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Chapter: Weathering and Soil

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Weathering and Its Effects

- Together, surface processes that work to break down rock are called weathering.
- Weathering breaks rock into smaller and smaller pieces, such as sand, silt, and clay. These smaller, loose pieces are called sediment.
- The terms *sand*, *silt*, and *clay* are used to describe specific sizes of sediment.
- Sand grains are larger than silt, and silt is larger than clay.

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Weathering and Its Effects

- Weathering wears mountains down to hills.
- Rocks at the top of mountains are broken down by weathering, and the sediment is moved downhill by gravity, water, and ice.
- Two different types of weathering—mechanical weathering and chemical weathering—work together to shape Earth's surface.

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Mechanical Weathering

- **Mechanical weathering** occurs when rocks are broken apart by physical processes. This means that the overall chemical makeup of the rock stays the same.

Click image to view movie.

1

Mechanical Weathering

- Growing plants, burrowing animals, and expanding ice are some of the things that can mechanically weather rock.

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Plants and Animals

- Water and nutrients that collect in the cracks of rocks result in conditions in which plants can grow. As the roots grow, they enlarge the cracks.

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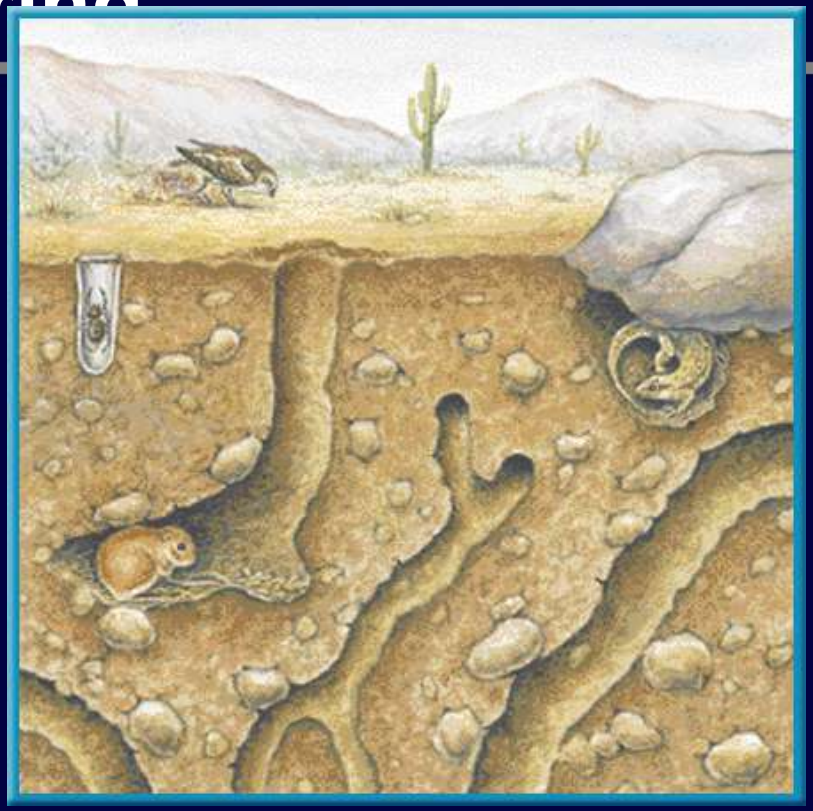
Plants and Animals

- Burrowing animals also cause mechanical weathering.
- As these animals burrow, they loosen sediment and push it to the surface. Once the sediment is brought to the surface, other weathering processes act on it.



