Prentice Hall

EARTH SCIENCE

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Chapter 5

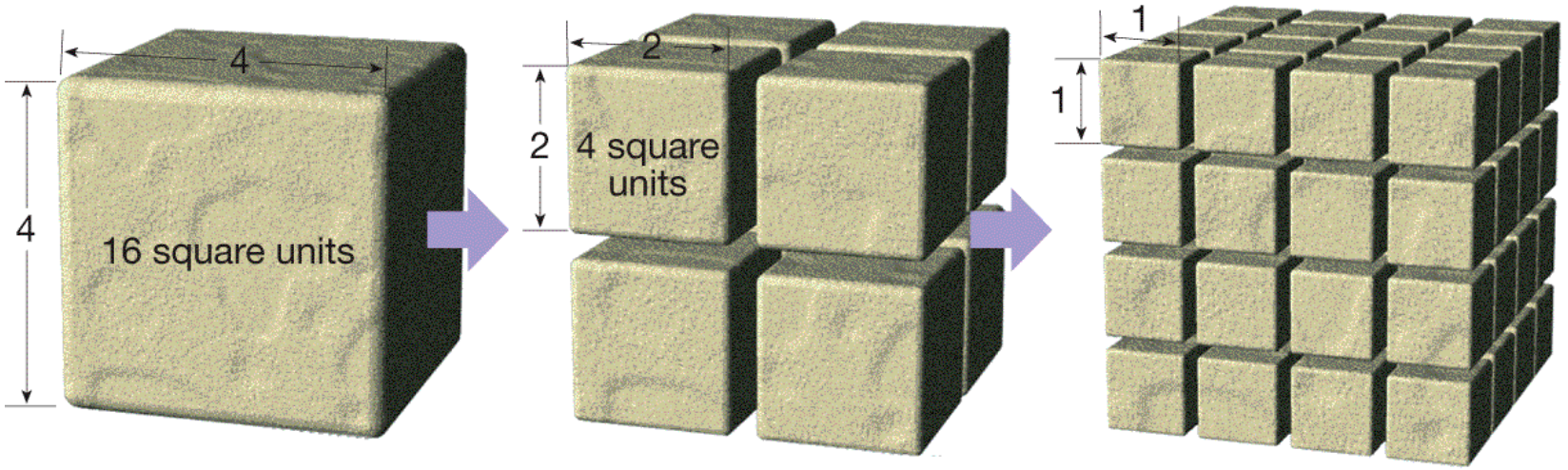
Weathering, Soil, and Mass Movements

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 process are especially important causes of weathering: frost wedging, unloading, and biological activity.

Increase in Surface Area by Mechanical Weathering



16 square units ×
6 sides ×
1 cube =
96 square units

4 square units ×
6 sides ×
8 cubes =
192 square units

1 square unit ×
6 sides ×
64 cubes =
384 square units

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.

