the fold is called a/an _____.

Faults occur when rock layers break.



17 The type of fault pictured is a _____ fault.

Mountains form through folding, volcanism, and faulting.



18 The type of mountains pictured are _____ mountains.

19 **Synthesize** The middle of tectonic plates tend to have fewer mountains than locations near tectonic plate boundaries. What might be one possible explanation for this?

Lesson Review

Vocabulary

Fill in the blank with the term that best completes the following sentences.

- 1 A normal fault is a result of a type of stress known as _____.
- 2 A strike-slip fault is a result of _____ stress.
- 3 A reverse fault is caused by a type of stress known as _____.

Key Concepts

Fill in the table below by identifying the type of mountain described in the example question.

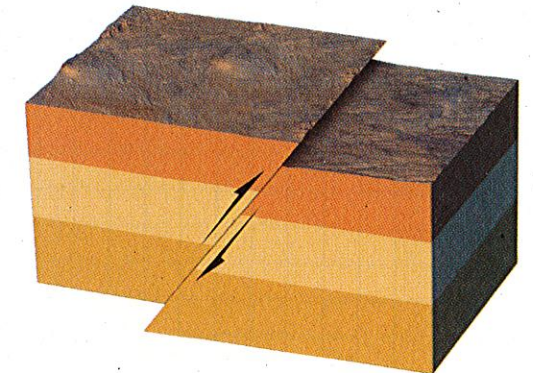
Example	Type of Mountain
4 Identify The Basin and Range province is characterized by many normal faults.	
5 Identify The Cascade Range in the United States has many eruptive mountains.	
6 Identify The Pyrenees Mountains have many syncline and anticline structures.	

7 **Describe** How does the movement of tectonic plates cause deformation in rock?

8 **Compare** How do folded, volcanic, and fault-block mountains differ?

Critical Thinking

Use the diagram below to answer the following questions.



9 **Correlate** What type of stress caused the fault shown in the image?

10 **Apply** Along which type of tectonic plate boundary would this fault be common? How do you know?

11 **Analyze** Can rock undergo compression, tension, and shear stress all at once? Explain.

12 **Conclude** Imagine you are walking along a roadway and see a syncline. What can you conclude about the formation of that fold?