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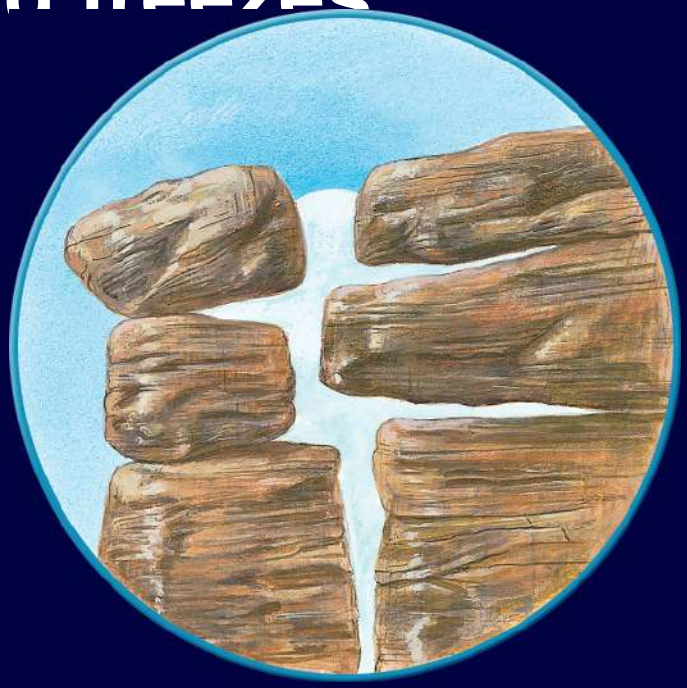
Ice Wedging

- **Ice wedging** occurs in temperate and cold climates where water enters cracks in rocks and freezes.

- When water enters cracks in rock and freezes, it expands, causing the cracks to enlarge and the rock to break



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Ice Wedging

- This cycle of freezing and thawing not only breaks up rocks, but also can break up roads and highways.

- When water enters cracks in road pavement and freezes, it forces the pavement apart. This causes potholes to form in roads.

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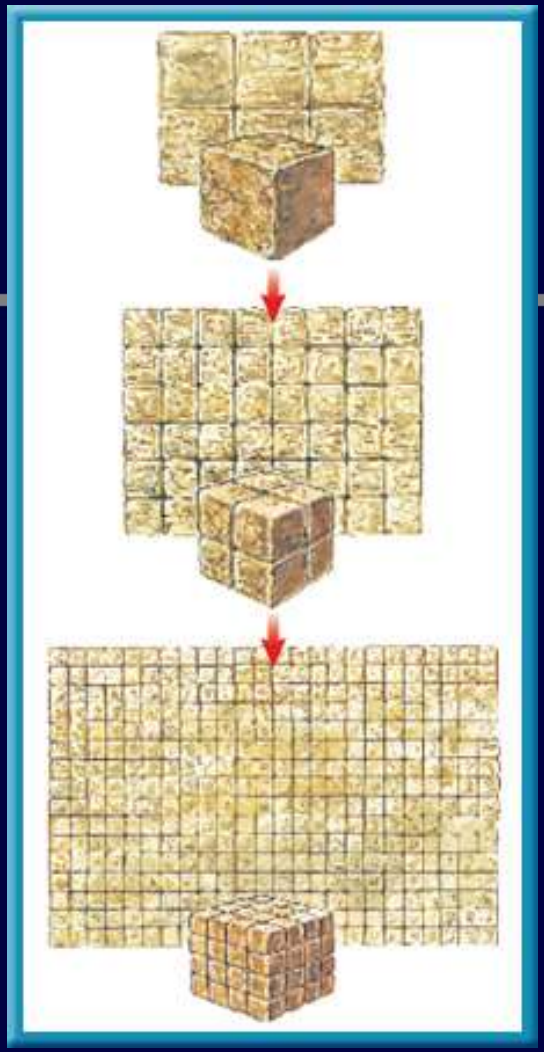
Surface Area

- As rock is broken apart by mechanical weathering, the amount of rock surface exposed to air and water increases.
- The background squares show the total number of surfaces exposed.



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Chemical Weathering

- **Chemical weathering** occurs when chemical reactions dissolve the minerals in rocks or change them into different minerals.
- This type of weathering changes the chemical composition of the rock, which can weaken the rock.

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Natural Acids

- Carbonic acid reacts with minerals such as calcite, which is the main mineral that makes up limestone.
- Over many thousands of years, carbonic acid has weathered so much limestone that caves have formed.

1

Natural Acids

- Chemical weathering also occurs when naturally formed acids come in contact with other rocks.
- Over a long period of time, the mineral feldspar, which is found in granite, some types of sandstone, and other rocks, is broken down into a clay mineral called kaolinite (KAY oh luh nite).

