

Prentice Hall

EARTH SCIENCE



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♦ Lutgens

Chapter

5

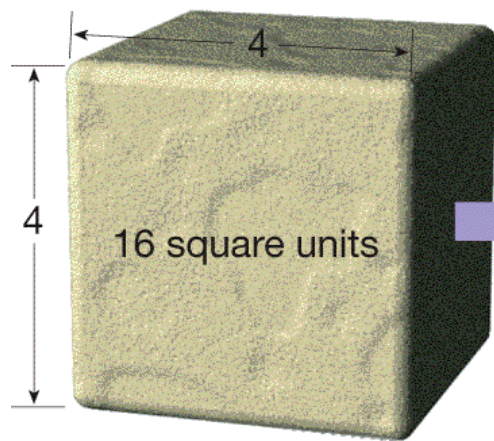
Weathering, Soil, and Mass Movements

5.1 Weathering

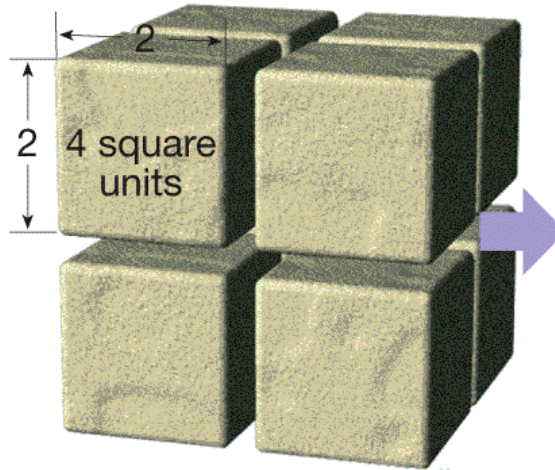
Mechanical Weathering

- ◆ **Mechanical weathering** occurs when physical forces break rock into smaller and smaller pieces without changing the rock's mineral composition.
- ◆ In nature three physical processes are especially important causes of weathering: frost wedging, unloading, and biological activity.

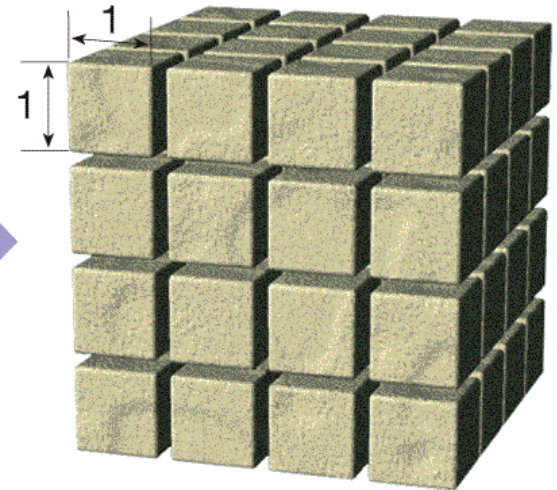
Increase in Surface Area by Mechanical Weathering



$$\begin{array}{l} 16 \text{ square units} \times \\ 6 \text{ sides} \times \\ 1 \text{ cube} = \\ \hline 96 \text{ square units} \end{array}$$



$$\begin{array}{l} 4 \text{ square units} \times \\ 6 \text{ sides} \times \\ 8 \text{ cubes} = \\ \hline 192 \text{ square units} \end{array}$$



$$\begin{array}{l} 1 \text{ square unit} \times \\ 6 \text{ sides} \times \\ 64 \text{ cubes} = \\ \hline 384 \text{ square units} \end{array}$$

5.1 Weathering

Mechanical Weathering

1. Frost wedging

- The mechanical breakup of rock caused by the expansion of freezing water in cracks and crevices
- Sections of rock that are wedged loose may tumble into large piles called **talus**, which typically form at the base of steep, rocky cliffs.

