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Chapter: Rocks

1

What is a rock?—Common Rocks

- Most rock used for building stone contains one or more common minerals, called rock-forming minerals, such as quartz, feldspar, mica, or calcite.
- When you look closely, the sparkles you see are individual crystals of minerals.
- A **rock** is a mixture of such minerals, rock fragments, volcanic glass, organic matter, or other natural materials.

1

The Rock Cycle

- To show how rocks slowly change through time, scientists have created a model called the **rock cycle**.
- It illustrates the processes that create and change rocks.

1

The Rock Cycle

- The rock cycle shows the three types of rock—igneous, metamorphic, and sedimentary—and the processes that form them.

Click image to view movie.

1

The Rock Cycle

- Rocks change by many processes.
- For example, a sedimentary rock can change by heat and pressure to form a metamorphic rock.
- The metamorphic rock then can melt and later cool to form an igneous rock.

1

The Rock Cycle

- The igneous rock then could be broken into fragments by weathering and erode away.
- The fragments might later compact and cement together to form another sedimentary rock. Any given rock can change into any of the three major rock types. A rock even can transform into another rock of the same type.

1

Matter and the Rock Cycle

- The rock cycle shows how rock can be weathered to small rock and mineral grains.
- This material then can be eroded and carried away by wind, water, or ice.
- This illustrates the principle of conservation of matter.
- The changes that take place in the rock cycle never destroy or create matter.
- The elements are just redistributed in other forms.

1

Question 1

Which of these is a rock?

A. feldspar
B. granite
C. mica
D. quartz

1

Answer

The answer is B. Rocks are mixtures of minerals. Granite is a mixture of feldspar, mica, quartz and other minerals.

1

Question 2

Weathering and erosion of igneous rocks produces material that can become _____ rock.

A. magma
B. metamorphic
C. more igneous
D. sedimentary

1

Answer

The answer is D. Sediments from the weathering of igneous rock form sedimentary rock through compaction and cementation.

1

Question 3

Which is formed by cooling magma?

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

1

Answer

The answer is B. Igneous rock is formed from cooling magma. Garnet is a mineral found in multiple rock types.

2

Formation of Igneous Rocks

- When some volcanoes erupt, they eject a flow of molten rock material.
- Molten rock material, called magma, flows when it is hot and becomes solid when it cools.
- When hot magma cools and hardens, it forms **igneous** (IHG nee us) **rock**.

2

Magma

- Most magmas come from deep below Earth's surface.
- Magma is located at depths ranging from near the surface to about 150 km below the surface.
- Temperatures of magmas range from about 650° to 1,200°C, depending on their chemical compositions and pressures exerted on them.

2

Magma

- The heat that melts rocks comes from sources within Earth's interior.
- One source is the decay of radioactive elements within Earth.
- Some heat is left over from the formation of the planet, which originally was very hot.
- Radioactive decay of elements contained in rocks balances some heat loss as Earth continues to cool.

2

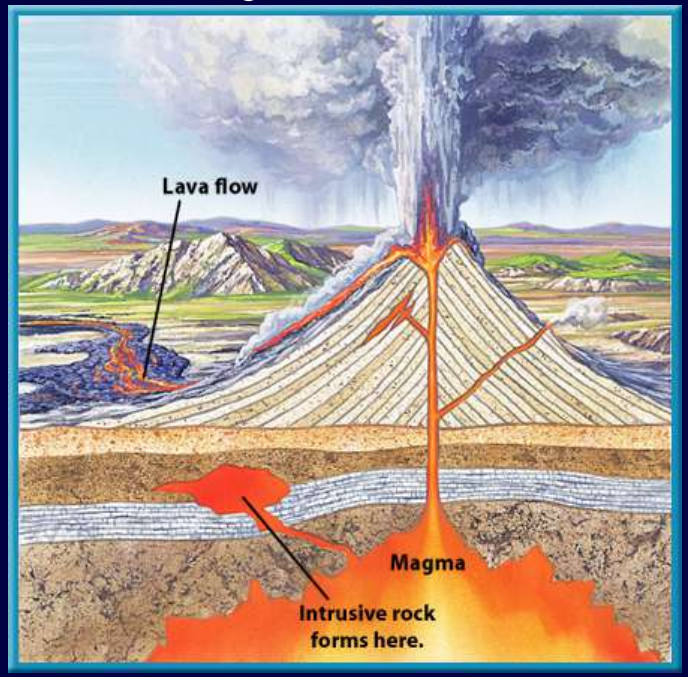
Magma

- Because magma is less dense than surrounding solid rock, it is forced upward toward the surface
- When magma reaches Earth's surface and flows from volcanoes, it is called **lava**.