1

Plant Acids

- Some roots and decaying plants give off acids that also dissolve minerals in rock. When these minerals dissolve, the rock is weakened.
- Eventually, the rock will break into smaller pieces.

1

Oxygen

- You've seen rusty swing sets, nails, and cars. Rust is caused by oxidation.
- **Oxidation** (ahk sih DAY shun) occurs when some materials are exposed to oxygen and water.

1

Oxygen

- One common example of this type of weathering is the alteration of the iron-bearing mineral magnetite to a rustlike material called limonite.
- Oxidation of minerals gives some rock layers a red color.

1

Effects of Climate

- **Climate** is the pattern of weather that occurs in a particular area over many years.
- In cold climates, where freezing and thawing are frequent, mechanical weathering rapidly breaks down rock through the process of ice wedging.

1

Effects of Climate

- Chemical weathering is more rapid in warm, wet climates.
- Lack of moisture in deserts and low temperatures in polar regions slow down chemical weathering.

1

Effects of Rock Type

- Rock type also can affect the rate of weathering in a particular climate. In wet climates, for example, marble weathers more rapidly than granite.

1

Question 1

Explain the difference between mechanical and chemical weathering.

1

Answer

Mechanical weathering occurs by physical processes. Growing plants, burrowing animals and expanding ice are processes that can mechanically weather rock. Chemical weathering occurs when chemical reactions dissolve minerals in rocks or change them into different minerals.

1

Question 2

Which of the following does not describe a size of sediment?

A. clay
B. sand
C. silt
D. soil

1

Answer

The answer is D. Clay, sand and silt all describe sizes of sediment.

1

Question 3

What weak acid is formed when water reacts with carbon dioxide gas in the air or soil?

A. carbonic
B. hydrocarbonic
C. nitric
D. sulfuric

1

Answer

The answer is A. Carbonic acid reacts with minerals in rocks, causing them to dissolve. Hydrochloric, nitric, and sulfuric acids are all strong acids.

2

Formation of Soil

- Soil is found in many places—backyards, empty city lots, farm fields, gardens, an

2

Formation of Soil

- What is soil and where does it come from?
  1. A layer of rock and mineral fragments produced by weathering covers the surface of Earth.
  2. Weathering gradually breaks rocks into smaller and smaller fragments.
  3. Plants and animals add organic matter, the remains of once-living organisms, to the rock fragments.
- Soil is a mixture of weathered rock, decayed organic matters, mineral fragments, water, and air.

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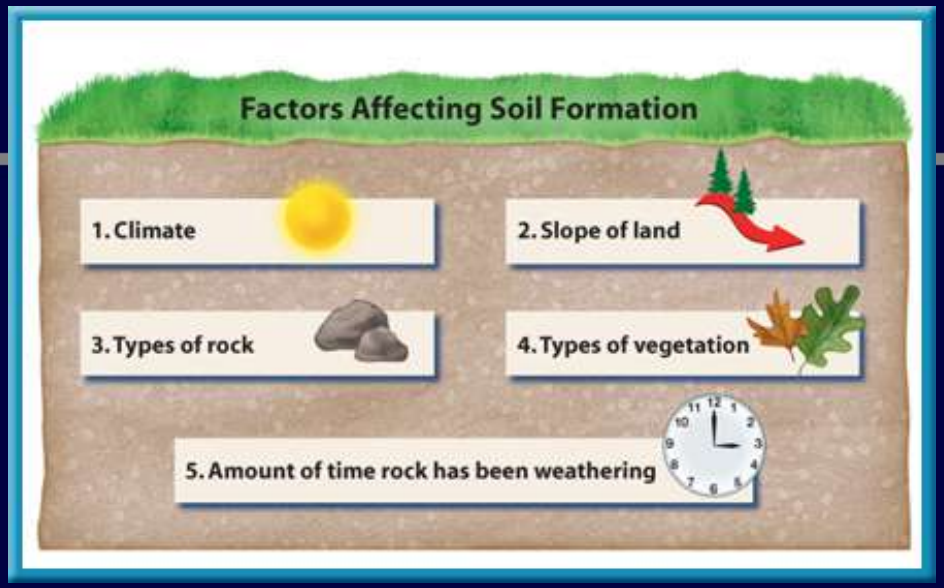
Formation of Soil

- Soil can take thousands of years to form and ranges from 60 m thick in some areas to just a few centimeters thick in others.



