



1 FOCUS

Section Objectives

- 11.5** Explain how mountains are classified.
- 11.6** Explain the difference between folded mountains and fault-block mountains.
- 11.7** Describe the formation of a dome.

Reading Focus

Build Vocabulary

L2

Concept Map Have students make a concept map using all the vocabulary terms. Maps should begin with the term *orogenesis*.

Reading Strategy

L2

Sample answers:

What are folded mountains?

- mountains formed primarily by folding
- formed by compressional stress
- formed also by thrust faulting
- What are fault-block mountains?*
- formed from tensional stress
- consist of elongated mountain ranges
- separated by valleys formed by grabens
- What are domes and basins?*
- formed by uplifting of basement rock
- produce circular or elongated structures
- usually found isolated, not as part of mountain range

2 INSTRUCT

Folded Mountains

Build Reading Literacy

L1

Refer to p. 362D in Chapter 13, which provides the guidelines for using prior knowledge.

Use Prior Knowledge Have students review the material on folds in Section 1. Have them draw a diagram of an anticline and a syncline. Ask: **What are three types of folds?** (*anticlines, synclines, and monoclines*) **What types of folds can you see in the photograph in Figure 8?** (*anticlines and synclines*) **Logical, Visual**

Reading Focus

Key Concepts

- How are mountains classified?
- What are the major types of mountains?

Vocabulary

- ◆ orogenesis
- ◆ folded mountain
- ◆ fault-block mountain
- ◆ graben
- ◆ horst
- ◆ uplifted mountain

Reading Strategy

Previewing Make a table like the one below. Before you read the section, rewrite the green topic headings as questions. As you read, write answers to the questions.

Types of Mountains	
What are folded mountains?	
a. _____ ?	_____
b. _____ ?	_____
c. _____ ?	_____

Mountains are one of the most inspiring features on Earth. The collection of processes that produce a mountain belt is called **orogenesis**. The rocks in mountains provide striking evidence of the enormous compressional forces that have deformed and lifted Earth's crust. Folding is often the most obvious sign of these forces, but thrust faulting, metamorphism, and igneous activity are also important processes in mountain building. ➤ **Mountains are classified by the dominant processes that have formed them.**

Figure 8 Folded Mountains

Folded sedimentary layers are exposed in the northern Rocky Mountains on the face of Mount Kidd, Alberta, Canada.



Folded Mountains

Many mountains contain huge spectacular folds of rocks, as shown in Figure 8. ➤ **Mountains that are formed primarily by folding are called folded mountains.** Compressional stresses are the major force that forms folded mountains.

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Customize for English Language Learners

Encourage students to use a dictionary to find the origins of the term *orogenesis*. (*from the Greek word parts oros- meaning "mountain" and genesis meaning to "come into being"*) Inform students that the words *rise*, *arise*, and

rose also come from the Greek word part *oros*. Have students look up these words and explain why they might come from a word meaning "mountain."

Thrust faulting is also important in the formation of folded mountains, which are often called fold-and-thrust belts. Folded mountains often contain numerous stacked thrust faults that have displaced the folded rock layers many kilometers horizontally. The Appalachian Mountains, the northern Rocky Mountains, and the Alps in Europe are examples of folded mountain ranges.

Fault-Block Mountains

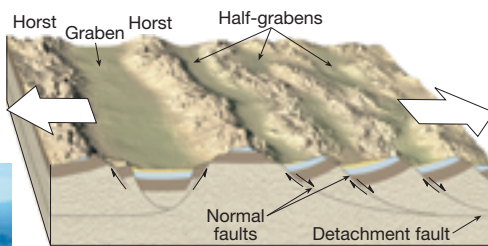
Most normal faults are small and have displacements of only a meter or so. Others extend for tens of kilometers where they may outline the boundary of a mountain front. 🔄 **Large-scale normal faults are associated with structures called fault-block mountains.** These mountains form as large blocks of crust are uplifted and tilted along normal faults.

In the western United States, examples of fault-block mountains include the Teton Range of Wyoming and the Sierra Nevada of California. Both are faulted along their eastern flanks, which were uplifted as the blocks tilted downward to the west. These steep mountain fronts were produced over a period of 5 million to 10 million years by many episodes of faulting. Each event produced just a few meters of displacement.

Normal faulting occurs where tensional stresses cause the crust to be stretched or extended. As the crust is stretched, a block called a **graben**, which is bounded by normal faults, drops down. *Graben* is the German word for ditch or trench. Grabens produce an elongated valley bordered by relatively uplifted structures called **horsts**. The Basin and Range Province of Nevada, Utah, and California, shown in Figure 9, is made of elongated grabens. Above the grabens, tilted fault-bound blocks or horsts produce linear fault-block mountains.



What is a horst?



B

A

Figure 9 Fault-Block Mountains **A** Part of the Basin and Range Province of Nevada, California, and Utah **B** Here, tensional stresses have elongated and fractured the crust into numerous blocks. Movement along these fractures has tilted the blocks producing parallel mountain ranges called fault-block mountains.

Mountain Building 315

Fault-Block Mountains

Use Visuals

L1

Figure 9 Have students examine the diagram of fault-block mountains. Ask: **What type of faults bound a graben?** (*normal faults*) **What causes a graben to form, and what type of feature does it form?** (*The crust is stretched, and the graben block drops down, forming a valley.*) **What causes the formation of a horst?** (*Fault-bound rock blocks have become uplifted and tilted.*)

Visual, Logical

Build Science Skills

L2

Using Models Have students model the formation of fault-block mountains and grabens by using three wooden blocks. If the blocks are rectangular rather than square, long narrow grabens will be formed. Suggest to students that they produce their “fault-block mountains” with several small movements rather than one large movement.



