

# Honors Earth Science: Chapter 4 - Weathering, Soil, and Mass Wasting

## I. Earth's external processes include

A. Weathering— the disintegration and decomposition of material at or near the surface

B. Mass wasting— the transfer of rock material downslope under the influence of gravity

Water, wind, gravity, glacier

C. Erosion— the incorporation and transportation of material by a mobile agent, usually water, wind, or ice

## II. Weathering

### A. Two kinds of weathering

#### 1. Mechanical weathering

No chemical change in the rock

Big rock ----> Little rock

a. Breaking of rocks into smaller pieces

b. Four processes

1. Frost wedging water freezes - expanding about 10%

2. Unloading exfoliation

3. Thermal expansion

4. Biological activity Burrowing animals  
Root Wedging

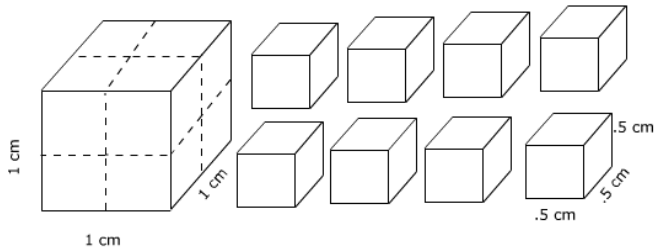
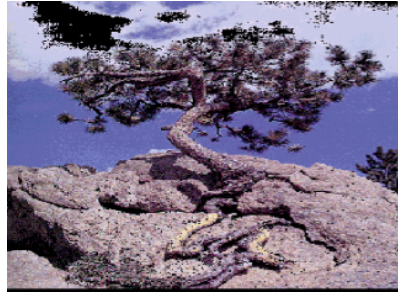
#### 2. Chemical weathering

a. Alters the internal structures of minerals by removing or adding elements

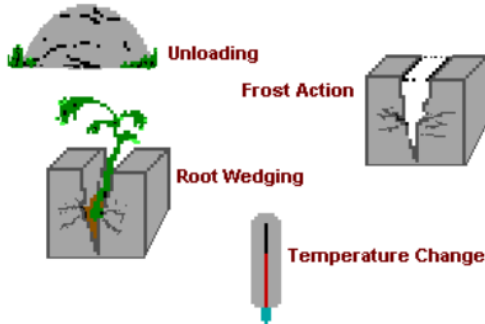
b. Most important agent is water

1. Oxygen dissolved in water oxidizes materials

2. Carbon dioxide (CO<sub>2</sub>) dissolved in water forms carbonic acid and alters the material



**Mechanical Weathering Includes:**



HALF OF THE WORLD'S PEOPLE LIVE ON LESS THAN \$2 A DAY...



©2008  
HARRY  
DUSTLE  
FOR ANIMALS  
WE CAN PROTECT

...AND WE WONDER WHY THE WORLD HAS PROBLEMS?





warm temperatures and abundant moisture

3. Differential weathering
  - a. Caused by variations in composition
  - b. Creates unusual and spectacular rock formations and landforms.

## II. Soil

A. An interface in the Earth system

B. A combination of mineral matter, water, and air—that portion of the regolith (rock and mineral fragments) that supports the growth of plants.

C. Soil texture and structure

### 1. Texture

a. Refers to the proportions of different particle sizes





1. Sand (large size)
2. Silt Regolith
3. Clay (small size)

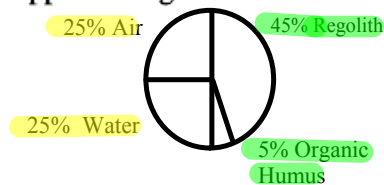
b. Loam is best suited for plant life

### 2. Structure

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

b. Four basic soil structures Peds - loose soil particles

1. Platy 
2. Prismatic 
3. Blocky 
4. Spheroidal 



C. Controls of soil formation

1. Parent material      Rock from which the soil weathered

- a. Residual soil—parent material is the bedrock
- b. Transported soil—parent material has been carried from elsewhere and deposited

2. Time

- a. Important in all geologic processes
- b. Amount of time to evolve varies for different soils