- Climate, slope, types of rock, types of vegetation, and length of time that rock has been weathering all affect the formation of soil.

2

Composition of Soil

- The rock and mineral fragments found in soils come from rocks that have been weathered.

2

Composition of Soil

- Most organic matter in soil comes from plants.
- Animals and microorganisms provide additional organic matter when they die.
- The decayed organic matter turns into a dark-colored material called **humus** (HYEW mus). Humus serves as a source of nutrients for plants.

2

Composition of Soil

- Soil has many small spaces between individual soil particles that are filled with water or air.
- When soil is moist, the spaces hold the water that plants need to grow. During a drought, the spaces are almost entirely filled with air.

2

Soil Profile

- You probably observed that most plant roots grow in the top layer of soil.
- The top layer typically is darker than the soil layers below it. These different layers of soil are called horizons.
- All the horizons of a soil form a soil profile.

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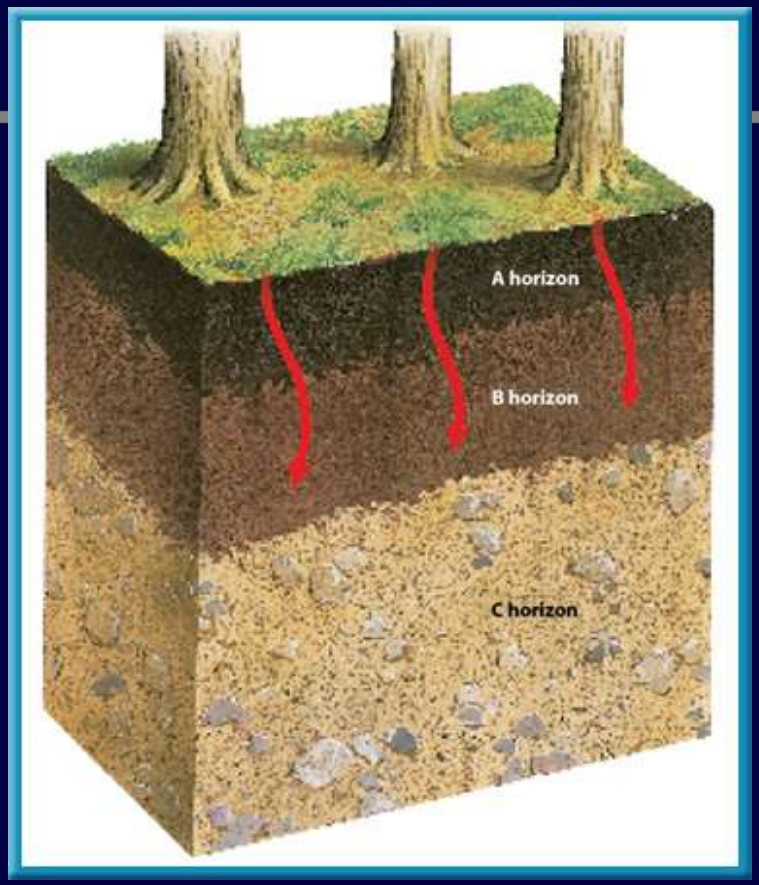
Soil Profile

- Most soils have three horizons—labeled A, B, and C.



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A Horizon

- The A horizon is the top layer of soil.
- In a forest, the A horizon might be covered with litter. **Litter** consists of leaves, twigs, and other organic material that eventually can be changed to humus by decomposing organisms.
- The A horizon also is known as topsoil.

