How to Use This Presentation

- To View the presentation as a slideshow with effects select "View" on the menu bar and click on "Slide Show."
- To advance through the presentation, click the right-arrow key or the space bar.
- From the resources slide, click on any resource to see a presentation for that resource.
- From the Chapter menu screen click on any lesson to go directly to that lesson's presentation.
- You may exit the slide show at any time by pressing the Esc key.

End Of Slide

Chapter menu | Resources

Resources

Chapter Presentation

Visual Concepts

Transparencies

Standardized Test Prep

Brain Food Video Quiz

Table of Contents

Objectives

- **Identify** the three major types of rock, and explain how each type forms.
- **Summarize** the steps in the rock cycle.
- **Explain** Bowen's reaction series.
- **Summarize** the factors that affect the stability of rocks.

End Of Slide

Three Major Types of Rock

- The material that makes up the solid parts of Earth is known as *rock*.
- Based on the processes that form and change the rocks of Earth's crust, geologists classify rocks into three major types by the way the rocks form.
- Igneous rock forms when magma, or molten rock, cools and hardens.

End Of Slide

Three Major Types of Rock, *continued*

- Sedimentary rock forms when sediment deposits that form when rocks, mineral crystals, and organic matter have been broken into fragments, called *sediments*, are compressed or cemented together.

- Metamorphic rock forms when existing rock is altered by changes in temperature, by changes in pressure, or by chemical processes.

End Of Slide

The Rock Cycle

- Any of the three major types of rock can be changed into another of the three types.
- Geologic forces and processes cause rock to change from one type to another.
- **rock cycle** the series of processes in which rock forms, changes from one form to another, is destroyed, and forms again by geological processes

The Rock Cycle, *continued*

The diagram below shows the rock cycle.

End Of Slide

Properties of Rocks

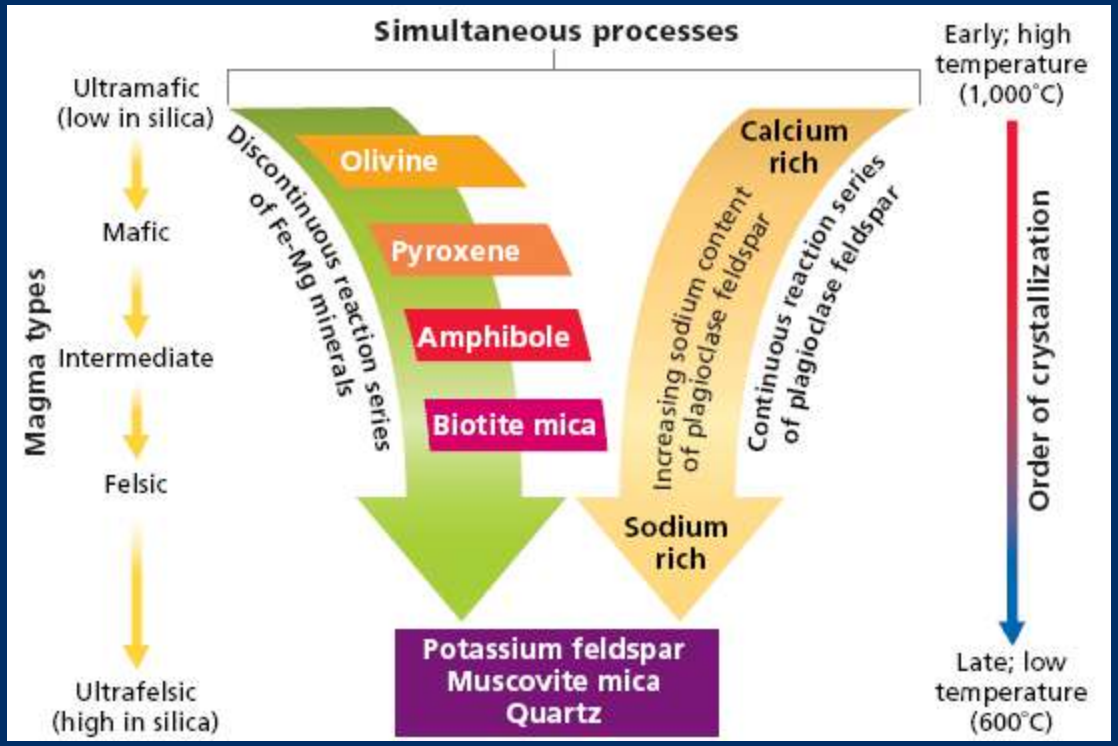
- All rock has physical and chemical properties that are determined by how and where the rock formed.
- The rate at which rock weathers and the way that rock breaks apart are determined by the chemical stability of the minerals in the rock.

Bowen's Reaction Series

- **Bowen's reaction series** the simplified pattern that illustrates the order in which minerals crystallize from cooling magma according to their chemical composition and melting point
- The pattern of mineral formation from magma depends on the chemical composition of the magma.

Properties of Rocks, *continued*

The diagram below shows Bowen's reaction series.



End Of Slide

Properties of Rocks, *continued*

Reading Check

Summarize Bowen's reaction series.

Properties of Rocks, *continued*

Reading Check

Summarize Bowen's reaction series.

As magma cools and solidifies, minerals crystallize out of the magma in a specific order that depends on their melting points.

Properties of Rocks, *continued*

Chemical Stability of Minerals

- The rate at which mineral chemically breaks down is dependent on the chemical stability of the mineral.
- *Chemical stability* is a measure of the tendency of a chemical compound to maintain its original chemical composition rather than break down to form a different chemical.
- The chemical stability of minerals is dependent on the strength of the chemical bonds between atoms in the mineral.

End Of Slide
Chapter menu
Resources

Properties of Rocks, *continued*

Physical Stability of Rocks

- Rocks have natural zones of weakness that are determined by how and where the rocks form.
- When rock that formed under intense pressure is uplifted to Earth's surface, decreased pressure allows the joints or fractures to open.
- Once these weaknesses are exposed to air and water, the processes of chemical and mechanical weathering begin.

End Of Slide
Chapter menu
Resources

Objectives

- **Summarize** three factors that affect whether rock melts.
- **Describe** how the cooling rate of magma and lava affects the texture of igneous rocks.
- **Classify** igneous rocks according to their composition and texture.
- **Describe** intrusive and extrusive igneous rock structures.

End Of Slide

The Formation of Magma

- **igneous rock** rock that forms when magma cools and solidifies
- **The three factors that affect whether rock melts include temperature, pressure, and the presence of fluids in the rock.**
- Rock melts when the t**emperature of the rock increases to above the melting point of minerals in the rock**.
- Rock **melts when excess pressure is removed from rock** that is hotter than its melting point.
- **Rock may melt when fluids, such as water, are added**. The addition of fluids generally decreases the melting point of certain minerals in the rock.

End Of Slide

The Formation of Magma, *continued*

Partial Melting

- Different minerals have different melting points, and minerals that have lower melting points are the first minerals to melt.
- As the temperature increases and as other minerals melt, the magma's composition changes.
- **The process in which different minerals in rock melt at different temperatures is called *partial melting*.**

The Formation of Magma, *continued*

The diagram below shows partial melting.

Partial Melting

This solid rock contains the minerals quartz (yellow), feldspar (gray), biotite (brown), and hornblende (green).

The first minerals that melt are quartz and some types of feldspars. The orange background represents magma.