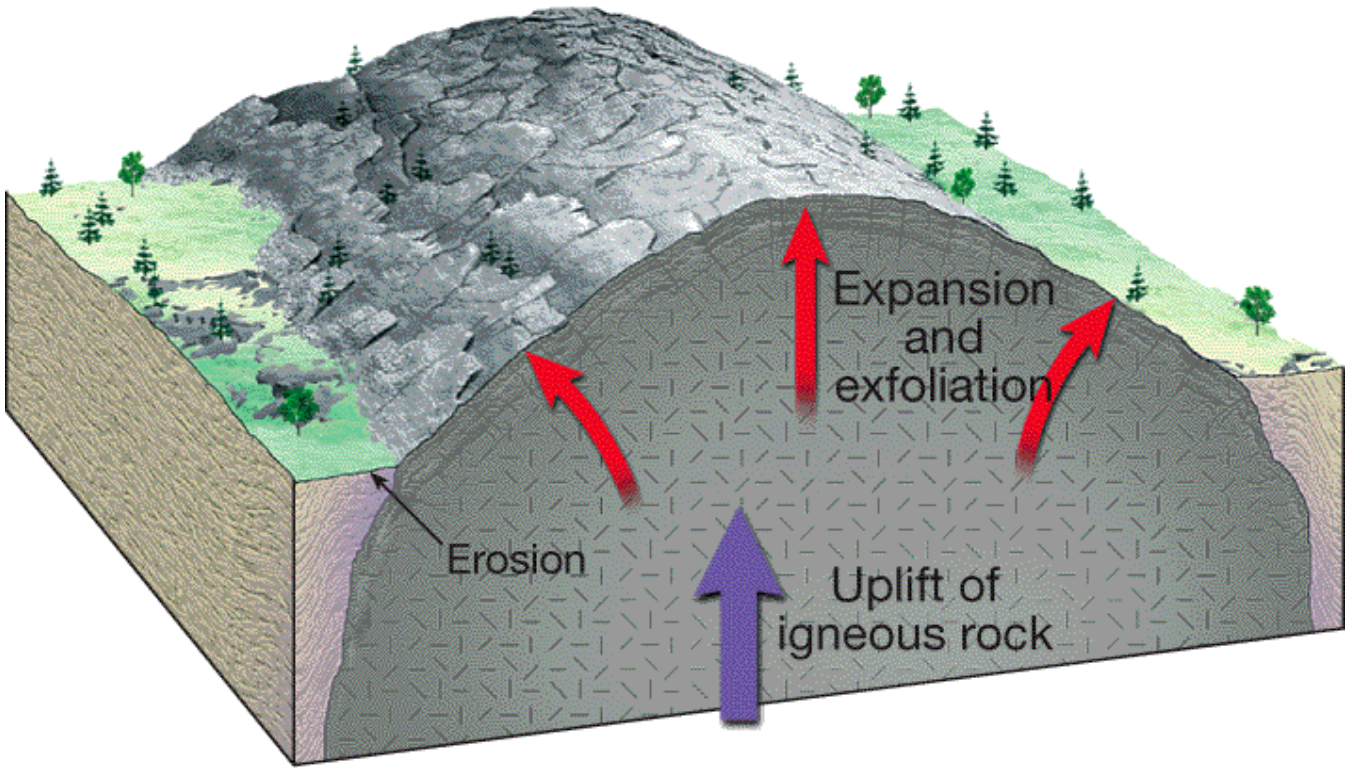
Frost Wedging

5.1 Weathering

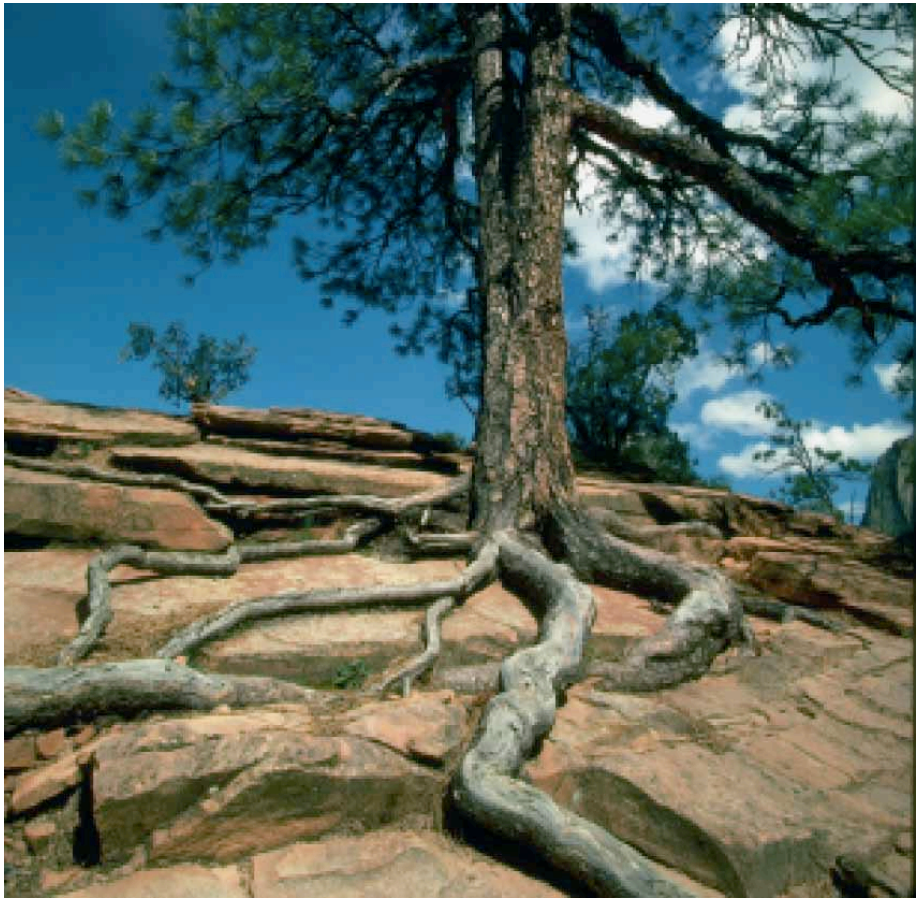
Mechanical Weathering

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