Frost Wedging



5.1 Weathering

Mechanical Weathering

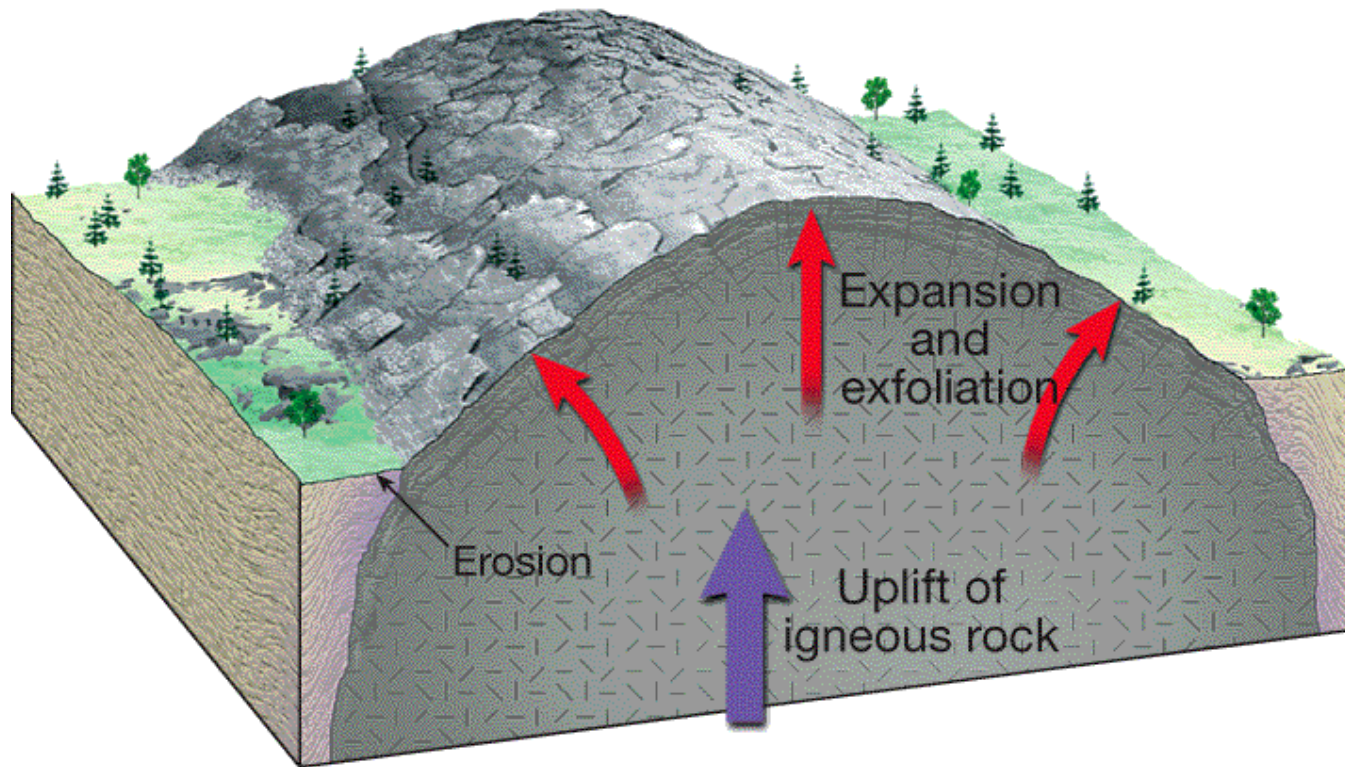
2. Unloading

- Reduced pressure on igneous rock causes it to expand and allows slabs of outer rock to break off in layers in a process called **exfoliation**.

3. Biological activity

- The activity of organisms, including plants, burrowing animals, and humans, can also cause mechanical weathering.

Unloading and Exfoliation of Igneous Rocks



Weathering and Biological Activity



5.1 Weathering

Chemical Weathering

- ◆ **Chemical weathering** is the transformation of rock into one or more new compounds.
- ◆ **Chemical Weathering of Granite**
 - Weathering of potassium feldspar produces clay minerals, soluble salt (potassium bicarbonate), and silica in solution.
 - Quartz remains substantially unaltered.

5.1 Weathering

Chemical Weathering

- ◆ Weathering of Silicate Minerals
 - Produces insoluble iron oxides and clay minerals
- ◆ Spheroidal Weathering
 - Causes the corners and edges of rock to be more rounded

5.1 Weathering

Rate of Weathering

- ◆ Two other factors affecting the rate of weathering are rock characteristics and climate.
 1. Rock characteristics
 - Mineral composition and solubility
 - Physical features such as joints

5.1 Weathering

Rate of Weathering

2. Climate

- Temperature and moisture are the most crucial factors.
- Chemical weathering is most effective in areas with high temperatures and abundant moisture.

Spheroidal Weathering



5.1 Weathering

Rate of Weathering

- ◆ Differential Weathering
 - Caused by variations in composition
 - Creates unusual and spectacular rock formations and landforms

5.2 Soil

Characteristics of Soil

- ◆ **Soil** is part of the regolith that supports the growth of plants.
 - **Regolith** is the layer of rock and mineral fragments that covers most of Earth's land surface.