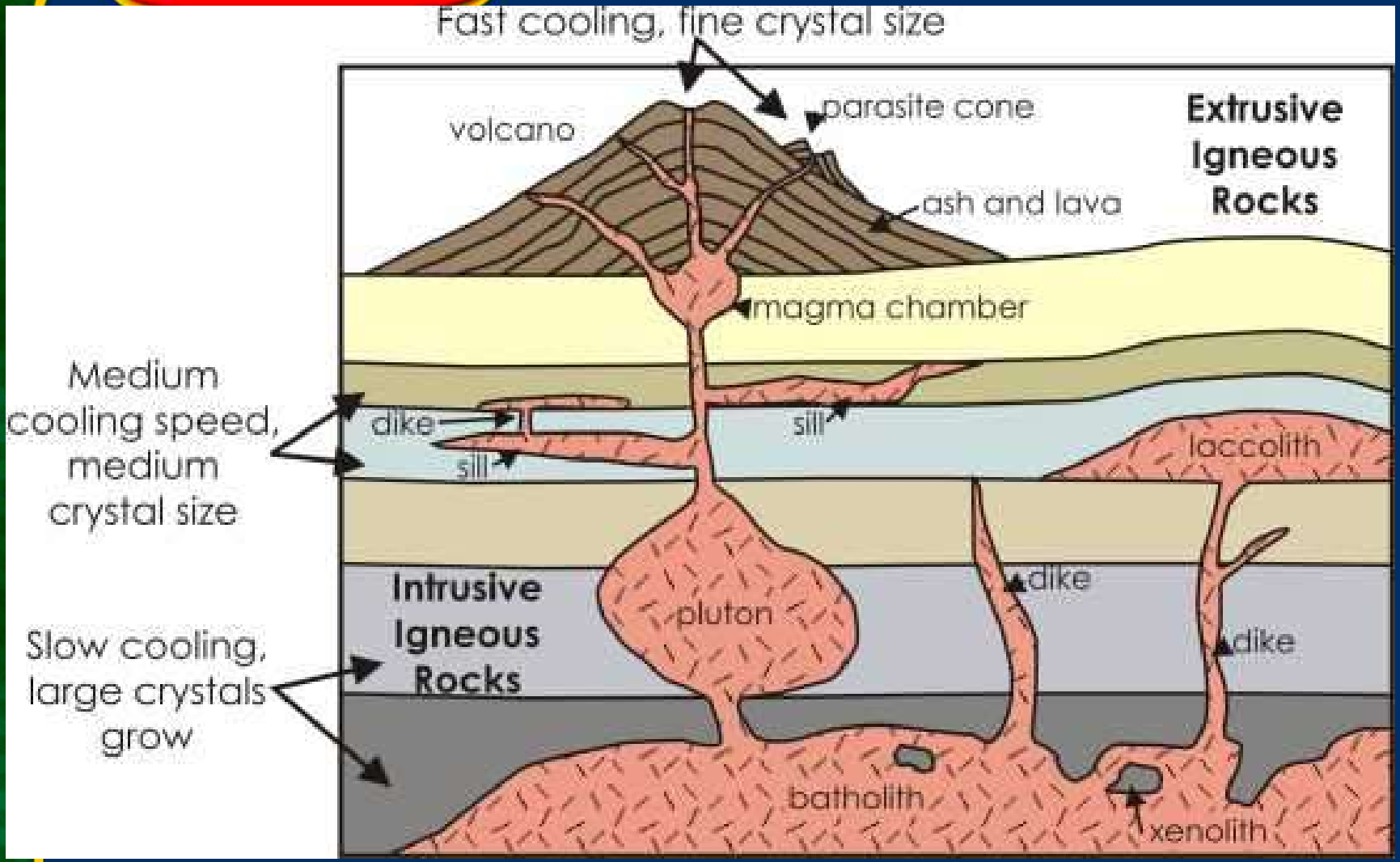
Minerals such as biotite and hornblende generally melt last, which changes the composition of the magma.

The Formation of Magma, *continued*

Fractional Crystallization

- When magma cools, the cooling process is the reverse of the process of partial melting.
- Chemicals in magma combine to form minerals, and each mineral has a different freezing point. Minerals that have the highest freezing points crystallize first.
- **The crystallization and removal of different minerals from the cooling magma is called *fractional crystallization*.**

End Of Slide



Textures of Igneous Rocks

- Igneous rocks are classified according to where magma cools and hardens.
- **intrusive igneous rock** rock formed from the cooling and solidification of magma beneath Earth's surface
- **extrusive igneous rock** rock formed from the cooling and solidification of lava at Earth's surface
- The texture of igneous rock is determined by the size of the crystals in the rock. The size of the crystals in determined mainly by the cooling rate of the magma.

End Of Slide

Textures of Igneous Rocks, *continued*

Coarse-Grained Igneous Rock

- Because intrusive igneous rocks cool slowly, they commonly have large mineral crystals.
- Igneous rocks that are composed of large, well-developed mineral grains are described as having a *coarse-grained texture*.

Fine-Grained Igneous Rock

- Because extrusive igneous rocks cool rapidly, they are commonly composed of small mineral grains.
- Igneous rocks that are composed of small crystals are described as having a *fine-grained texture*.

End Of Slide

Chapter menu

Resources

Textures of Igneous Rocks, *continued*

Other Igneous Rock Textures

- When magma cools slowly at first, but then cools more rapidly as the magma nears or reaches Earth's surface, the igneous rock that forms may have large crystals embedded within a mass of smaller crystals. This texture is called *porphyritic* texture.

- When highly viscous magma cools very rapidly, few crystals will grow. When the magma contains a small amount of dissolved gases, a *glassy texture* will result. When the magma contains a large percentage of dissolved gases, the gases are trapped as bubbles in the rock, and a *vesicular texture* will result.

End Of Slide

Textures of Igneous Rocks, *continued*

Reading Check

What is the difference between fine-grained and coarse-grained igneous rock?

Textures of Igneous Rocks, *continued*

Reading Check

What is the difference between fine-grained and coarse-grained igneous rock?

Fine-grained igneous rock forms mainly from magma that cools rapidly; coarse-grained igneous rock forms mainly from magma that cools more slowly.

Composition of Igneous Rock

- The mineral composition of an igneous rock is determined by the chemical composition of the magma from which the rock formed.

Felsic Rock

- **felsic** describes magma or igneous rock that is rich in feldspars and silica and that is generally light in color
- Common minerals in felsic rocks include potassium feldspar and quartz.
- The felsic family includes many common rocks, such as granite, rhyolite, obsidian, and pumice.

End Of Slide

Composition of Igneous Rock, *continued*

Mafic Rock

- **mafic** describes magma or igneous rock that is rich in magnesium and iron and that is generally dark in color
- Common minerals in mafic rocks include plagioclase feldspar and pyroxenes.
- The mafic family includes the common rocks basalt and gabbro.

Intermediate Rocks

- Rocks in the intermediate family contain lower proportions of silica than rocks in the felsic family do but contain higher proportions of silica than rocks in the mafic family do.
- Rocks in the intermediate family include diorite and andesite.

End Of Slide

Intrusive Igneous Rock Structures

Batholiths and Stocks

- Batholiths are intrusive formations that spread over at least 100 km^2 when they are exposed on Earth's surface.
- Stocks are similar to batholiths but cover less than 100 km^2 at the surface.
- **Laccoliths**

A laccolith is an intrusive formation that forms when magma flows between rock layers and pushes the overlying rock layers into a dome.

