



ECIV 3302 Engineering Geology

Chapter 5 **WEATHERING AND SOIL**

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The materials are mostly adapted from the presentation of Stan & Cindy Hatfield

Earth's external processes

- **Weathering** — the physical breakdown (disintegration) and chemical alteration (decomposition) of rock at Earth's surface
- **Mass wasting** — the transfer of rock and soil downslope under the influence of gravity
- **Erosion** — the physical removal of material by mobile agents such as water, wind, ice, or gravity



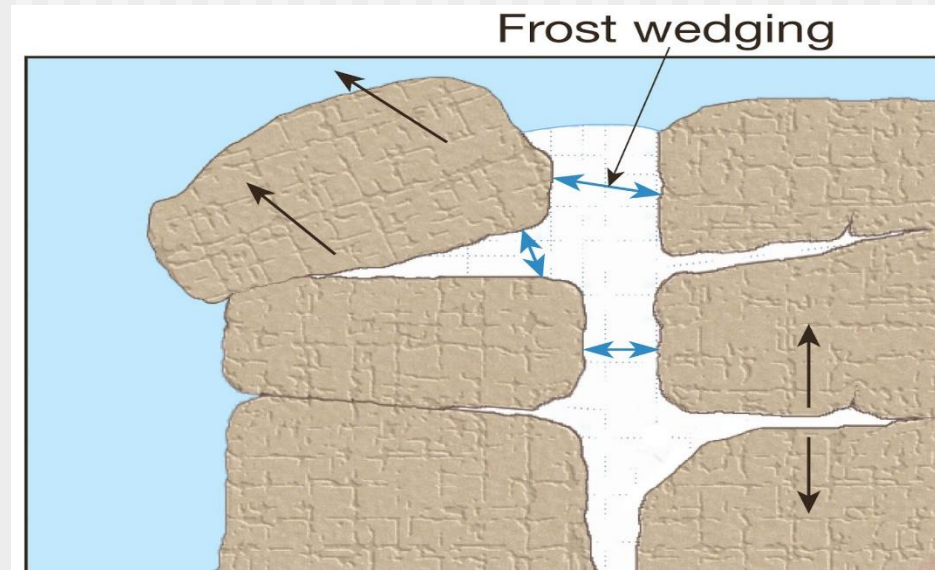
Weathering

■ Types of weathering:

a. **Mechanical weathering:** breaking of rocks into smaller pieces

- Types of mechanical weathering:

- Frost wedging
- Unloading
- Thermal expansion
- Biological activity



Weathering

b. Chemical weathering:

- Breaks down rock components and internal structures of minerals
- Most important agent is water
 - Responsible for transport of ions and molecules involved in chemical processes

Weathering

■ Major processes of chemical weathering

- Dissolution

- Aided by small amounts of acid in the water

- Oxidation

- Any reaction when electrons are lost from one element

- Hydrolysis

- The reaction of any substance with water
 - Hydrogen ion attacks and replaces other ions

Weathering

- Alterations caused by chemical weathering:
 - Decomposition of unstable minerals
 - Formation or retention of stable materials
 - Physical changes such as the rounding of corners or edges