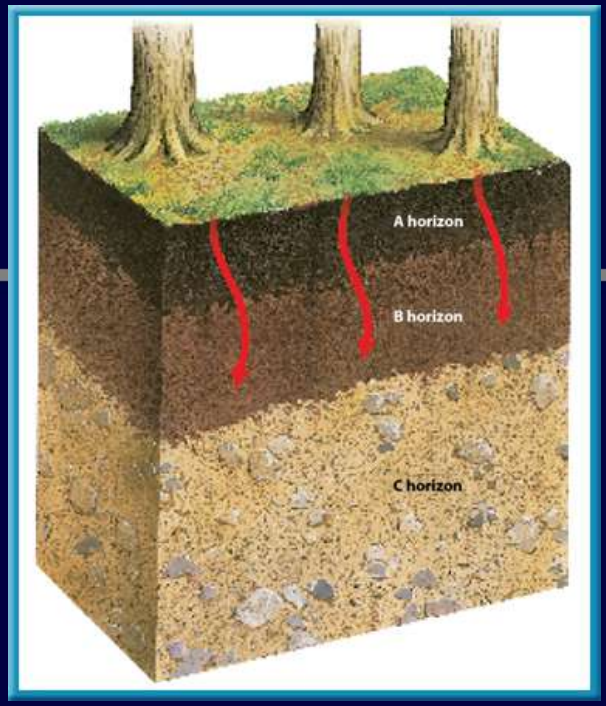
2

B Horizon

- The layer below the A horizon is the B horizon.
- Because less organic matter is added to this horizon, it is lighter in color than the A horizon and contains less humus.
- As a result, the B horizon is less fertile.

2

B Horizon



- **Leaching** is the removal of minerals that have been dissolved in water. In soil, water seeps through the A horizon where it reacts with humus and carbon dioxide to form acid.
- The acid dissolves some of the minerals in the A horizon and carries the material into the B horizon.

2

C Horizon

- The C horizon consists of partially weathered rock and is the bottom horizon in a soil profile.
- This horizon does not contain much organic matter and is not strongly affected by leaching.
- What would you find if you dug to the bottom of the C horizon? You would find rock—the rock that gave rise to the soil horizons above it.

2

Glacial Deposits

- At many places on Earth, the land is covered by a thick layer of sediment that was deposited by glaciers.
- This material, which is an unsorted mixture of clay, silt, sand, and boulders, covers much of the northern United States.
- The soils that developed from this glacial material are extremely fertile.

2

Soil Types

- The United States has many different soil types. They vary in color, depth, texture, and

2

Soil Types Reflect Climate

- Soils in deserts contain little organic material and also are thinner than soils in wetter climates.

- Prairie soils have thick, dark A horizons because the grasses that grow there contribute lots of organic matter.

2

Soil Types Reflect Climate

- Temperate forest soils have thinner A horizons and B horizons that have been enriched in many elements because of leaching.
- Other regions such as tundra and tropical areas also have distinct soils.

2

Other Factors

- Parent material has an effect on the soils that develop from it.
- Rock type also affects the type of vegetation that grows in a region, because different rocks provide different amounts of nutrients for plant growth.
- Type of vegetation then affects soil formation.