End Of Slide
Chapter menu
Resources

Intrusive Igneous Rock Structures, *continued*

Reading Check

What is the difference between stocks and batholiths?

End Of Slide

Intrusive Igneous Rock Structures, *continued*

Reading Check

What is the difference between stocks and batholiths?

A batholith is an intrusive structure that covers an area of at least 100 km^2. A stock covers an area of less than 100 km^2.

End Of Slide

Intrusive Igneous Rock Structures, *continued*

Sills and Dikes

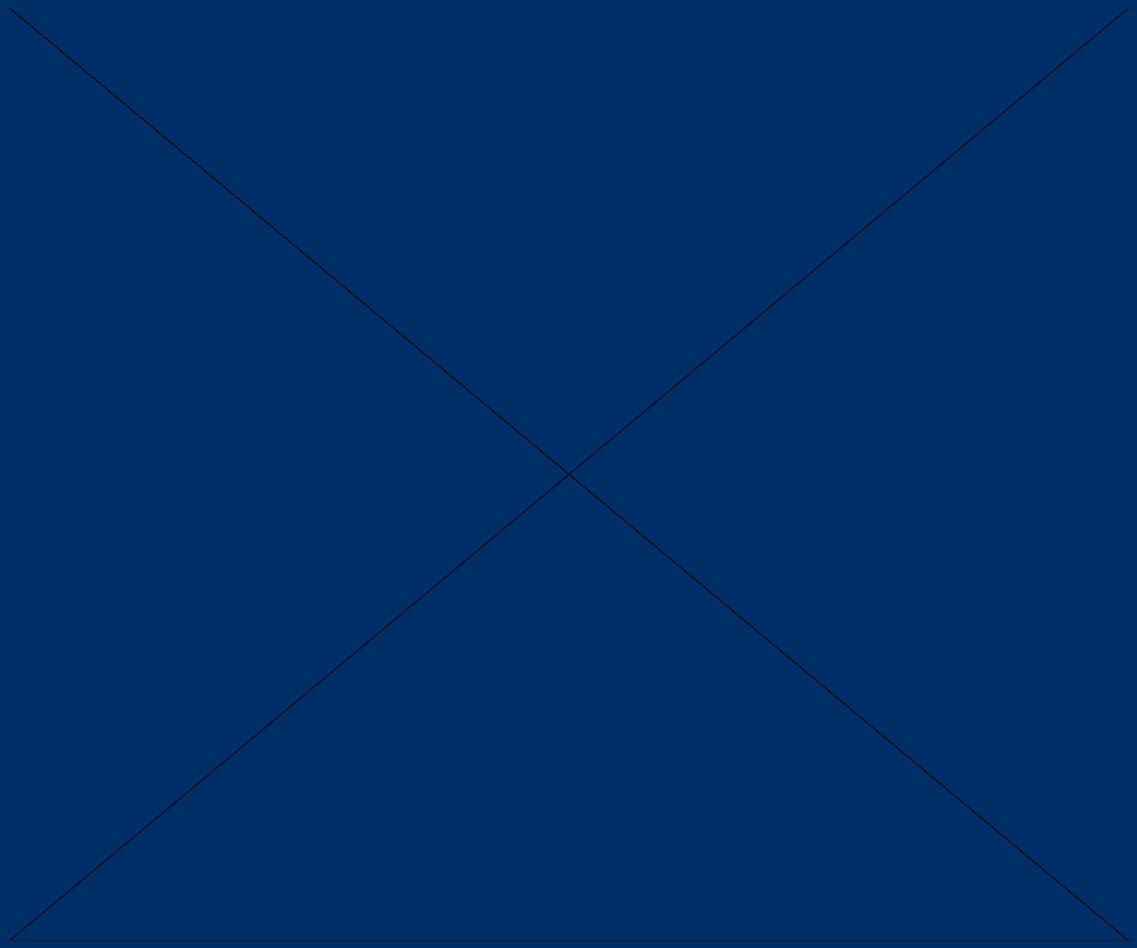
- When magma flows between layers of rock and hardens to form a body of rock that is parallel to the layers of rock that surround it, a *sill* forms.
- When magma forces its way through rock layers by following existing fractures or by creating new fractures, a *dike* forms. Dikes cut across layers rather than lying parallel to the rock layers.
- Sills and dikes vary in thickness from a few centimeters to hundreds of meters.

Extrusive Igneous Rock Structures

- Igneous rock masses that form on Earth's surface are called *extrusions*.
- A *volcano* is a vent through which magma, gases, or volcanic ash is expelled. Volcanic cones and volcanic necks are common examples of extrusive igneous structures.
- Lava flows, lava plateaus, and tuff layers are other common extrusions.

End Of Slide
Chapter menu
Resources

Comparing Intrusive and Extrusive Igneous Rock



End Of Slide

Objectives

- **Explain** the processes of compaction and cementation.
- **Describe** how chemical and organic sedimentary rocks form.
- **Describe** how clastic sedimentary rock forms.
- **Identify** seven sedimentary rock features.

End Of Slide

Formation of Sedimentary Rocks

- Most sedimentary rock is made up of combinations of different types of sediment, which is loose fragments of rock, minerals, and organic materials.
- Two main processes convert loose sediment into sedimentary rock—compaction and cementation.
- **compaction** **the process in which the volume and porosity of a sediment is decreased by the weight of overlying sediments as a result of burial beneath other sediments**
- **cementation** **the process in which minerals precipitate into pore spaces between sediment grains and bind sediments together to form rock**