TABLE 5.1

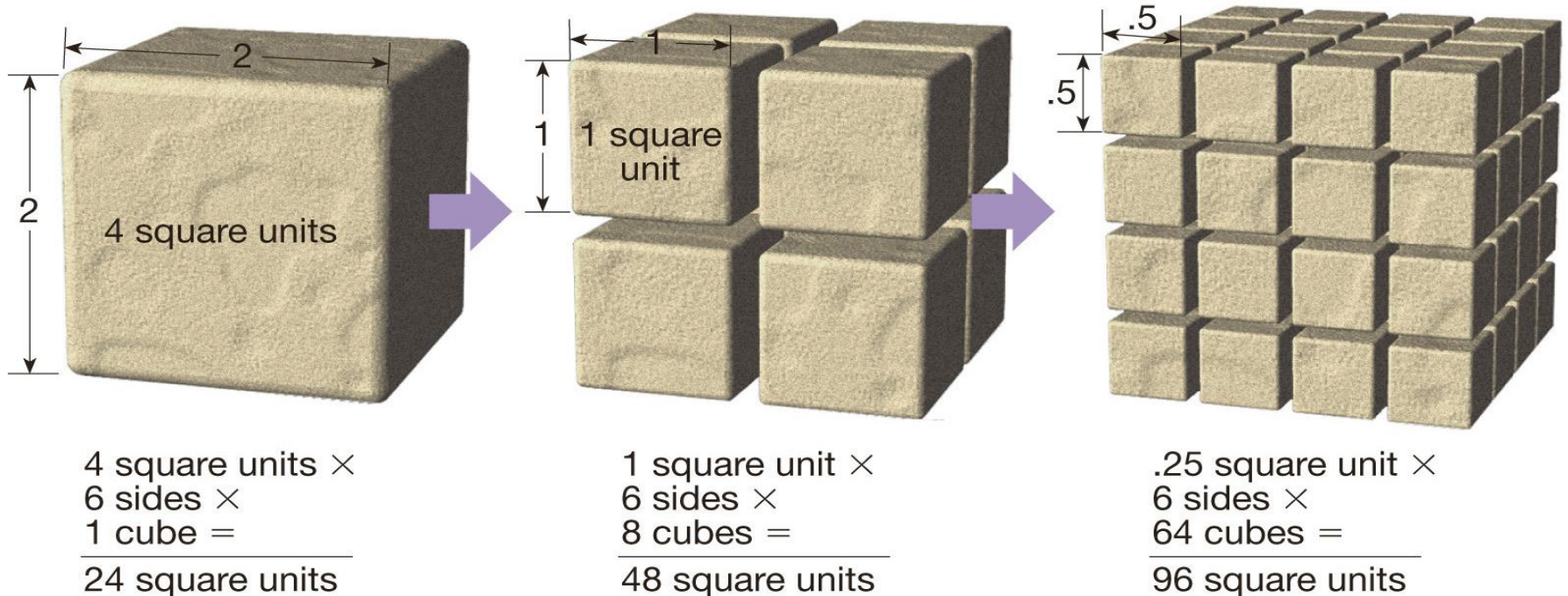
Products of Weathering

Mineral	Residual Products	Material in Solution
Quartz	Quartz grains	Silica
Feldspars	Clay minerals	Silica, K^+ , Na^+ , Ca^{2+}
Amphibole (hornblende)	Clay minerals Limonite Hematite	Silica, Ca^{2+} , Mg^{2+}
Olivine	Limonite Hematite	Silica, Mg^{2+}

Rates of weathering

Factors affecting weathering:

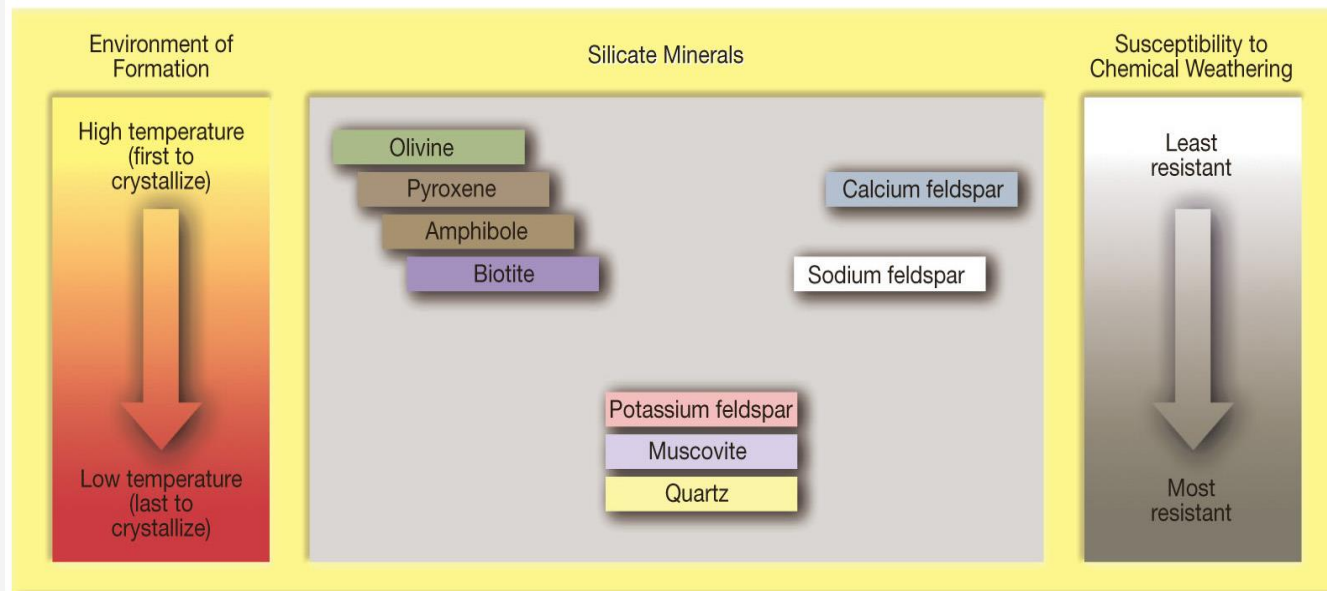
1. Surface area



Rates of weathering

2. Rock characteristics

- Rocks containing calcite (marble and limestone) readily dissolve in weakly acidic solutions
- Silicate minerals weather in the same order as their order of crystallization