2

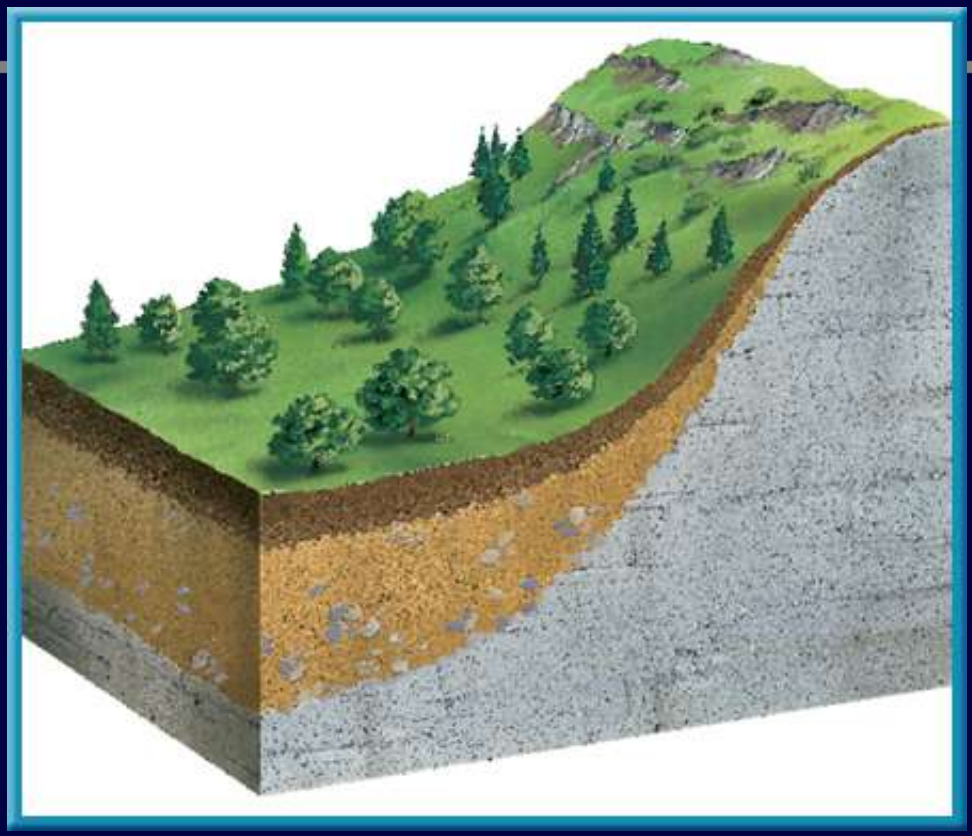
Other Factors

- Time also affects soil development.
- If weathering has been occurring for only a short time, the parent rock determines the soil characteristics.

2

Other Factors

- The slope of the land affects soil development.
  - Thin, poorly developed soils form on steep slopes, but valleys often have thick, well-developed soils.



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Question 1

Decayed organic material in soil turns into _____.

A. detritus
B. effluvia
C. humus
D. litter

2

Answer

The answer is C. Litter can eventually be changed to humus by decomposing organisms. Detritus is loose material that has worn away from rocks.

2

Question 2

Which horizon in a soil profile will be darkest in color?

A. A
B. B
C. C
D. D

2

Answer

The answer is A. The A horizon has more humus and fewer rock and mineral particles than the other layers. It is generally dark and fertile.

2

Question 3

Which soil layer is most like the parent material?

A. A horizon
B. B horizon
C. C horizon
D. D horizon

2

Answer

The answer is C. Most soils have three horizons, A, B, and C. The C horizon is the bottom layer and is most like the rock below it.

3

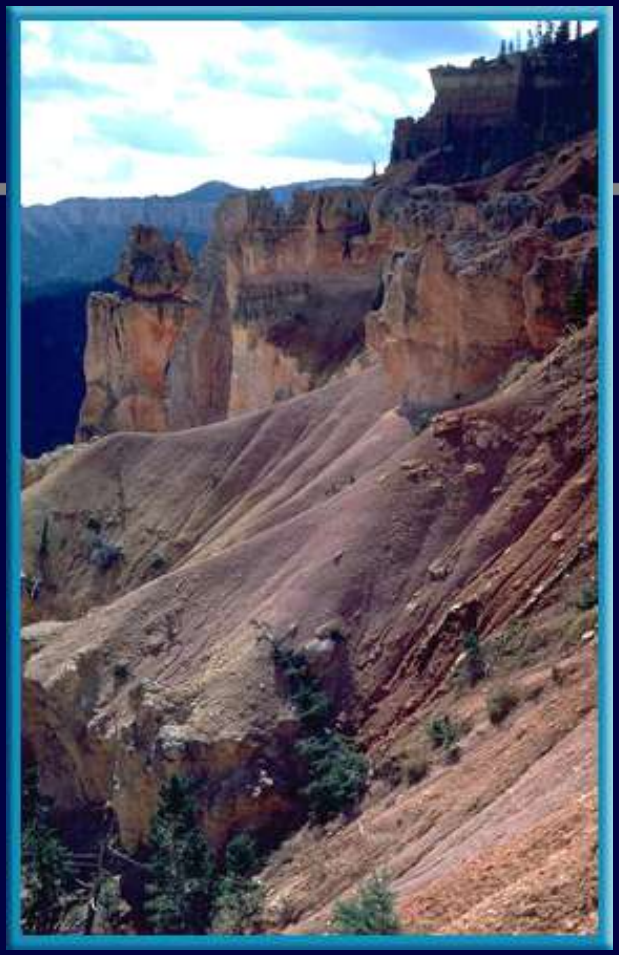
Soil—An Important Resource

- Soil erosion is harmful because plants do not grow as well when topsoil has been removed.