2

Intrusive Rocks

- As magma cools, atoms and compounds in the liquid rearrange themselves into new crystals called mineral grains.
  - Rocks form as these mineral grains grow together.
  - Rocks that form from magma below the surface are called **intrusive** igneous rocks.



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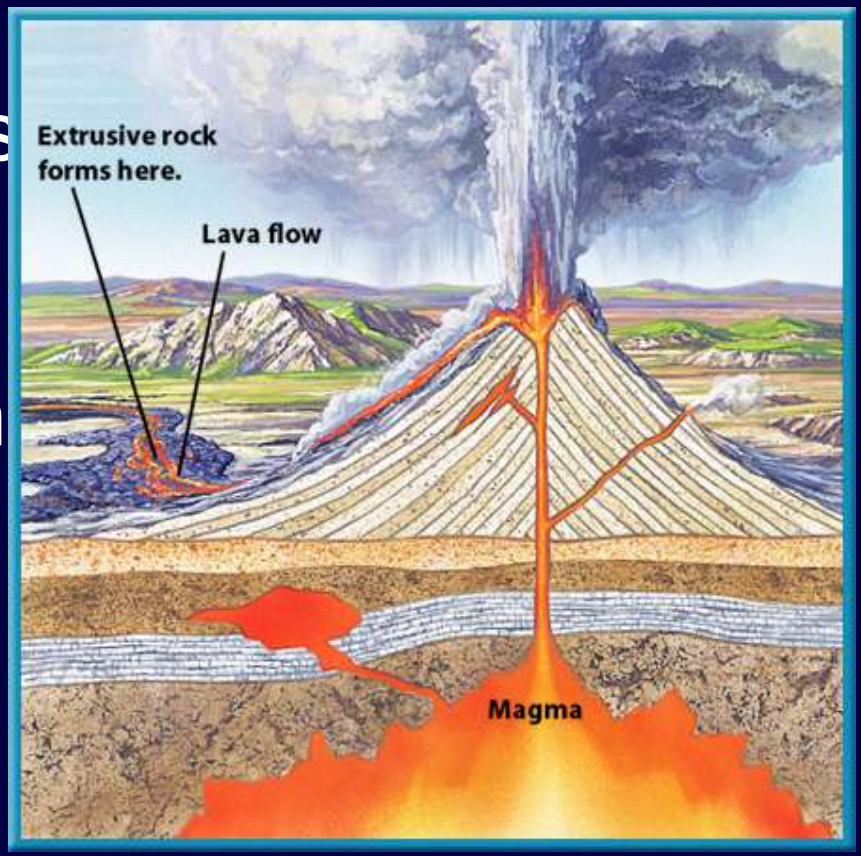
Extrusive Rocks

- **Extrusive** igneous rocks are formed as lava cools on the surface of Earth.
- When lava flows on the surface, it is exposed to air and water, and cools quickly under these conditions.