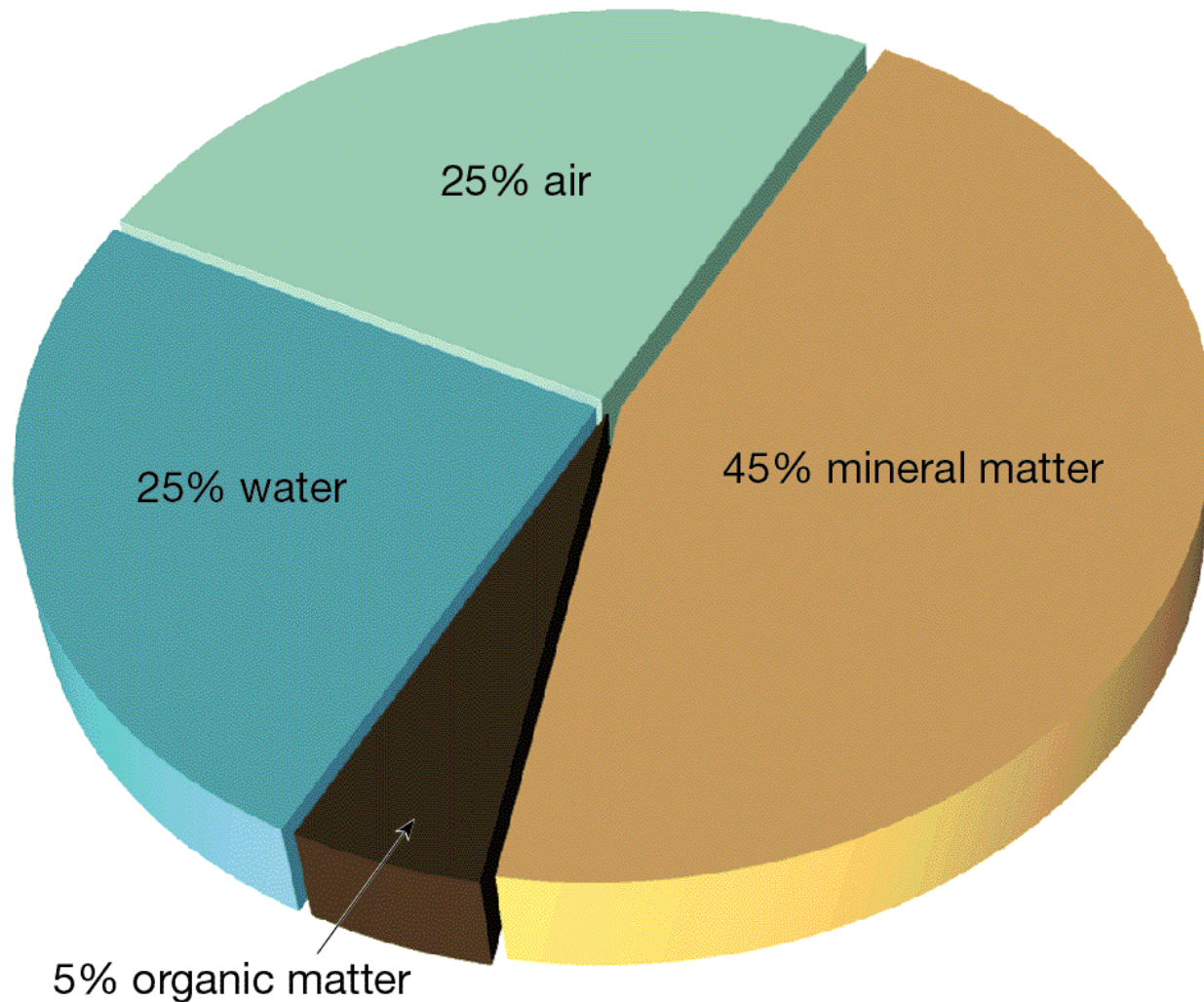
5.2 Soil

Characteristics of Soil

◆ Soil Composition

- Soil has four major components: mineral matter, or broken-down rock; humus, which is the decayed remains of organisms; water; and air.