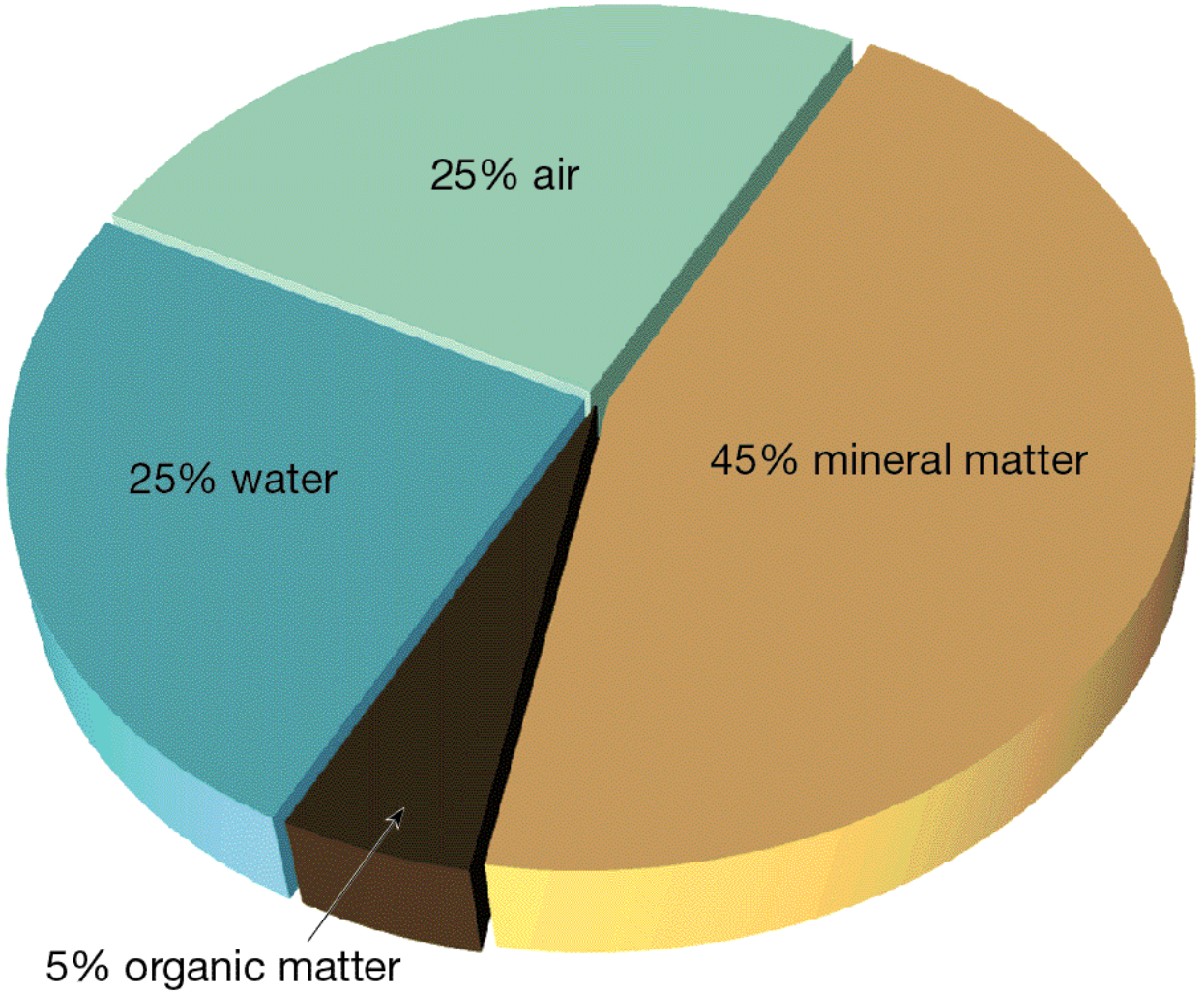
- **Soil** is part of the regolith that supports the growth of plants.
  - **Regolith** is the layer of rock and mineral fragments that covers most of Earth's land surface.