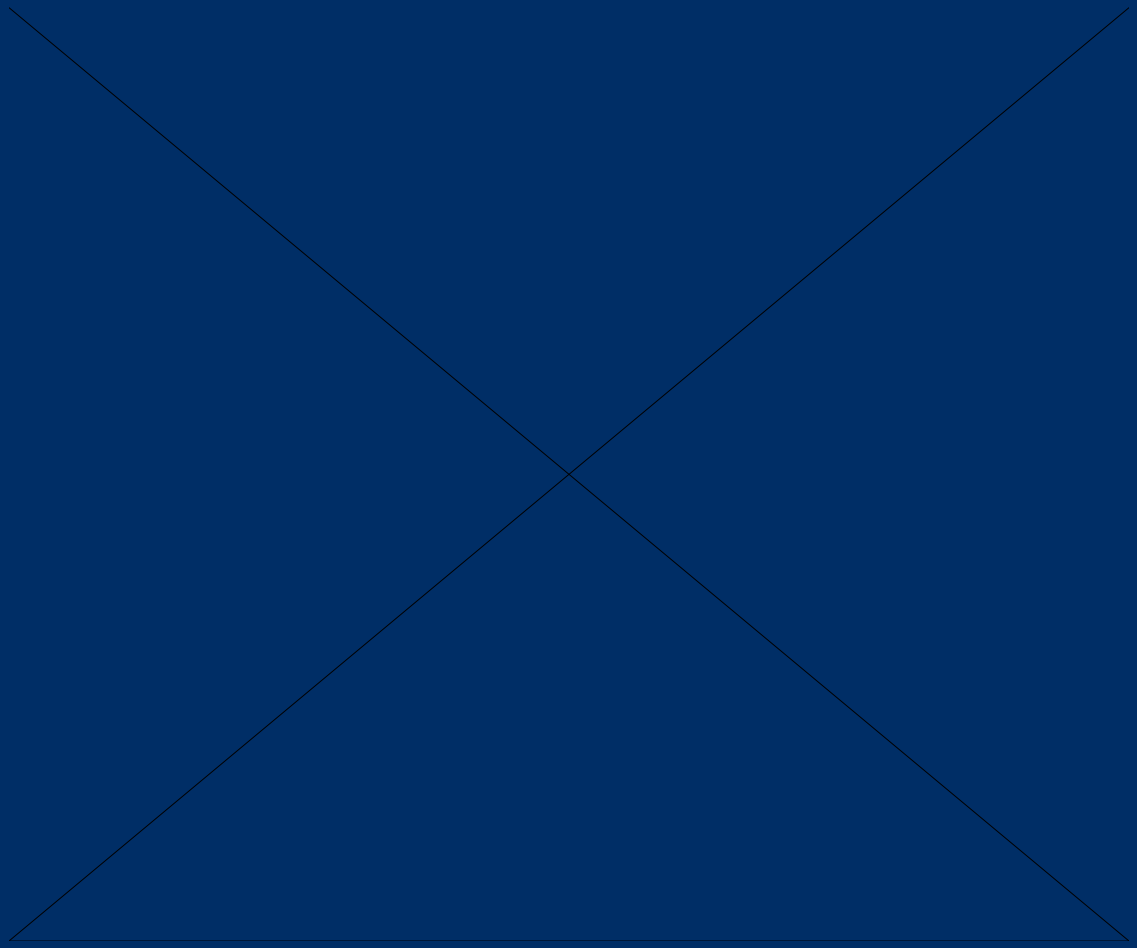
End Of Slide
Chapter menu
Resources

Formation of Sedimentary Rocks, *continued*

- Geologists classify sedimentary rocks by the processes by which the rocks form and by the composition of the rocks.
- **There are three main classes of sedimentary rocks—chemical, organic, and clastic**.
- These three classes contain their own classifications of rocks that are **grouped based on the shape, size, and composition of the sediments that form the rocks**.

End Of Slide

Types of Sedimentary Rock



End Of Slide

Chemical Sedimentary Rock

- **chemical sedimentary rock** sedimentary rock that forms when minerals precipitate from a solution or settle from a suspension
- Some chemical sedimentary rock forms when dissolved minerals precipitate out of water because of changing concentrations of chemicals.
- When water evaporates, the minerals that were dissolved in the water are left behind. Eventually, the concentration of minerals in the remaining water becomes high enough to cause minerals to precipitate out of the water.
- Rocks that form through evaporation are called *evaporites*. Gypsum and halite are common evaporites.

End Of Slide
Chapter menu
Resources

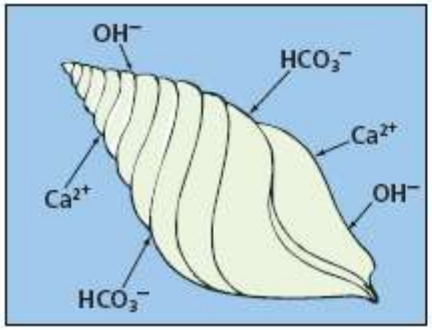
Organic Sedimentary Rocks

- **organic sedimentary rock** sedimentary rock that forms from the remains of plants or animals
- Coal and some limestones are examples of organic rocks.
- Organic limestones form when marine organisms, such as coral, clams, oysters, and plankton, remove the chemical components of the minerals calcite and aragonite from sea water.
- The organisms make their shells from these minerals, and when the organisms die, their shells settle to the bottom of the ocean, accumulate, and are compacted to form limestone.

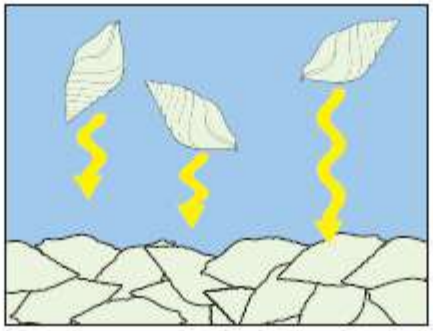
End Of Slide

Organic Sedimentary Rocks, *continued*

The diagram below shows the formation of organic limestone.



Organisms that live in lakes or oceans take chemicals from the water and produce the mineral calcium carbonate, $CaCO_3$. They use the $CaCO_3$ to build their shells or skeletons.



When the organisms die, the hard remains that are made of $CaCO_3$ settle to the lake or ocean floor.

The shells of the dead organisms pile up. Eventually, the layers are compacted and cemented to form limestone.

End Of Slide

Clastic Sedimentary Rock

- **clastic sedimentary rock** sedimentary rock that forms when fragments of preexisting rocks are compacted or cemented together
- Clastic sedimentary rocks are classified by the size of the sediments they contain.
- Rock that contains large, rounded pieces is called *conglomerate*. Rock that contains large, angular pieces is called *breccia*.
- Rock that is composed of sand-sized grains is called *sandstone*. Rock that is composed of clay-sized particles is called *shale*.

End Of Slide

Clastic Sedimentary Rock, *continued*

Reading Check

Name three groups of clastic sedimentary rock.

Clastic Sedimentary Rock, *continued*

Reading Check

Name three groups of clastic sedimentary rock.

Three groups of clastic sedimentary rock are conglomerates and breccias, sandstones, and shales.

End Of Slide

Characteristics of Clastic Sediments

- The physical characteristics of sediments are determined mainly by the way sediments were transported to the place where they are deposited.
- Sediments are transported by four main agents: water, ice, wind, and the effects of gravity.
- The speed with which the agent of erosion moves affects the size of sediment particles that can be carried and the distance that the particles will move.
- In general, both the distance the sediment is moved and the agent that moves the sediment determine the characteristics of that sediment.

End Of Slide

Characteristics of Clastic Sediments, *continued*

Sorting

- The tendency for currents of air or water to separate sediments according to size is called sorting.
- In well-sorted sediments, all of the grains are roughly the same size and shape. Poorly sorted sediment consists of grains that are many different sizes.
- The sorting of a sediment is the result of changes in the speed of the agent that is moving the sediment. Faster-moving currents can carry larger particles than slower-moving currents can.

End Of Slide
Chapter menu
Resources

Characteristics of Clastic Sediments, *continued*

Angularity

- As sediment is transported from its source to where it is deposited, the particles collide with each other and with other objects in their path. These collisions cause the particles to change size and shape.
- When particles first break from the source rock, they tend to be angular and uneven.
- Particles that have moved long distances from the source tend to be more rounded and smooth.
- In general, the farther sediment travels from its source, the finer and smoother the particles of sediment become.

End Of Slide

Sedimentary Rock Features

- The setting in which sediment is deposited is called a *depositional environment*.
- Each depositional environment has different characteristics that create specific structures in sedimentary rock. These features allow scientists to identify the depositional environment in which the rock formed.

Stratification

- Layering of sedimentary rock is called *stratification*. Stratified layers, also called *beds*, vary in thickness and composition.
- Stratification occurs when the conditions of sediment deposition change.

End Of Slide
Chapter menu
Resources

Sedimentary Rock Features, *continued*

Cross-Beds and Graded Bedding

- Cross-beds, or slanting layers within rock strata, commonly form in sand dunes or river beds.
- Graded bedding is a feature in which various sizes and kinds of materials are deposited in one layer, with the largest grains at the bottom and finest grains at the top.