Composition by Volume of Good-Quality Soil



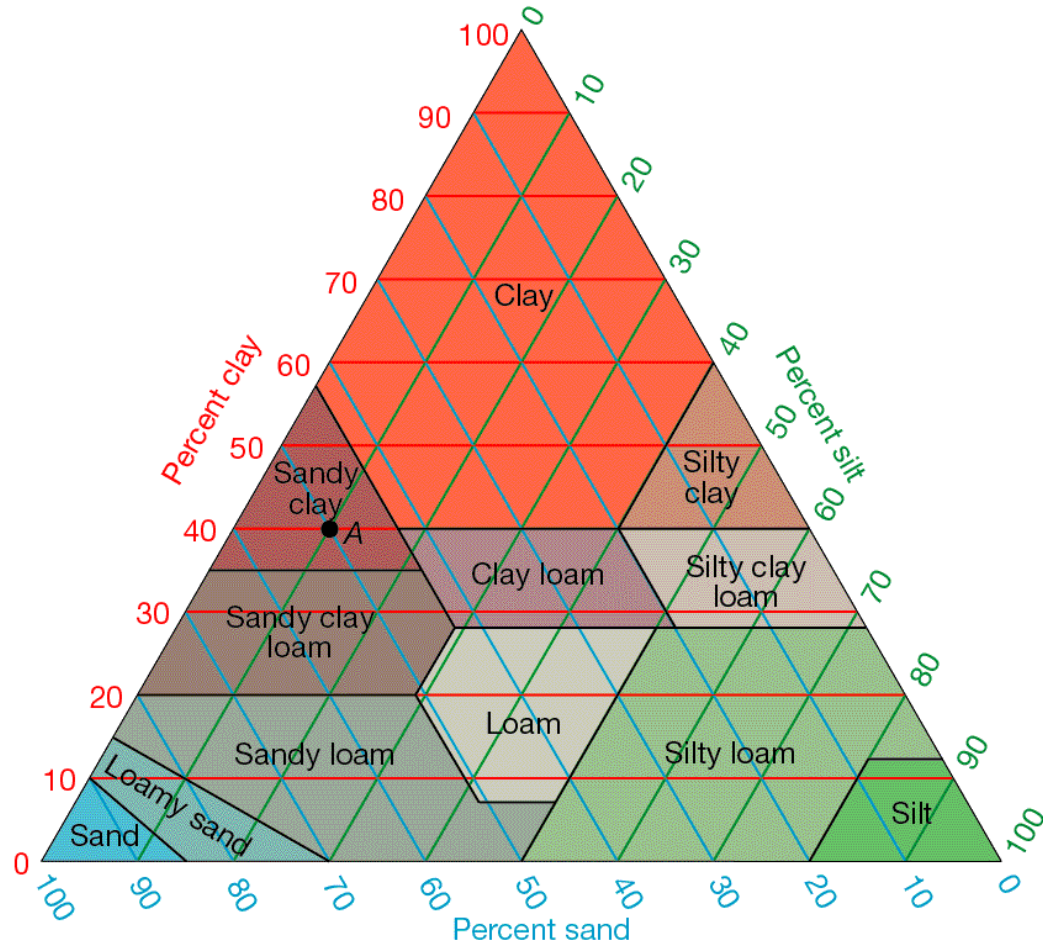
5.2 Soil

Characteristics of Soil

◆ Soil Texture

- Texture refers to the proportions of different particle sizes.
 - Sand (large size)
 - Silt
 - Clay (small size)
- Loam (a mixture of all three sizes) is best suited for plant life.