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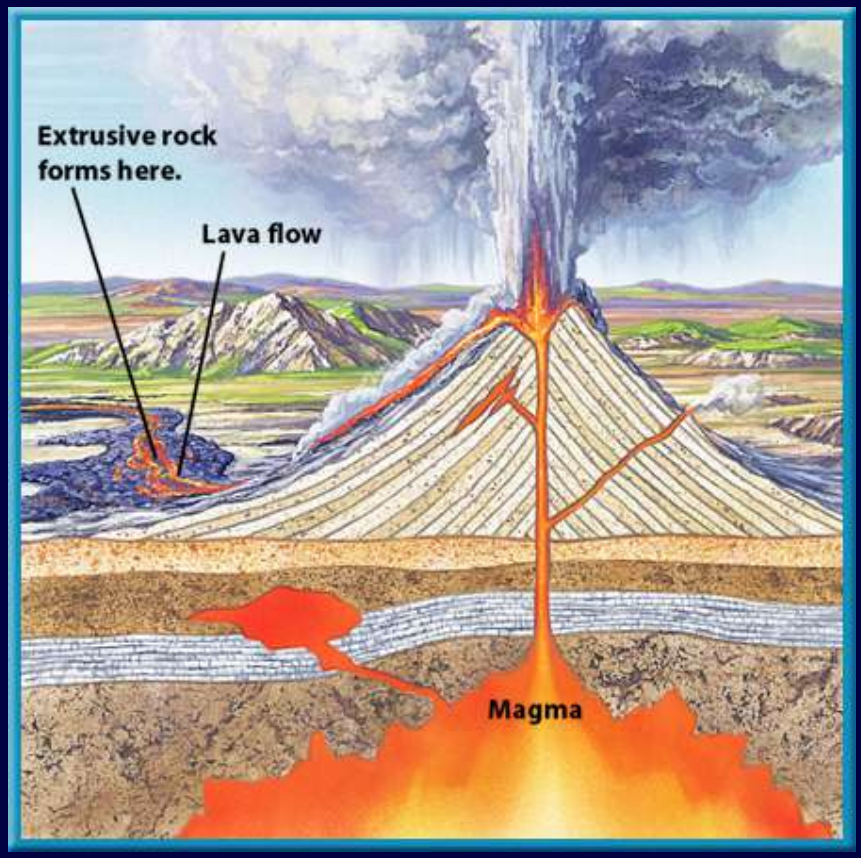
Extrusive Rocks

- The quick cooling rate keeps mineral grains from growing large, because the atoms in the liquid don't have the time to arrange into large crystals.



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Volcanic Glass

- Pumice, obsidian, and scoria are examples of volcanic glass.
- These rocks cooled so quickly that few or no mineral grains formed.
- Most of the atoms in these rocks are not arranged in orderly patterns, and few crystals are present.

2

Volcanic Glass

- In the case of pumice and scoria, gases become trapped in the gooey molten material as it cools.
- Holes are left behind where the rock formed around the pockets of gas.

2

Classifying Igneous Rocks

- Igneous rocks are intrusive or extrusive depending on how they are formed.
- A way to further classify these rocks is by the magma from which they form. An igneous rock can form from basaltic, andesitic, or granitic magma.

2

Classifying Igneous Rocks

- The type of magma that cools to form an igneous rock determines important chemical and physical properties of that rock.
- These include mineral composition, density, color, and melting temperature.

2

Basaltic Rocks

- **Basaltic** (buh SAWL tihk) igneous rocks are dense, dark-colored rocks.
- They form from magma that is rich in iron and magnesium and poor in silica, which is the compound SiO_2.
- The presence of iron and magnesium in minerals in basalt gives basalt its dark color.
- Basaltic lava is fluid and flows freely from volcanoes in Hawaii, such as Kilauea.

2

Granitic Rocks

- **Granitic** igneous rocks are light-colored rocks of lower density than basaltic rocks.
- Granitic magma is thick and stiff and contains lots of silica but lesser amounts of iron and magnesium.

2

Andesitic Rocks

- Andesitic igneous rocks have mineral compositions between those of basaltic and granitic rocks.
- Many volcanoes around the rim of the Pacific Ocean formed from andesitic magmas.
- Like volcanoes that erupt granitic magma, these volcanoes also can erupt violently.

2

Question 1

Igneous rock is formed by _____.

A. cooling of hot magma
B. change in pressure
C. compression of loose materials
D. pressure from watery fluids

2

Answer

The answer is A. If igneous rock is melted, it changes to magma.