3

Causes and Effects of Soil Erosion

- Soil erodes when it is moved from the place where it formed.
- Generally, erosion is more severe on steep slopes than on gentle slopes. It's also more severe in areas where there is little vegetation.



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Causes and Effects of Soil Erosion

- Humans sometimes cause erosion to occur faster than new soil can form.
- One example is when people remove ground cover. Ground cover is vegetation that covers the soil and protects it from erosion.

3

Causes and Effects of Soil Erosion

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3

Agricultural Cultivation

- Soil erosion is a serious problem for agriculture.
- If topsoil is eroded, the quality of the soil is reduced.
- The difference between the amount of nutrients added and the amount of nutrients removed is called the nutrient balance.
- If topsoil erodes rapidly, the nutrient balance might be negative.

3

Forest Harvesting

- When forests are removed, soil is exposed and erosion increases.

3

Forest Harvesting

- Each year thousands of square kilometers of tropical rain forest are cleared for lumber, farming, and grazing.
- Soils in tropical rain forests appear rich in nutrients but are almost infertile below the first few centimeters.
- The soil is useful to farmers for only a few years before the topsoil is gone.

3

Overgrazing

- In some arid regions of the world, sheep and cattle raised for food are grazed on grasses until almost no ground cover remains to protect the soil.
- Without protection, soil is carried away by wind, and the moisture in the soil evaporates.

3

Excess Sediment

- Severe erosion sometimes occurs where land is exposed.
- Eroded soil is moved to a new location where it is deposited.
- If the sediment is deposited in a stream, the stream channel might fill.

3

Preventing Soil Erosion

- Soil is a natural resource that must be managed and protected. People can do several things to conserve soil.

3

Manage Crops

- All over the world, farmers work to slow soil erosion.
- In dry areas, instead of plowing under crops, many farmers graze animals on the vegetation.

3

Manage Crops

- In recent years, many farmers have begun to practice no-till farming.
- In no-till farming, farmers leave plant stalks in the field over the winter months. At the next planting, they seed crops without destroying these stalks and without plowing the soil.

3

Manage Crops

- No-till farming provides cover for the soil year-round, which reduces water runoff and soil erosion.

3

Reduce Erosion on Slopes

- On gentle slopes, planting along the natural contours of the land, called contour farming, reduces soil erosion.

3

Reduce Erosion on Slopes

- Where slopes are steep, terracing often is used. Terracing (TER uh sing) is a method in which steep, sloped, level topped areas are built onto the sides of steep hills and mountains so that crops can be grown.

3

Reduce Erosion of Exposed Soil

- A variety of methods are used to control erosion where soil is exposed.
- During the construction process water is sometimes sprayed onto bare soil to prevent erosion by wind. When construction is complete, topsoil is added in areas where it was removed and trees are planted.

3

Reduce Erosion of Exposed Soil

- At strip mines, water flow can be controlled so that most of the eroded soil is kept from leaving the mine.
- After mining is complete, the land is reclaimed.

3

Question 1

Which slows soil erosion?

A. contour farming
B. forest harvesting
C. overgrazing
D. removing ground cover

3

Answer

The answer is A. Contour farming reduces erosion on gentle slopes by slowing the flow of water down the slopes.

3

Question 2

What is the method of slowing soil erosion in which level-topped areas are built onto the sides of steep hills and mountains so that crops can be grown?

A. contour farming
B. cultivation
C. no-till farming
D. terracing

3

Answer

The answer is D. The steep-sided, level terraces reduce runoff by creating flat areas and shorter sloping sections.

3

Question 3

Cultivation in which the soil is not plowed is called _____ farming.

A. contour
B. no-till
C. terrace
D. vegetative

3

Answer

The answer is B. In no-till farming, old plant stalks are left in the fields over the winter months. This plant material provides cover for the soil and reduces erosion.

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