Soil Texture



5.2 Soil

Characteristics of Soil

◆ Soil Structure

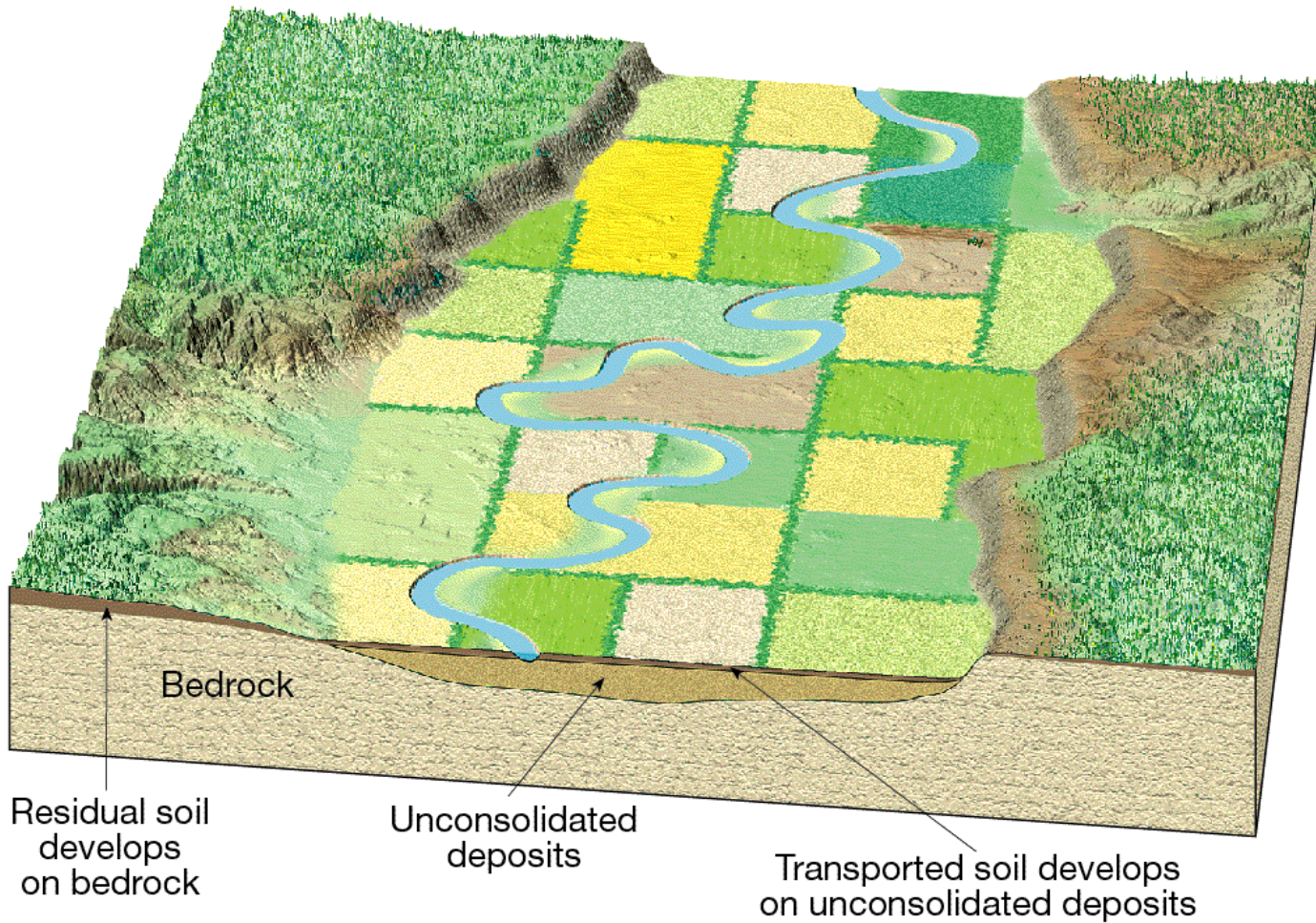
- Soil particles clump together to give a soil its structure.

5.2 Soil

Soil Formation

- ◆ The most important factors in soil formation are parent material, time, climate, organisms, and slope.
 1. Parent material
 - Residual soil—parent material is the bedrock
 - Transported soil—parent material has been carried from elsewhere and deposited

Parent Material and Soils



5.2 Soil

Soil Formation

2. Time

- Important in all geologic processes
- The longer a soil has been forming, the thicker it becomes.

3. Climate

- Greatest effect on soil formation

5.2 Soil

Soil Formation

4. Organisms

- Organisms influence the soil's physical and chemical properties.
- Furnish organic matter to soil

5. Slope

- Angle
 - Steep slopes often have poorly developed soils.
 - Optimum slope is a flat-to-undulating upland surface.