Ripple Marks

- Ripple marks form when air or water flows over sand to form ripples, and the ripples are preserved in the rock. Ripple marks commonly form in sediment at the beach or on a river bed.

End Of Slide

Sedimentary Rock Features, *continued*

Reading Check

What is graded bedding?

End Of Slide

Sedimentary Rock Features, *continued*

Reading Check

What is graded bedding?

Graded bedding is a type of stratification in which different sizes and types of sediments settle to different levels.

Sedimentary Rock Features, *continued*

Mud Cracks

- Mud cracks form when muddy deposits dry and shrink. The shrinking causes the drying mud to crack.
- Mud cracks form on river floodplains or on dry lake beds.

Fossils and Concretions

- Fossils are the remains of organisms that are preserved in rock.
- Concretions are lumps of minerals that precipitate from fluids and build up around a nucleus or in a cavity in existing rock.

End Of Slide

Objectives

- **Describe** the process of metamorphism.
- **Explain** the difference between regional and contact metamorphism.
- **Distinguish** between foliated and nonfoliated metamorphic rocks, and give an example of each.

End Of Slide
Chapter menu
Resources

Formation of Metamorphic Rocks

- **metamorphism** the process in which one type of rock changes into metamorphic rock because of chemical processes or changes in temperature and pressure
- During metamorphism, heat, pressure, and hot fluids cause some minerals to change into other minerals.
- Minerals may also change in size or shape, or they may separate into parallel bands that give the rock a layered appearance.
- Hot fluids may circulate through the rock and change the mineral composition of the rock by dissolving some materials and by adding others.

End Of Slide

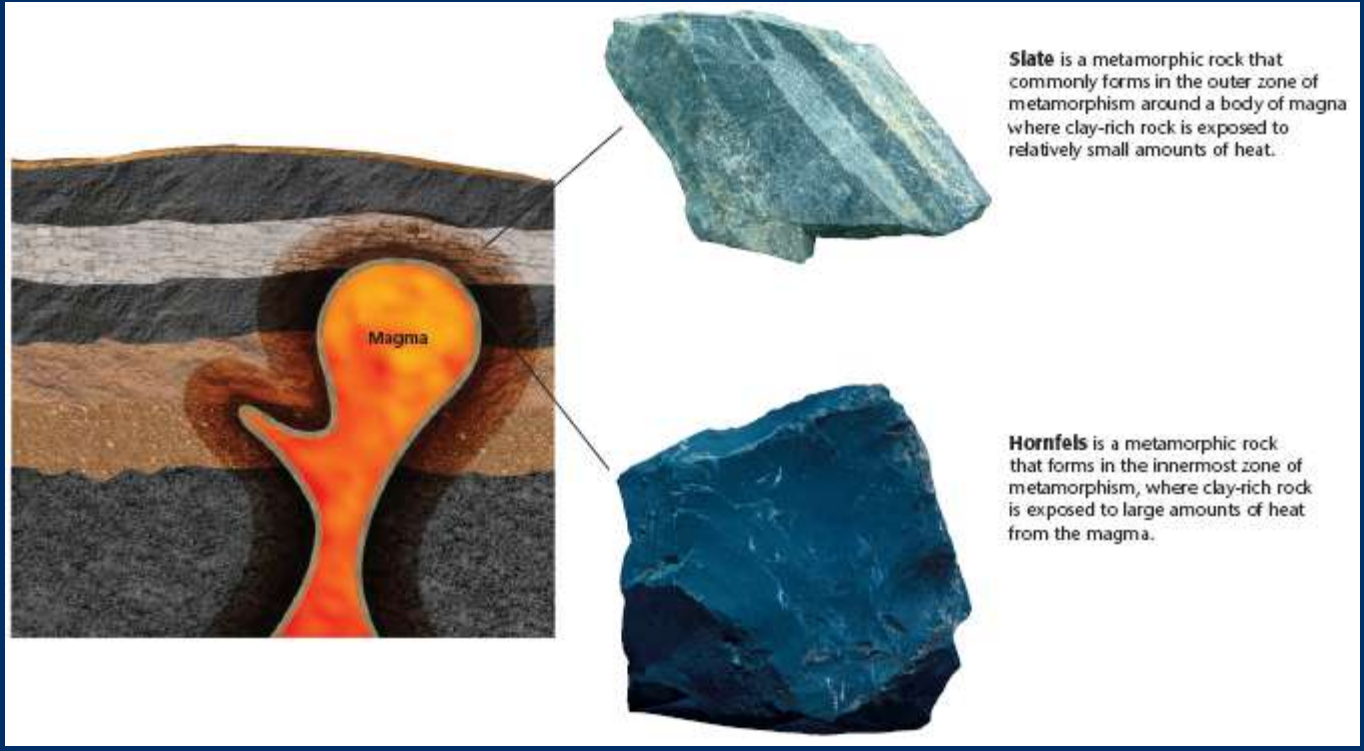
Formation of Metamorphic Rocks, *continued*

- The type of rock that forms because of metamorphism can indicate the conditions under which the original rock changed.
- The composition of the rock being metamorphosed, the amount and direction of pressure, and the presence or absence of certain fluids cause different combinations of minerals to form.
- Two types of metamorphism occur in Earth's crust—contact metamorphism and regional metamorphism.

End Of Slide

Formation of Metamorphic Rocks, *continued*

The diagram below shows how the type of rock that forms during metamorphism indicates the conditions under which the metamorphism occurred.



End Of Slide

Formation of Metamorphic Rocks, *continued*

Contact Metamorphism

- **contact metamorphism** a change in the texture, structure, or chemical composition of a rock due to contact with magma

Regional Metamorphism

- **regional metamorphism** a change in the texture, structure, or chemical composition of a rock due to changes in temperature and pressure over a large area, generally are a result of tectonic forces

End Of Slide
Chapter menu
Resources

Formation of Metamorphic Rocks, *continued*

Reading Check

How are minerals affected by regional metamorphism?

End Of Slide

Formation of Metamorphic Rocks, *continued*

Reading Check

How are minerals affected by regional metamorphism?

The high pressures and temperatures that result from the movements of tectonic plates may cause chemical changes in the minerals.

Classification of Metamorphic Rocks

Foliated Rocks

- **foliation** the metamorphic rock texture in which minerals grains are arranged in planes or bands
- Extreme pressure may cause the mineral crystals in the rock to realign or regrow to form parallel bands.
- Foliation also occurs as minerals that have different compositions separate to produce a series of alternating dark and light bands.
- Foliated metamorphic rocks include the common rocks slate, schist, and gneiss.