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

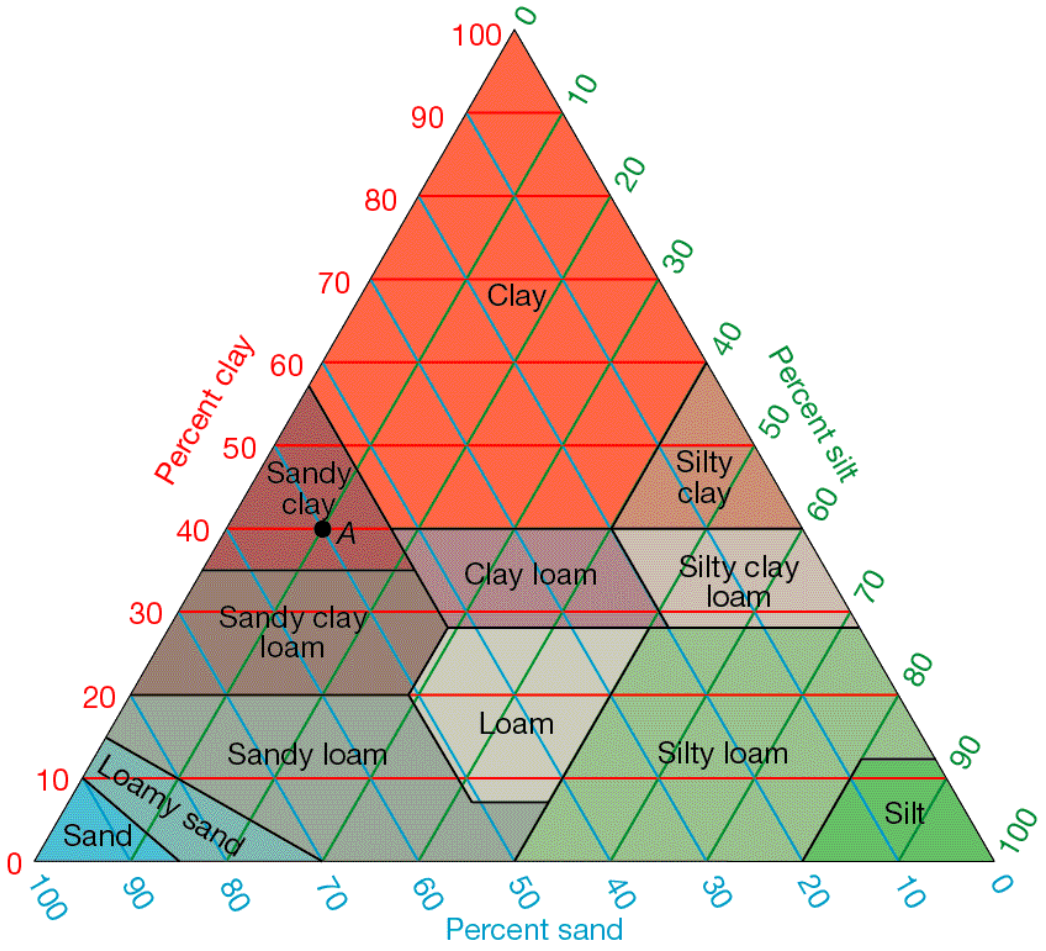


5.2 Soil

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.