2

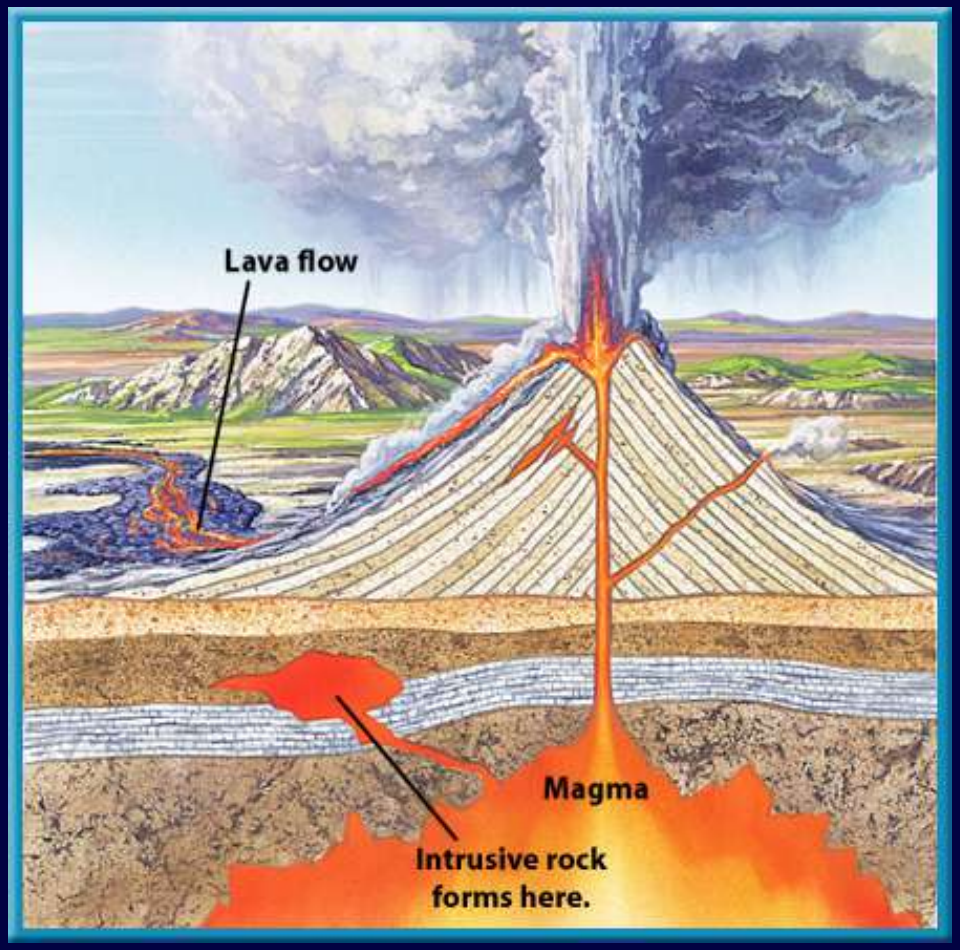
Question 2

What is the difference between intrusive and extrusive igneous rock?

2

Answer

Intrusive igneous rocks form from magma below Earth's surface. Extrusive igneous rocks form from lava flowing at Earth's surface.



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Question 3

Which of the following is a volcanic rock that contained trapped gases during its formation?

A. marble
B. pumice
C. sandstone
D. slate

2

Answer

The answer is B. Pumice is a low density igneous rock formed when molten material containing trapped gases cools and hardens.

3

Formation of Metamorphic Rocks

- Rocks that have changed because of changes in temperature and pressure or the presence of hot watery fluids are called **metamorphic rocks**.
- Changes that occur can be in the form of the rock, the composition of the rock, or both.
- Metamorphic rocks can form from igneous, sedimentary, or other metamorphic rocks.

3

Heat and Pressure

- Rocks beneath Earth's surface are under great pressure from rock layers above them.
- Temperature also increases with depth in Earth.
- In some places, the heat and pressure are just right to cause rocks to melt and magma to form.
- In other areas where melting doesn't occur, some mineral grains can change by dissolving and recrystallizing—especially in the presence of fluids.

3

Heat and Pressure

- Sometimes, under these conditions, minerals exchange atoms with surrounding minerals and new, bigger minerals form.
- Depending on the amount of pressure and temperature applied, one type of rock can change into several different metamorphic rocks.
- Each type of metamorphic rock can come from several kinds of parent rocks.

3

Heat and Pressure

- The sedimentary rock shale will change into slate.
- As increasing pressure and temperature are applied, the slate can change into phyllite, then schist, and eventually gneiss.

Slate

3

Heat and Pressure

- Schist also can form when basalt is metamorphosed, or changed, and gneiss can come from granite.