End Of Slide

Classification of Metamorphic Rocks, *continued*

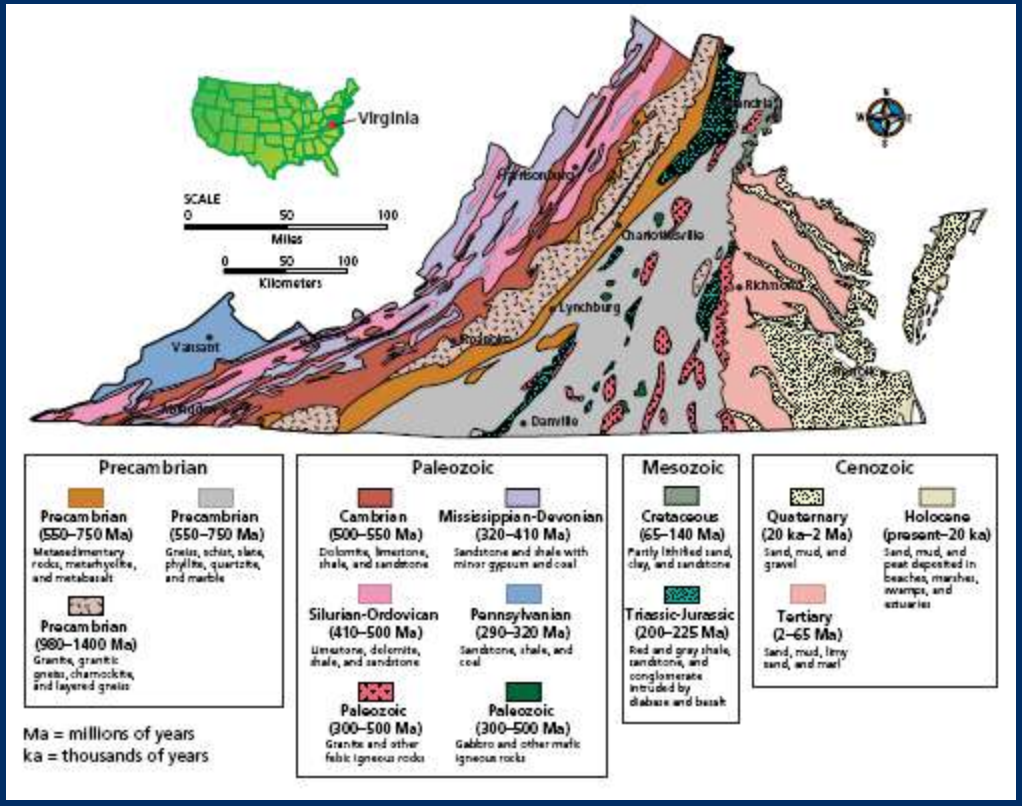
Nonfoliated Rocks

- **nonfoliated** the metamorphic rock texture in which minerals grains are not arranged in planes or bands
- Many nonfoliated metamorphic rocks contain grains of only one mineral or contain very small amounts of other minerals. Thus, the rock does not form bands of different minerals.
- Other nonfoliated metamorphic rocks contain grains that are round or square. These grains are unlikely to change shape or position when exposed to directed pressure.
- Nonfoliated metamorphic rocks include the common rocks marble and quartzite.

End Of Slide
Chapter menu
Resources

Maps in Action

Geologic Map of Virginia



End Of Slide

Brain Food Video Quiz

Multiple Choice

1. A rock that contains a fossil is most likely

   A. igneous
   B. sedimentary
   C. metamorphic
   D. felsic

Multiple Choice, *continued*

1. A rock that contains a fossil is most likely

   A. igneous
   B. sedimentary
   C. metamorphic
   D. felsic

Multiple Choice, *continued*

2. The large, well-developed crystals found in some samples of granite are a sign that

F. the lava from which it formed cooled rapidly.

G. the magma contained a lot of dissolved gases.

H. the lava from which it formed cooled slowly.

I. water deposited minerals in the rock cavities.

Multiple Choice, *continued*

2. The large, well-developed crystals found in some samples of granite are a sign that

F. the lava from which it formed cooled rapidly.

G. the magma contained a lot of dissolved gases.

H. the lava from which it formed cooled slowly.

I. water deposited minerals in the rock cavities.

Multiple Choice, *continued*

3. How does coal differ from breccia?

A. Coal is an example of sedimentary rock, and breccia is an example of metamorphic rock.

B. Coal is an example of metamorphic rock, and breccia is an example of igneous rock.

C. Coal is an example of organic rock, and breccia is an example of clastic rock.

D. Coal is an example of clastic rock, and breccia is an example of a conglomerate.

Multiple Choice, *continued*

3. How does coal differ from breccia?

A. Coal is an example of sedimentary rock, and breccia is an example of metamorphic rock.

B. Coal is an example of metamorphic rock, and breccia is an example of igneous rock.

C. Coal is an example of organic rock, and breccia is an example of clastic rock.

D. Coal is an example of clastic rock, and breccia is an example of a conglomerate.

Multiple Choice, *continued*

4. How does the order in which igneous rocks form relate to their ability to resist weathering agents?

F. Rocks that form last weather faster.

G. Rocks that form first are the most resistant.

H. Rocks that form last are the most resistant.

I. There is no relationship between the order of igneous rock formation and weathering.

Multiple Choice, *continued*

4. How does the order in which igneous rocks form relate to their ability to resist weathering agents?

F. Rocks that form last weather faster.

G. Rocks that form first are the most resistant.

H. Rocks that form last are the most resistant.

I. There is no relationship between the order of igneous rock formation and weathering.

Multiple Choice, *continued*

5. What occurs when heat from nearby magma causes changes in the surrounding rocks?

A. contact metamorphism

B. fluid metamorphism

C. intrusive metamorphism

D. regional metamorphism

Multiple Choice, *continued*

5. What occurs when heat from nearby magma causes changes in the surrounding rocks?

A. contact metamorphism

B. fluid metamorphism

C. intrusive metamorphism

D. regional metamorphism

Short Response

6. What type of sedimentary rock forms when angular clastic materials are cemented together?

Short Response, *continued*

6. What type of sedimentary rock forms when angular clastic materials are cemented together?

breccias

Short Response, *continued*

7. What type of rock forms when heat, pressure, and chemical processes change the physical properties of igneous rock?

Short Response, *continued*

7. What type of rock forms when heat, pressure, and chemical processes change the physical properties of igneous rock?

metamorphic rock

Reading Skills

Read the passage below. Then, answer questions 8–10.

Igneous and Sedimentary Rocks

Scientists think that Earth began as a melted mixture of many different materials. These materials underwent a physical change as they cooled and solidified. These cooled materials became the first igneous rocks. Igneous rock continues to form today. Liquid rock changes from a liquid to a solid when lava that is brought to Earth's surface by volcanoes hardens. This process can also take place far more slowly, when magma deep beneath Earth's surface changes to a solid.

At the same time that new rock is forming, old rocks are broken down by other processes. Weathering is the process by which wind, water, and gravity break up rock. During erosion, broken up pieces of rock are carried by water, wind, or ice and are deposited as sediments elsewhere. These pieces pile up and, under heat and pressure, form sedimentary rock—rock composed of cemented fragments of older rocks.