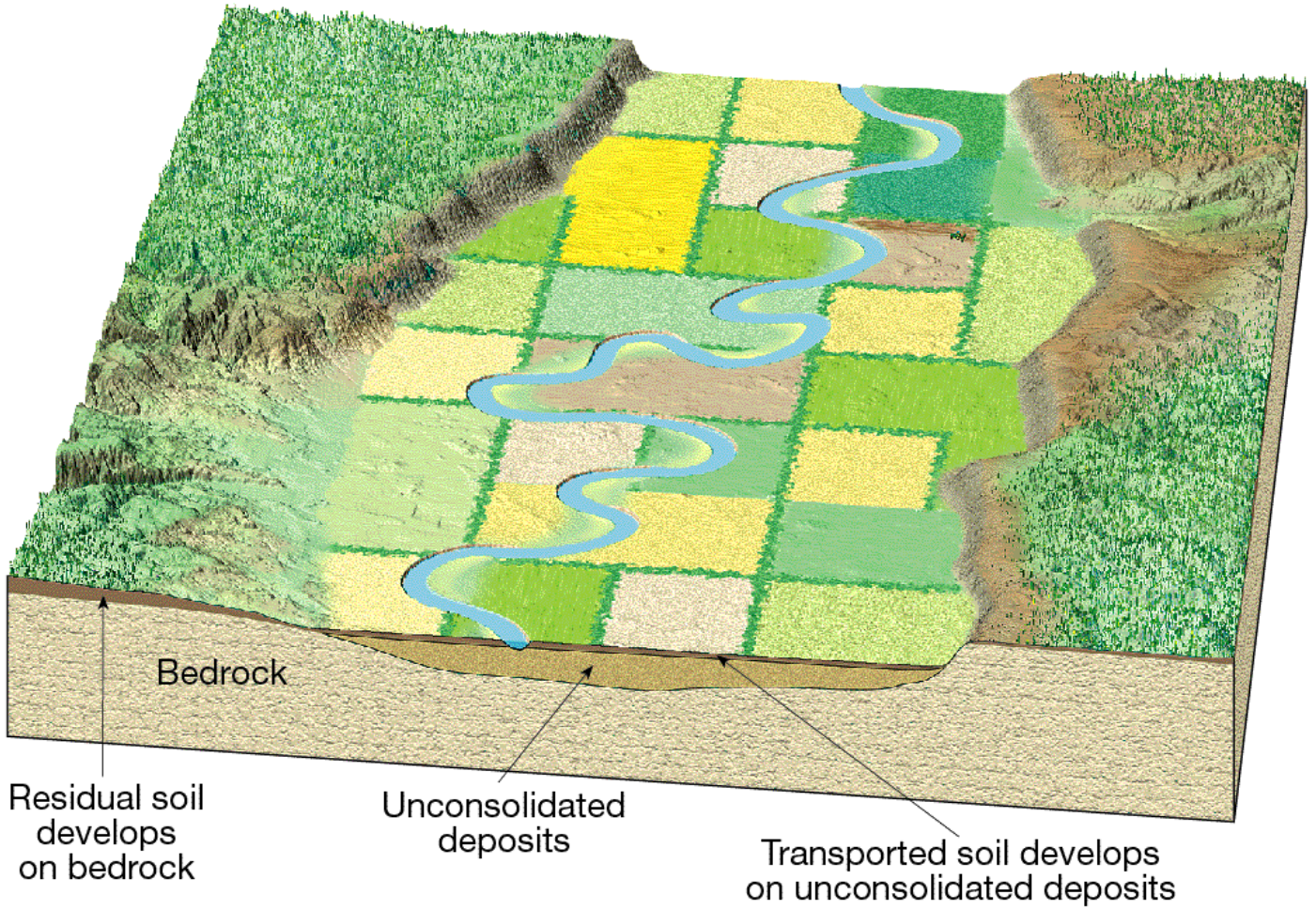
5.2 Soil

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

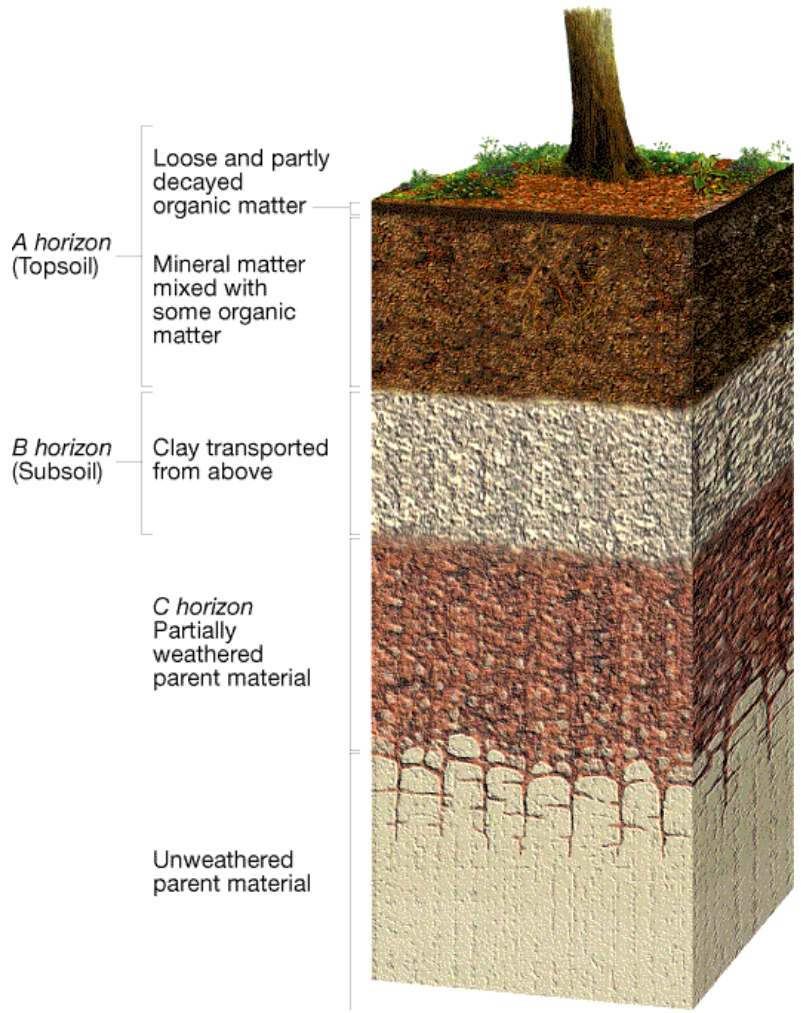
5.2 Soil

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 know 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