5.2 Soil

Soil Formation

5. Slope

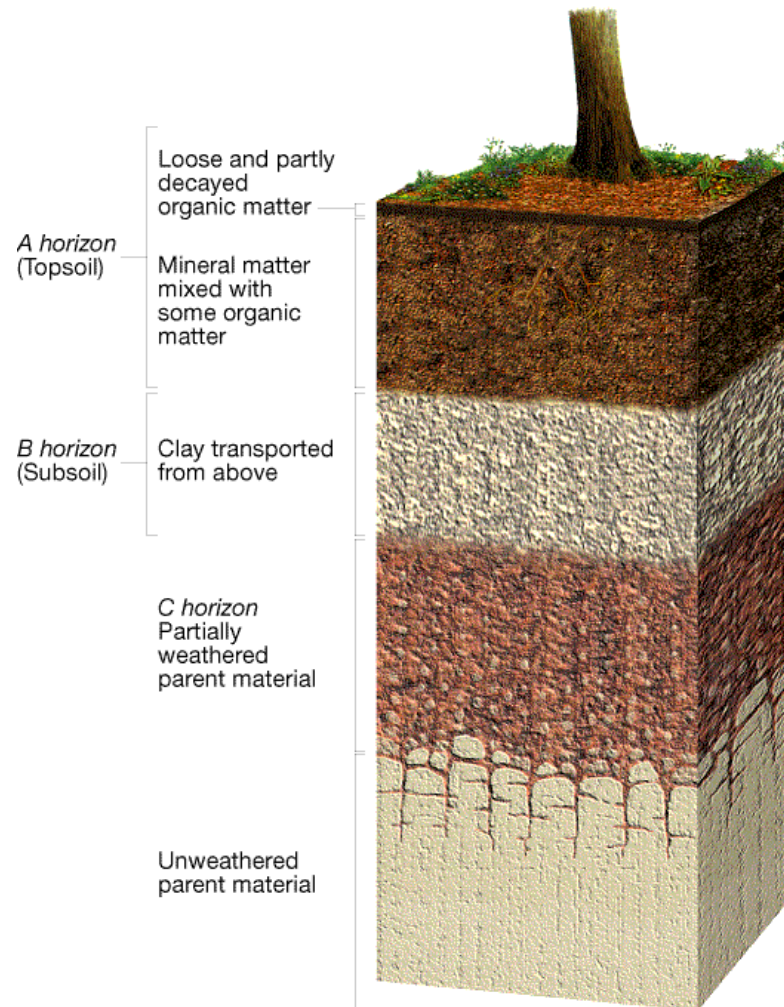
- Orientation, or direction the slope is facing, influences soil formation.
 - Soil temperature
 - Moisture

5.2 Soil

The Soil Profile

- ◆ Soil varies in composition, texture, structure, and color at different depths. **Soil horizons** are zones or layers of soil. A **soil profile** is a vertical section through all the soil horizons.
 - The A horizon is commonly known as topsoil.
 - The B horizon is subsoil and contains clay particles washed out from the A horizon.
 - The C horizon is between B horizon and unaltered parent material.

Soil Profile



A Soil Profile Showing Different Horizons



5.2 Soil

Soil Types

- ◆ Three common types of soil are pedalfer, pedocal, and laterite.

1. **Pedalfer**

- Best developed under forest vegetation
- Accumulation of iron oxides and aluminum-rich clays in the B horizon

5.2 Soil

Soil Types

2. **Pedocal**

- Accumulates calcium carbonate
- Associated with drier grasslands

3. **Laterite**

- Hot, wet, tropical climates
- Intense chemical weathering

5.2 Soil

Soil Erosion

- ◆ Water erodes soil.
- ◆ Rates of Erosion
 - Human activities that remove natural vegetation, such as farming, logging, and construction, have greatly accelerated erosion.
- ◆ Sediment Deposition
 - Reservoirs fill with sediment.
 - Sediments are contaminated by pesticides and fertilizers.

5.2 Soil

Soil Erosion

- ◆ Controlling Erosion
 - Planting rows of trees called windbreaks
 - Terracing hillsides
 - Plowing along the contours of hills
 - Rotating crops

5.3 Mass Movements

Triggers of Mass Movements

- ◆ The transfer of rock and soil downslope due to gravity is called **mass movement**.
- ◆ Among the factors that commonly trigger mass movements are saturation of surface materials with water, oversteepening of slopes, removal of vegetation, and earthquakes.

5.3 Mass Movements

Types of Mass Movements

- ◆ Geologists classify mass movements based on the kind of material that moves, how it moves, and the speed of movement.
- ◆ Rockfalls
 - A **rockfall** occurs when rocks or rocks fragments fall freely through the air.

5.3 Mass Movements

Types of Mass Movements

◆ Slides

- In a slide, a block of material moves suddenly along a flat, inclined surface.
- Slides that include segments of bedrock are called **rockslides**.

◆ Slumps

- A **slump** is the downward movement of a block of material along a curved surface.

Heavy Rains Can Trigger Slumps



5.3 Mass Movements

Types of Mass Movements

◆ Flows

- Flows are mass movements of material containing a large amount of water.
- **Mudflows** move quickly and carry a mixture of soil, rock, and water that has a consistency of wet concrete.
- **Earthflows** move relatively slowly and carry clay-rich sediment.

5.3 Mass Movements

Types of Mass Movements

◆ Creep

- **Creep** is the slow, downhill movement of soil and regolith.

Creep