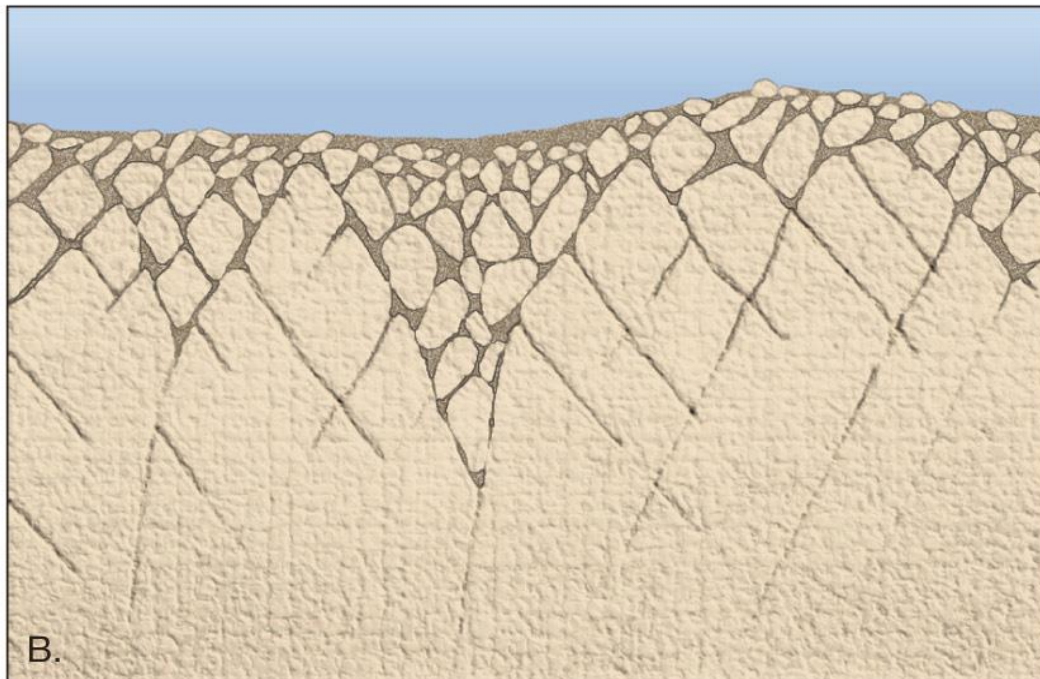
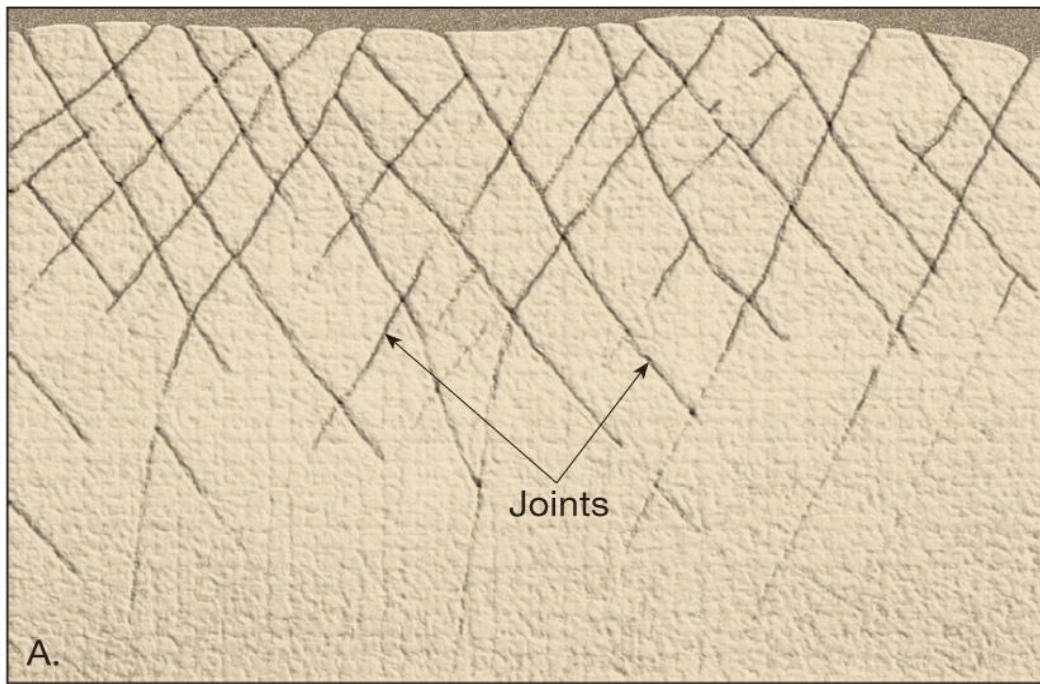
Rates of weathering

3. Climate

- Temperature and moisture characteristics
- Chemical weathering is most effective in areas of warm, moist climates

4. Differential weathering

- Rocks do not weather uniformly due to regional and local factors
- Results in many unusual and spectacular rock formations and landforms