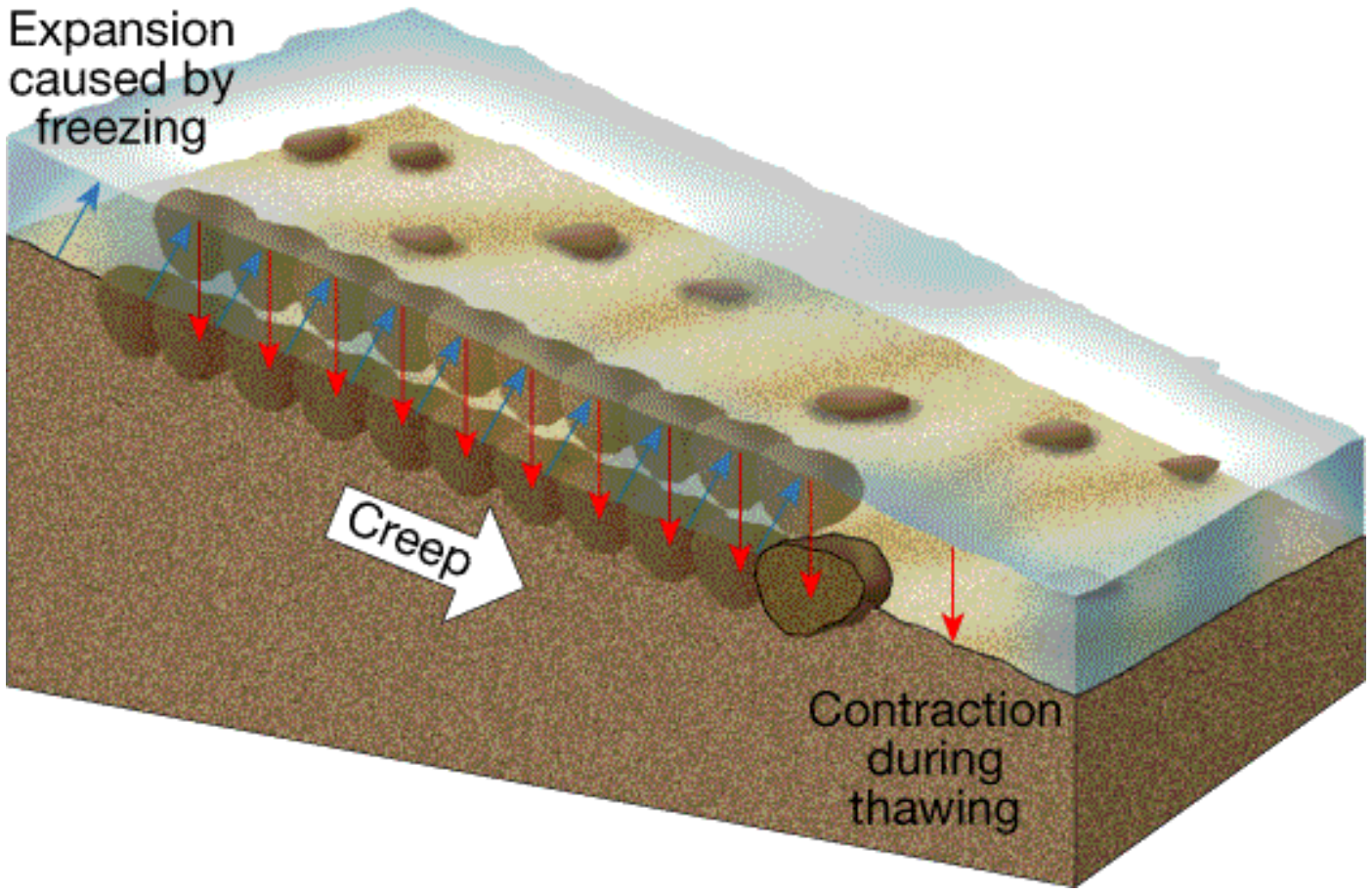
- Flows
  - Flows are mass movements of material containing a large amount of water.
  - **Mudflows** move quickly and carry a mixture of soil, rock, and water that has a consistency of wet concrete.
  - **Earthflows** move relatively slowly and carry clay-rich sediment.

5.3 Mass Movements

Types of Mass Movements

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

Creep


Expansion
caused by
freezing
Creep
Contraction
during
thawing