Reading Skills, *continued*

8. Which of the following statements about the texture of sedimentary rock is most likely true?

A. Sedimentary rocks are always lumpy and made up of large pieces of older rocks.

B. Sedimentary rocks all contain alternating bands of lumpy and smooth textures.

C. Sedimentary rocks are always smooth and made up of small pieces of older rocks.

D. Sedimentary rocks have a variety of textures that depend on the size and type of pieces that make up the rock.

Reading Skills, *continued*

8. Which of the following statements about the texture of sedimentary rock is most likely true?

A. Sedimentary rocks are always lumpy and made up of large pieces of older rocks.

B. Sedimentary rocks all contain alternating bands of lumpy and smooth textures.

C. Sedimentary rocks are always smooth and made up of small pieces of older rocks.

D. Sedimentary rocks have a variety of textures that depend on the size and type of pieces that make up the rock.

Reading Skills, *continued*

9. Which of the following statements can be inferred from the information in the passage?

F. Igneous rocks are the hardest form of rock.

G. Sedimentary rocks are the final stage in the life cycle of a rock.

H. Igneous rocks began forming early in Earth's history.

I. Sedimentary rocks are not affected by weathering.

Reading Skills, *continued*

9. Which of the following statements can be inferred from the information in the passage?

F. Igneous rocks are the hardest form of rock.

G. Sedimentary rocks are the final stage in the life cycle of a rock.

H. Igneous rocks began forming early in Earth's history.

I. Sedimentary rocks are not affected by weathering.

Reading Skills, *continued*

10. Is igneous rock or sedimentary rock more likely to contain fossils? Explain your answer

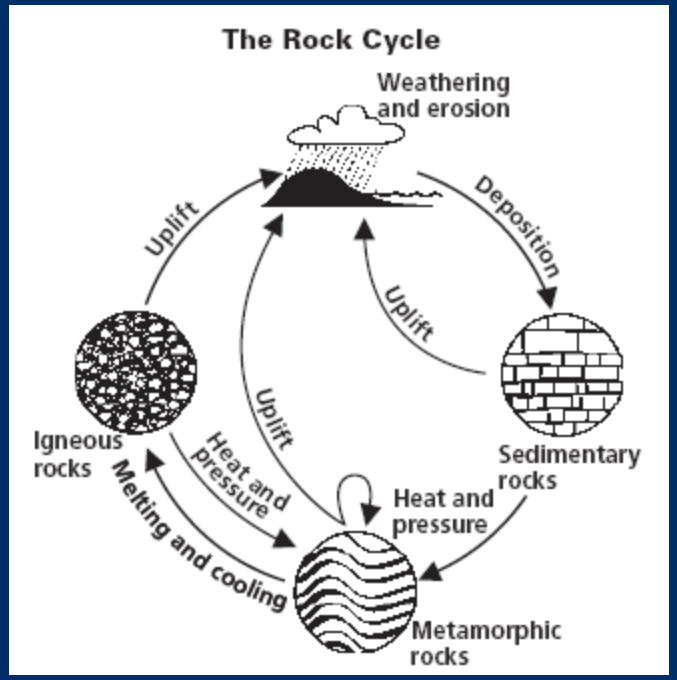
Reading Skills, *continued*

10. Is igneous rock or sedimentary rock more likely to contain fossils? Explain your answer

sedimentary rock; Sedimentary rocks are made up of pieces of older rocks and may contain fossils. Fossils in the original material of an igneous rock would have been destroyed when melted.

Interpreting Graphics

Use the figure below to answer question 11. The figure shows the rock cycle.



Interpreting Graphics, *continued*

11. Which of the following processes brings rocks to Earth's surface, where they can be eroded?

A. deposition

B. weathering

C. erosion

D. uplift

Interpreting Graphics, *continued*

11. Which of the following processes brings rocks to Earth's surface, where they can be eroded?

A. deposition

B. weathering

C. erosion

D. uplift

Interpreting Graphics, *continued*

Use the table below to answer questions 12-13. The table describes the characteristics of four rock samples.

Rock Types

Rock sample	Characteristics
Rock A	multiple compacted, round, gravel-sized fragments
Rock B	coarse, well-developed, crystalline mineral grains
Rock C	small, sand-sized grains, tan coloration
Rock D	gritty texture; many small, embedded seashells

Interpreting Graphics, *continued*

12. Is rock D igneous, sedimentary, or metamorphic? Explain the evidence that supports this classification.

Interpreting Graphics, *continued*

12. Is rock D igneous, sedimentary, or metamorphic? Explain the evidence that supports this classification.

Answers should include the following: rock D is a sedimentary rock; the presence of fossils or embedded seashells is a clear clue that this is a sedimentary rock; sedimentary rocks are composed of particles that are cemented together.

Interpreting Graphics, *continued*

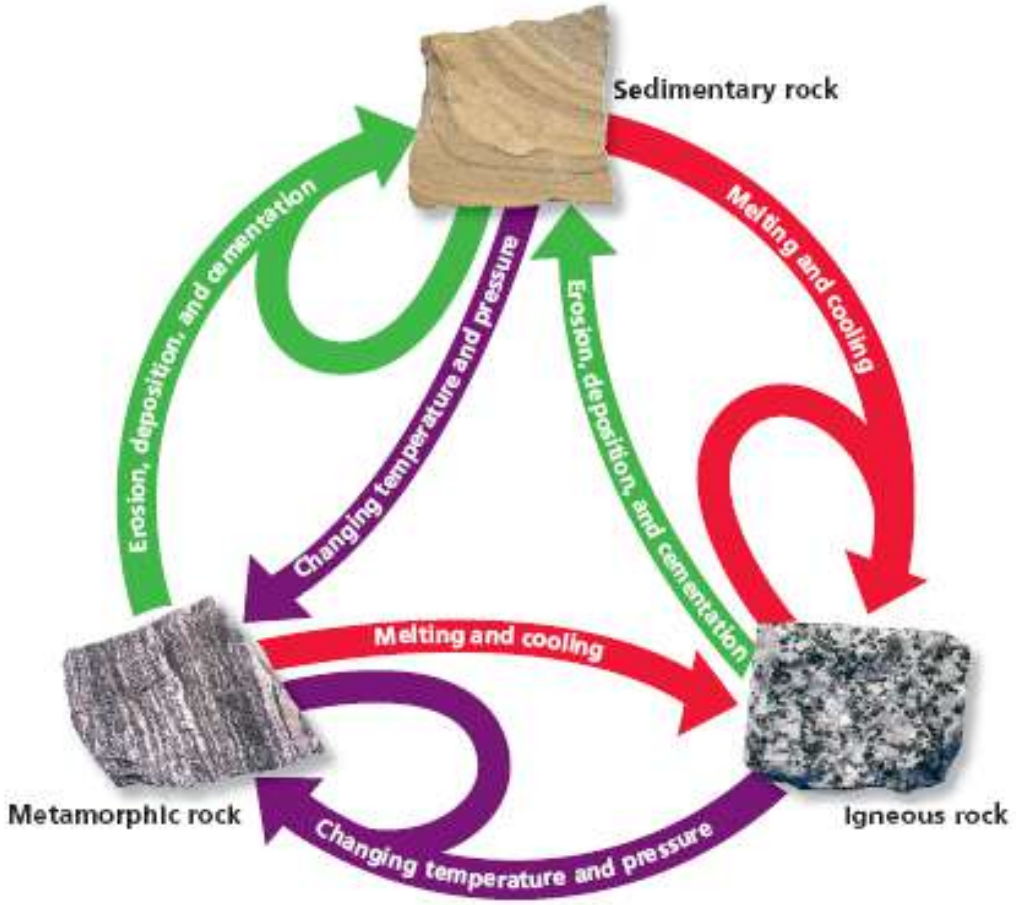
13. Is rock A made up of only one mineral? Explain the evidence that supports this classification.