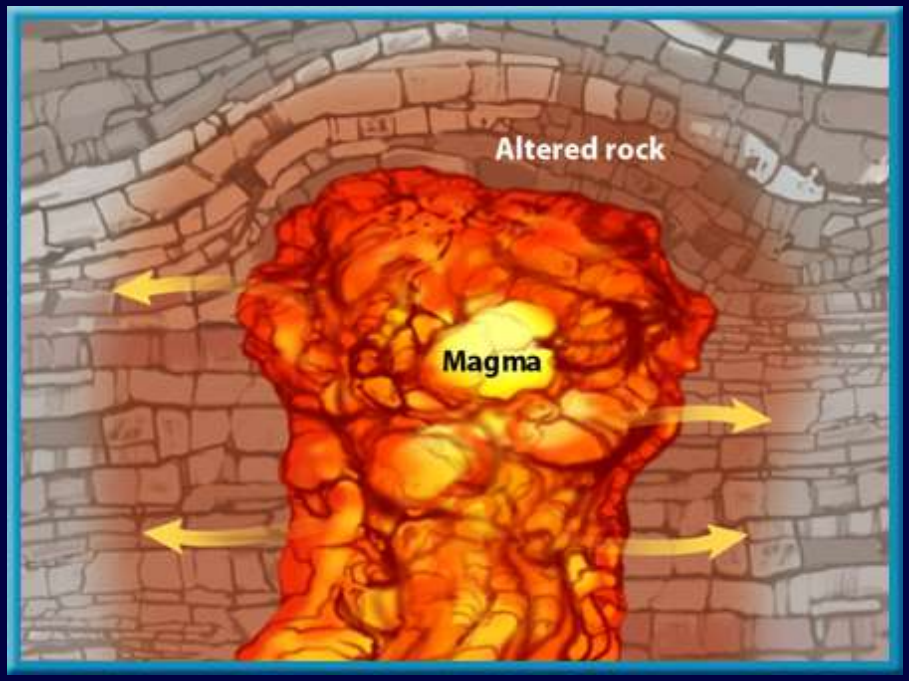
3

Hot Fluids

- Fluids, which are mostly water with dissolved elements and compounds, can react chemically with a rock and change its composition, especially when hot.
- That's what happens when rock surrounding a hot magma body reacts with these fluids.

3

Hot Fluids



- Most fluids that transform rocks during metamorphic processes are hot and mainly are comprised of water and carbon dioxide.
- In the presence of hot, water-rich fluids, solid rock can change in mineral composition without having to melt.

3

Classifying Metamorphic Rocks

- Metamorphic rocks form from igneous, sedimentary, or other metamorphic rocks.
- Heat, pressure, and hot fluids trigger the changes.
- Each resulting rock can be classified according to its composition and texture.

3

Foliated Rocks

- When mineral grains line up in parallel layers, the metamorphic rock is said to have a foliated texture.
- Two examples of foliated rocks are slate and gneiss.

Slate

- Slate forms from the sedimentary rock shale.

3

Foliated Rocks

- The minerals in slate are pressed together so tightly that water can't pass between them easily.
- Because it's watertight, slate is ideal for paving around pools and patios.
- The naturally flat nature of slate and the fact that it splits easily makes it useful for roofing and tiling many surfaces.

3

Foliated Rocks

- Gneiss (NISE), another foliated rock, forms when granite and other rocks are
- Foliation in gneiss shows up as alternating light and dark bands.
- Movement of atoms has separated the dark minerals, such as biotite mica, from the light minerals, which are mainly quartz and feldspar.

3

Nonfoliated Rocks

- In some metamorphic rocks, layering does not occur.
- The mineral grains grow and rearrange, but they don't form layers.
- This process produces a **nonfoliated** texture.

3

Nonfoliated Rocks

- Sandstone is a sedimentary rock that's often composed mostly of quartz grains.
- When sandstone is heated under a lot of pressure, the grains of quartz grow in size and become interlocking, like the pieces of a jigsaw puzzle.
- The resulting rock is called quartzite.

3

Nonfoliated Rocks

- Marble is another nonfoliated metamorphic rock.
- Marble forms from the sedimentary rock limestone, which is composed of the mineral calcite.
- Usually, marble contains several other minerals besides calcite.

3

Nonfoliated Rocks

- Hornblende and serpentine give marble a black or greenish tone, whereas hematite makes it red.
- Marble is a popular material for artists to sculpt because it is not as hard as other rocks.

3

Question 1

What type of rocks can form from any type of rock?

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

3

Answer

The answer is C. Heat, pressure and hot fluids trigger changes in various rock types forming metamorphic rocks.

3

Question 2

Name the metamorphic rock texture in which mineral grains line up in parallel layers.

A. foliated
B. nonfoliated
C. sedimentary
D. volcanic

3

Answer

The answer is A. Slate is a foliated metamorphic rock formed from shale.

3

Question 3

Which of these is a nonfoliated metamorphic rock?

A. basalt
B. marble
C. shale
D. slate

3

Answer

The answer is B. Marble forms from limestone. Basalt is an igneous rock. Slate is a foliated metamorphic rock that forms from the sedimentary rock, shale.