Spheroidal weathering of extensively jointed rock

Joint-controlled weathering

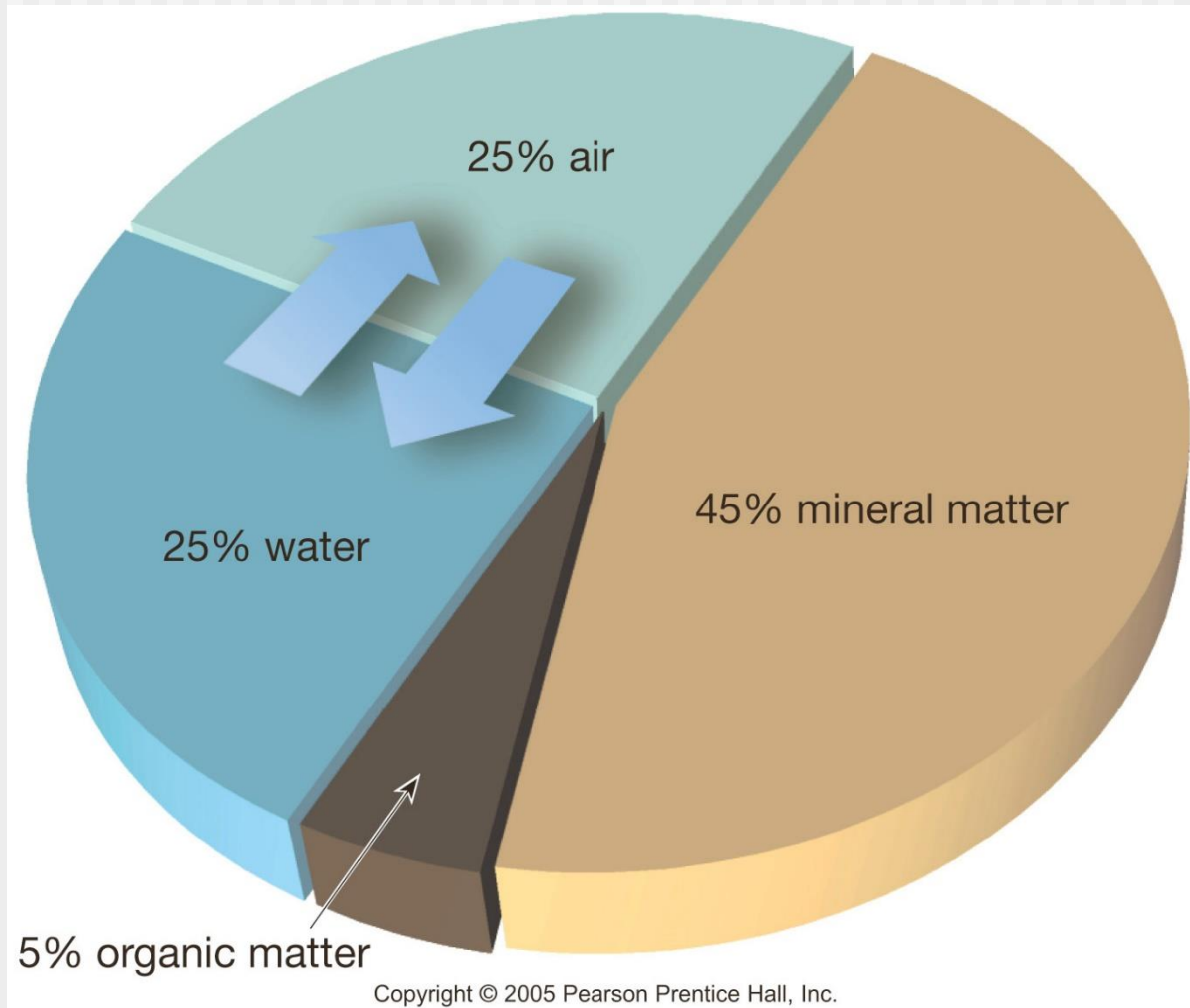


D.

Soil

- **Soil** = combination of mineral and organic matter, water, and air.
 - Rock and mineral fragments produced by weathering (**regolith**) that supports the growth of plants
 - **Humus** (decayed animal and plant remains) is a small, but essential, component.