Interpreting Graphics, *continued*

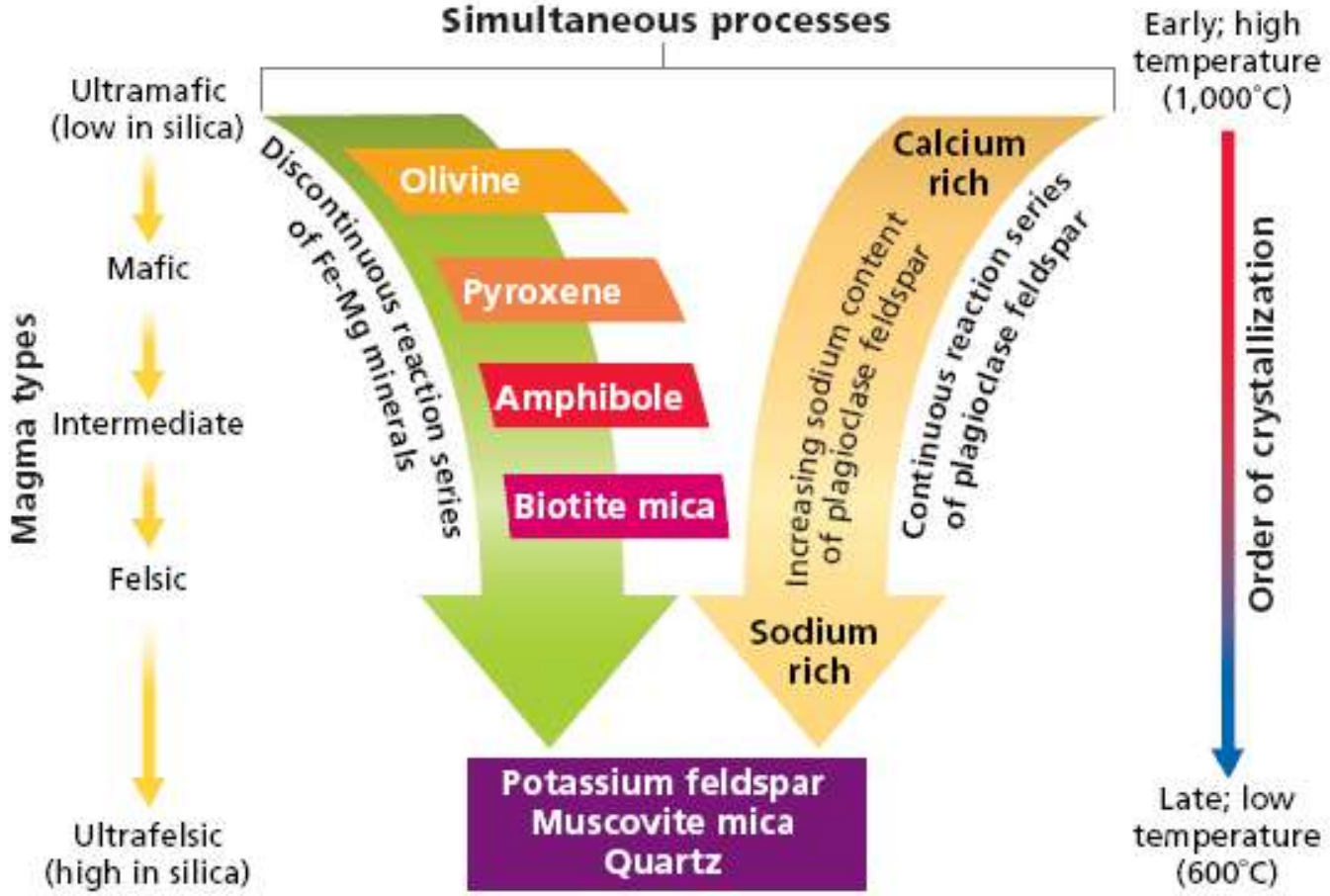
13. Is rock A made up of only one mineral? Explain the evidence that supports this classification.

Answers should include the following: most rocks are combinations of one or more minerals; the rock described in the table appears to be made up of more than one type of substance, so it is most likely not made of only a single mineral.

The Rock Cycle



Bowen's Reaction Series



The Formation of Magma

Partial Melting

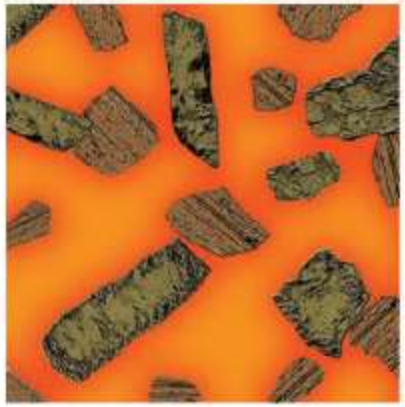
This solid rock contains the minerals quartz (yellow), feldspar (gray), biotite (brown), and hornblende (green).

The first minerals that melt are quartz and some types of feldspars. The orange background represents magma.

Minerals such as biotite and hornblende generally melt last, which changes the composition of the magma.

The Formation of Magma

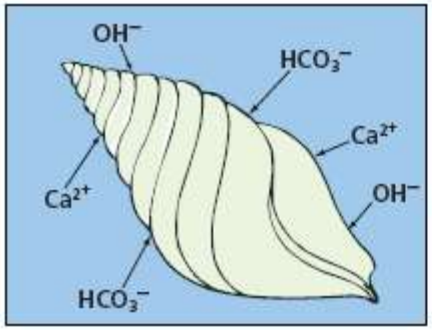
Fractional Crystallization



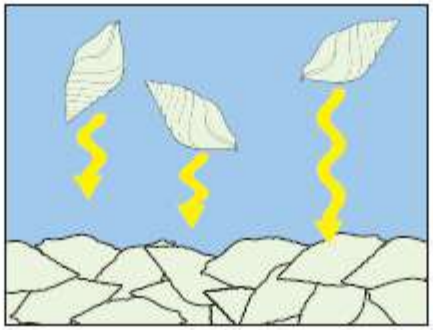
As the temperature decreases, the first minerals to crystallize from magma are minerals that have the highest freezing points, such as biotite and hornblende.

As the magma changes composition and cools, minerals that have lower freezing points form.

Organic Limestone Formation



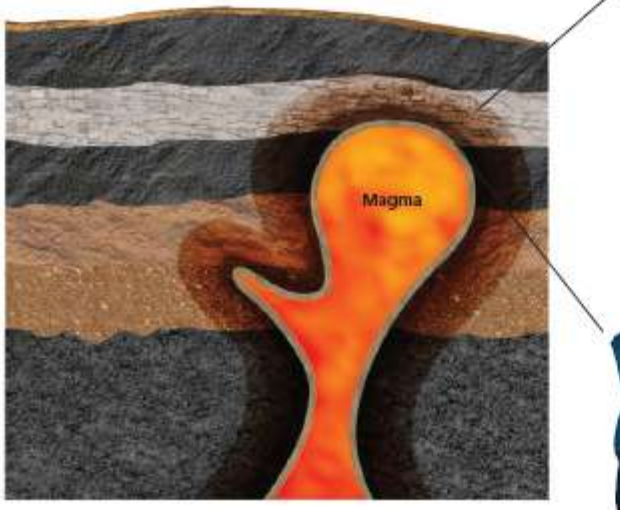
Organisms that live in lakes or oceans take chemicals from the water and produce the mineral calcium carbonate, $CaCO_3$. They use the $CaCO_3$ to build their shells or skeletons.



When the organisms die, the hard remains that are made of $CaCO_3$ settle to the lake or ocean floor.

The shells of the dead organisms pile up. Eventually, the layers are compacted and cemented to form limestone.

Indicators of Metamorphic Conditions



Slate is a metamorphic rock that commonly forms in the outer zone of metamorphism around a body of magna where clay-rich rock is exposed to relatively small amounts of heat.

Hornfels is a metamorphic rock that forms in the innermost zone of metamorphism, where clay-rich rock is exposed to large amounts of heat from the magma.

Geologic Map of Virginia