4

Formation of Sedimentary Rocks

- Igneous rocks are the most common rocks on Earth, but because most of them exist below the surface you might not have seen too many o
- 75 percent of the rocks exposed at the surface are sedimentary rocks.

4

Formation of Sedimentary Rocks

- **Sediments** are loose materials such as rock fragments, mineral grains, and bits of shell that have been moved by wind, water, ice, or gravity.
- Sediments come from already-existing rocks that are weathered and eroded.
- **Sedimentary rock** forms when sediments are pressed and cemented together, or when minerals form from solutions.

4

Stacked Rocks

- Sedimentary rocks often form as layers.
- The older layers are on the bottom because they were deposited first.

- Sometimes, forces within Earth overturn layers of rock, and the oldest are no longer on the bottom.

4

Classifying Sedimentary Rocks

- Sedimentary rocks can be made of just about any material found in nature.
- Sediments come from weathered and eroded igneous, metamorphic, and sedimentary rocks.
- Some sedimentary rocks come from the remains of some organisms.
- The composition of a sedimentary rock depends upon the composition of the sediments from which it formed.

4

Classifying Sedimentary Rocks

- Like igneous and metamorphic rocks, sedimentary rocks are classified by their composition and by the manner in which they formed.
- Sedimentary rocks usually are classified as detrital, chemical, or organic.

4

Detrital Sedimentary Rocks

- The word *detrital* (dih TRI tul) comes from the Latin word *detritus*, which means “to wear away.”
- Detrital sedimentary rocks are made from the broken fragments of other rocks.

4

Weathering and Erosion

- When rock is exposed to air, water, or ice, it breaks down chemically and mechanically.
- This process, which breaks rocks into smaller pieces, is called weathering.
- These pieces are classified by size.
- The movement of weathered material is called erosion.

4

Compaction

- Where sediments are deposited, layer upon layer builds up.
- Pressure from the upper layers pushes down on the lower layers.
- If the sediments are small, they can stick together and form solid rock. This process is called **compaction**.

4

Cementation

- If sediments are large, like sand and pebbles, pressure alone can't make then stick together.
- Large sediments have to be cemented together.
- As water moves through soil and rock, it picks up materials released from minerals during weathering.
- The resulting solution of water and dissolved materials moves through open spaces between sediments.

4

Cementation

- **Cementation** occurs when minerals such as quartz, calcite, and hematite are deposited between the pieces of sediment.
- These minerals, acting as natural cements, hold the sediment together like glue, making a detrital sedimentary rock.

4

Shape and Size of Sediments

- Detrital rocks have granular textures, much like granulated sugar.
- They are named according to the shapes and sizes of the sediments that

4

Shape and Size of Sediments

- Conglomerate and breccia both form from large sediments.
- If the sediments are rounded, the rock is called conglomerate. If the sediments have sharp angles, the rock is called breccia.
- The roundness of sediment particles depends on how far they have been moved by wind or water.

4

Materials Found in Sedimentary Rocks

- The gravel-sized sediments in conglomerate and breccia can consist of any type of rock or mineral, including quartz, feldspar, gneiss, granite, or limestone.
- The cement that holds the sediments together usually is made of quartz or calcite.

Materials Found in Sedimentary Rocks

- Concrete is made of gravel and sand grains that have been cemented
- Although the structure is similar to that of naturally occurring conglomerate, it cannot be considered a

4

Materials Found in Sedimentary Rocks

- Sandstone is formed from smaller particles than conglomerates and breccias.
- Siltstone is similar to sandstone except it is made of smaller, silt-sized particles.
- Shale is a detrital sedimentary rock that is made mainly of clay-sized particles.

4

Chemical Sedimentary Rocks

- Chemical sedimentary rocks form when dissolved minerals come out of solution.
- Minerals collect when seas or lakes evaporate. The deposits of minerals that come out of solution form sediments and rocks.
- Chemical sedimentary rocks are not made from pieces of preexisting rocks.

4

Limestone

- Calcium carbonate is carried in solution in ocean water.
- When calcium carbonate ($CaCO_3$) comes out of solution as calcite and its many crystals grow together, limestone forms.
- Limestone also can contain other minerals and sediments, but it must be at least 50 percent calcite.
- Limestone usually is deposited on the bottom of lakes or shallow seas.