Kinesthetic, Visual

Integrate Biology

L2

East Africa Rift Valley Tell students that the Rift Valley of East Africa is nearly 6000 km long and is made up of several large grabens, above which tilted horsts produce a linear mountainous topography. The Rift Valley contains the excavation sites of some of the earliest human fossils ever found. It has been hypothesized that humans (genus *Homo*) originated in this area from 2.5 to 1.6 million years ago. Further hypotheses suggest that humans left Africa about 100,000 years ago and that all modern humans (*Homo sapiens*) have evolved from this migration. This last hypothesis is known as the “out-of-Africa” model and is supported by DNA analysis of human fossils. Ask: **How do you think scientists have learned about human origins?** (*They have studied the fossil record and compared the DNA of various groups of humans.*) **What DNA evidence would support the out-of-Africa model?** (*DNA that showed similarities among different groups of humans in different parts of the world*)

Answer to . . .



A horst is an uplifted block bounded by normal faults.

Domes and Basins

MAP MASTER Skills Activity

Identify The granite core, consisting of the oldest rocks, is found in the center or core of the Black Hills in the area labeled “Central crystalline area.”

3 ASSESS

Evaluate Understanding

L2

To assess students’ knowledge of the section content, have each student draw a labeled diagram of one of the three types of mountains discussed in this section. Each student should then exchange his or her diagram with a classmate who diagramed a different type of mountain. Each student should label the type of mountain shown in one another’s drawing. The student who made the diagram should be sure the label is correct.

Reteach

L1

Have students make a table of mountain types. For each type of mountain listed, students should describe its features and explain how it was formed.

Writing In Science

Answers will vary but should accurately reflect the structures and rocks commonly found in uplifted mountains. Uplifted mountains have sedimentary rocks around the outside, tilted away from the center of the mountains. The core of the mountains could be older sedimentary rocks, older igneous or metamorphic rocks, or an exposed intrusive igneous laccolith.

Answer to . . .



in the center or core of the dome

MAP MASTER Skills Activity

Domed Mountains

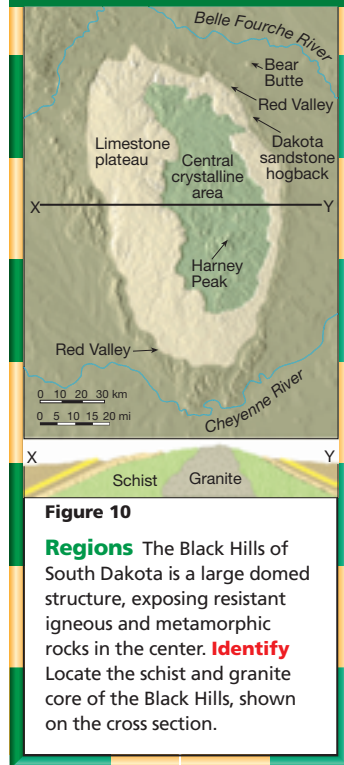


Figure 10

Regions The Black Hills of South Dakota is a large domed structure, exposing resistant igneous and metamorphic rocks in the center. **Identify** Locate the schist and granite core of the Black Hills, shown on the cross section.

Domes and Basins

The Black Hills of western South Dakota form a large domed structure thought to be formed by upwarping. Broad upwarping in basement rock may deform the overlying cover of sedimentary strata. This upwarping can generate large folds. **When upwarping produces a circular or elongated structure, the feature is called a dome.** Erosion has stripped away the highest portion of the sedimentary beds in the Black Hills, exposing older igneous and metamorphic rocks in the center. Look at the map in Figure 10. The remnants of the sedimentary layers surround the crystalline core of the mountains. The oldest rocks form the core.



Where are the oldest rocks found in a dome?

Downwarped structures having a circular shape are called basins. Several large basins exist in the United States. The basins of Michigan and Illinois have very gently sloping beds similar to saucers. These basins are thought to be the result of large accumulations of sediment, whose weight caused the crust to subside.

Because large basins usually contain sedimentary beds sloping at very low angles, the basins are usually identified by the age of the rocks composing them. The youngest rocks are found near the center. The oldest rocks are at the flanks. A geologic map of lower Michigan, for example, looks somewhat like a bull’s-eye. The oldest rocks are near the center of the state. Progressively younger rocks ring the center. This is just the opposite order of a domed structure, such as the Black Hills, where the oldest rocks form the core.

Section 11.2 Assessment

Reviewing Concepts

- Describe how mountains are classified.
- List the major types of mountains.
- What is a graben? In what type of mountains are grabens most commonly found?
- What is the dominant type of stress associated with folded mountains?

Critical Thinking

- Applying Concepts** In a mountain range, you observe a series of anticlines and synclines and numerous thrust faults. How would you classify the type of mountains in this mountain range?

- Comparing and Contrasting** Compare uplifted mountains and fault-block mountains.

Writing In Science

Descriptive Paragraph Write a paragraph describing a trip across an uplifted mountain. Describe the types of rocks and structures you might observe.

Section 11.2 Assessment

- Mountains are classified by the processes that are involved in forming them.
- folded mountains, fault-block mountains, and uplifted or domed mountains
- A graben is a block that is bounded by normal faults that has been down-dropped. Grabens are most commonly found in fault-block mountains.
- compressional stress
- Most likely, it is a folded mountain range.

- Uplifted mountains are formed when a large basement block or a laccolith uplifts the overlying rocks. Uplifted mountains commonly are isolated and are not part of a mountain range. Fault-block mountains are formed when tensional stresses cause an area to be stretched by normal faulting. The area is faulted to form elongated valleys or grabens, separated by horsts or uplifted blocks that form linear fault-block mountains.