Composition of a “good” soil



Soil

■ Factors controlling soil formation

1. Parent material

- Residual vs. transported soil

2. Time

- Amount of time for soil formation varies for different soils depending on geologic and climatic conditions

Soil

3. Climate

- Most influential control of soil formation
- Key factors are temperature and precipitation

4. Plants and animals

- Influence the soil's physical and chemical properties

5. Topography

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

Variations in soil development



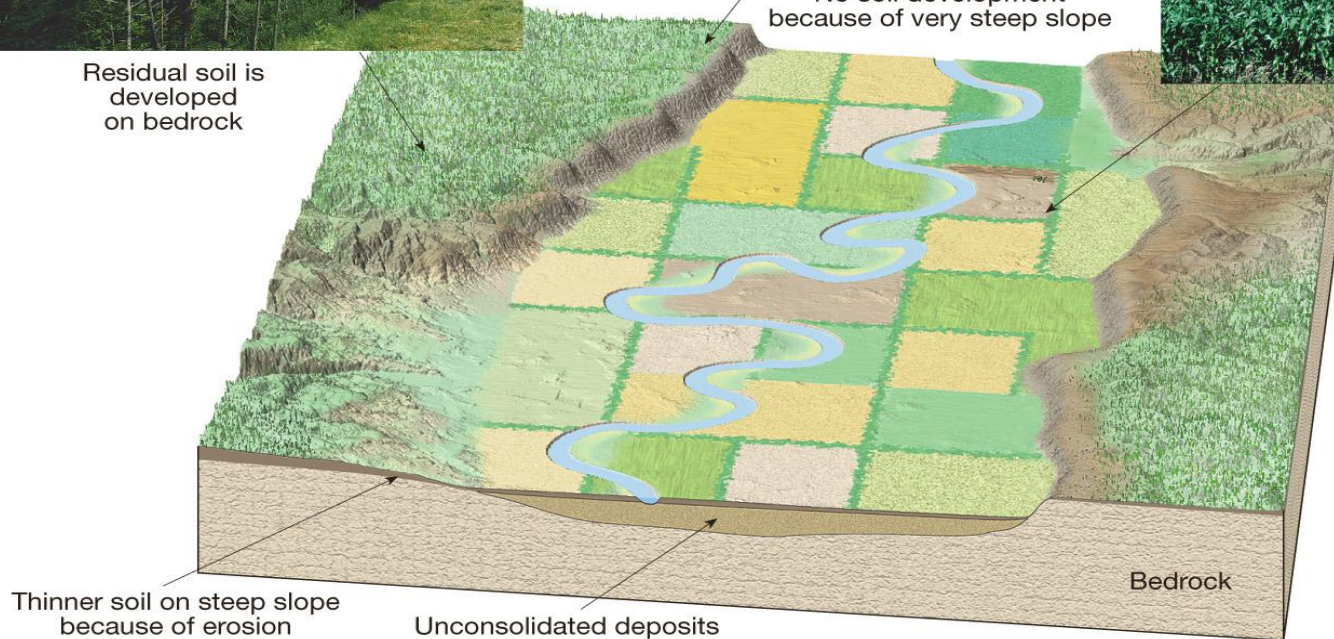
Residual soil is developed on bedrock



No soil development because of very steep slope



Transported soil is developed on unconsolidated deposits



Thinner soil on steep slope because of erosion

Unconsolidated deposits

Bedrock

Soil

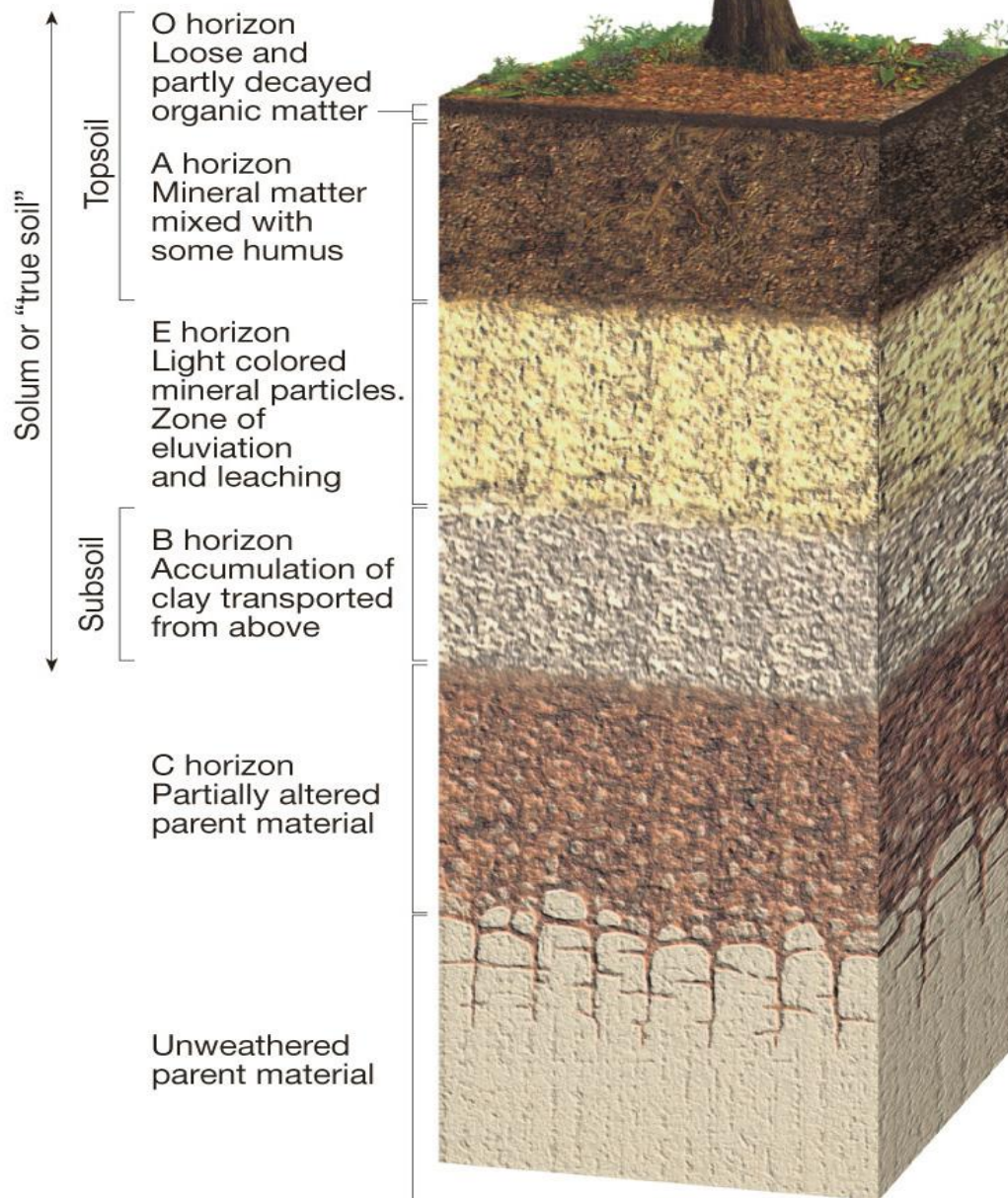
■ The soil profile

- Soil forming processes operate from the surface downward
- Vertical differences are called **horizons** – zones or layers of soil
 - **O horizon** – organic matter
 - **A horizon** – organic and mineral matter
 - ✓ High biological activity
 - ✓ O and A horizons make up the **topsoil**

Soil

■ The soil profile

- E horizon – little organic matter
 - ✓ Zone of eluviation and leaching
- B horizon – zone of accumulation
- C horizon – partially altered parent material
- Collectively the O, A, E, and B horizons = **solum**, or “true soil”



Idealized soil profile

Soil profile showing different horizons



Soil

■ Soil erosion

- Part of the natural recycling of earth materials
- Natural rates of soil erosion depend on
 - Soil characteristics
 - Climate
 - Slope
 - Type of vegetation
- In many regions soil erosion is much greater than the rate of soil formation
- Sedimentation and chemical pollution
 - Related to excessive soil erosion
 - Occasionally soil particles are contaminated with pesticides