4

Limestone

- Large areas of the central United States have limestone bedrock because seas covered much of the country for millions of years.
- It is hard to imagine Kansas being covered by ocean water, but it has happened several times throughout geological history.

4

Rock Salt

- When water that is rich in dissolved salt evaporates, it often deposits the mineral halite.
- Halite forms rock salt.
- Rock salt deposits can range in thickness from a few meters to more than 400 m.
- Companies mine these deposits because rock salt is an important resource.

4

Organic Sedimentary Rocks

- Rocks made of the remains of once-living things are called organic sedimentary rocks.
- One of the most common organic sedimentary rocks is fossil-rich limestone.
- Like chemical limestone, fossil-rich limestone is made of the mineral calcite.
- Fossil-rich limestone mostly contains remains of once-living ocean organisms.

4

Organic Sedimentary Rocks

- Animals such as mussels, clams, corals, and snails make their shells from $CaCO_3$ that eventually becomes calcite.
- When they die, their shells accumulate on the ocean floor.
- When these shells are cemented together, fossil-rich limestone forms.
- If a rock is made completely of shell fragments that you can see, the rock is called coquina (koh KEE nuh).

4

Chalk

- Chalk is another organic sedimentary rock that is made of microscopic shells.
- When you write with naturally occurring chalk, you're crushing and smearing the calcite-shell remains of once-living ocean organisms.

4

Coal

- Another useful organic sedimentary rock is coal.
- Coal forms when pieces of dead plants are buried under other sediments in swamps.
- These plant materials are chemically changed by microorganisms.
- The resulting sediments are compacted over millions of years to form coal, an important source of energy.

4

Question 1

If sedimentary rocks form as layers, why aren't the oldest layers always below the youngest layers?

Answer

Sometimes forces within Earth overturn layers of rock, disturbing the order of the rock layers.

4

Question 2

Which detrital rock forms from the smallest sediments?

A. conglomerate
B. sandstone
C. shale
D. siltstone

4

Answer

The answer is C. Shale forms from clay sediments.

4

Question 3

What is the process in which small sediments stick together and form solid rocks?

A. cementation
B. compaction
C. cycling
D. erosion

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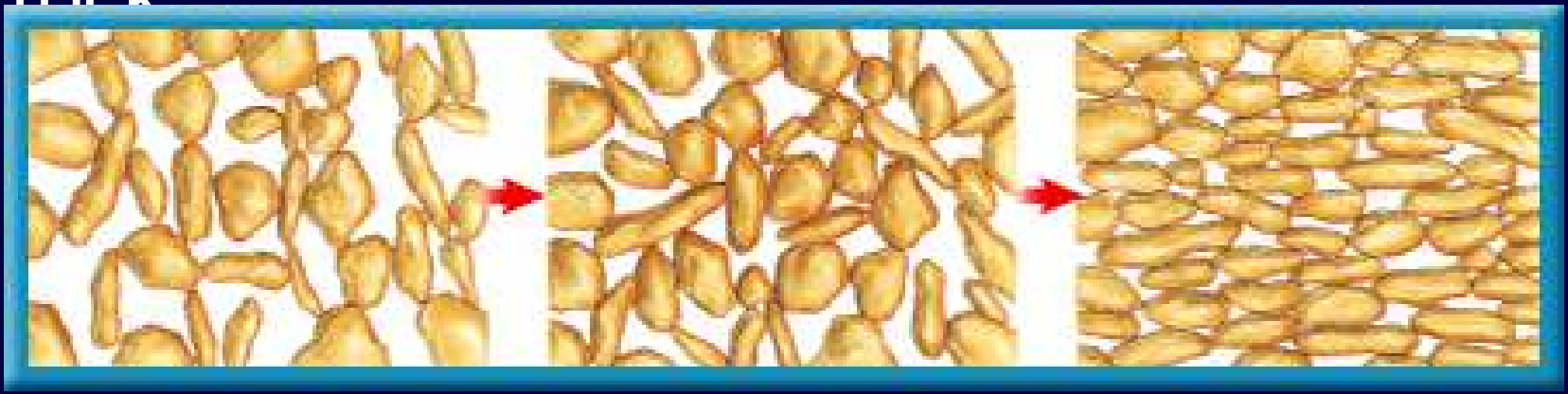
Answer

The answer is B. Erosion moves sediments to new locations. Compaction occurs when pressure on layers causes sediments to stick together and form solid rock.



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