3. Climate      \*\*\* Most Important\*\*  
30 year average of daily weather

4. Plants and animals

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

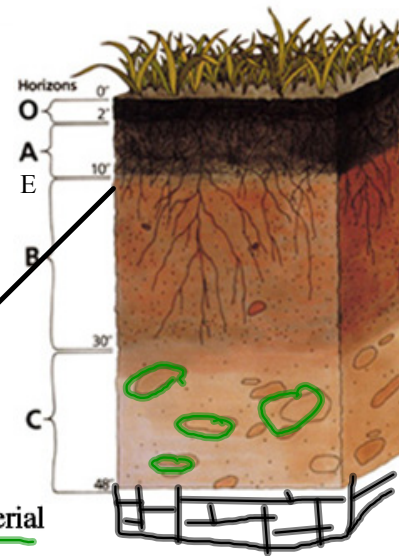
5. Slope

- a. Angle
  - 1. Steep slope—often poor soils
  - 2. Optimum is a flat-to-undulating upland surface
- B. Orientation (direction the slope is facing) influences
  - 1. Soil temperature
  - 2. Moisture

D. Soil Profile

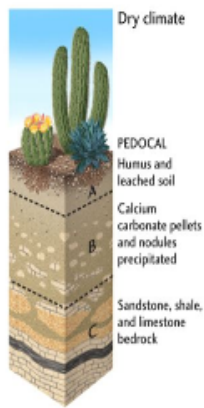
- 1. Soil forming processes operate from the surface downward

2. Horizons—zones or layers of soil
  - a. Horizons in temperate regions
    - Organic 1. O—organic matter
    2. A—organic and mineral matter
    - Eluviation 3. E—little organic matter
    4. B—zone of accumulation
    5. C—partially altered parent material
  - b. O and A together called topsoil
  - c. O, A, E, and B together called solum, or "true soil"

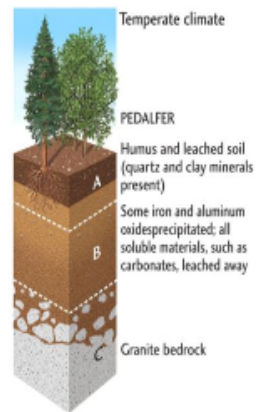


E. Soil types

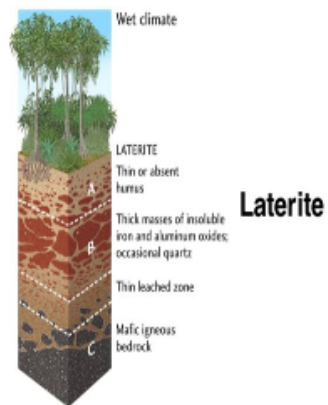
1. Hundreds of soil types worldwide 8 types in Cumberland County, PA
2. Three very generic types
  - a. **Pedalfer** Fe
    1. Accumulation of iron oxides and Al-rich clays in the B horizon
    2. Best developed under forest vegetation
  - b. **Pedocal**
    1. Accumulate calcium carbonate
    2. Associated with drier grasslands
  - c. **Laterite**
    1. Hot, wet, tropical climates High temperatures accelerate chemical reactions
    2. Intense chemical weathering Abundant moisture  
Very limited thin Topsoil



## Pedocal



## Pedalfer



## Laterite





F. Soil Erosion

1. Recycling of Earth materials
2. Natural rates of erosion depend on
  - a. Soil characteristics
  - b. Climate
  - c. Slope
  - d. Type of vegetation
3. Soil erosion and sedimentation can cause
  - a. Reservoirs to fill with sediment
  - b. Contamination by pesticides and fertilizers

IV. Weathering creates ore deposits

A. Process called secondary enrichment

1. Concentrates metals into economical deposits
2. Two ways of enrichment
  - a. Removing undesired material from the decomposing rock, leaving the desired elements behind
  - b. Desired elements are carried to lower zones and deposited

B. Examples

1. Bauxite, the principal ore of aluminum
2. Many copper and silver deposits

Water, Wind, Glaciers, GRAVITY - Agents of Erosion

V. Mass Wasting

A. The downslope movement of rock, regolith, and soil under the direct influence of gravity

B. Gravity is the controlling force

C. Important triggering factors are

1. Saturation of the material with water

- a. Destroys particle cohesion
- b. Water adds weight

2. Oversteepening of slopes

- a. Unconsolidated granular particles assume a stable slope called the angle of repose.
- b. Stable slope angle is different for various materials
- c. Oversteepened slopes are unstable

3. Removal of anchoring vegetation

4. Ground vibrations from earthquakes

D. Types of mass wasting processes

1. Generally each type is defined by

a. The material involved

1. Debris
2. Mud
3. Earth
4. Rock

What is moved?  
How it moves?  
How fast it moves?

b. The movement of the material

1. Fall (free-fall of pieces)
2. Slide (material moves along a surface)
3. Flow (material moves as a viscous fluid)

c. The velocity or rate of the movement

1. Fast
2. Slow

2. Forms of mass wasting

a. Slump

1. Rapid
2. Movement along a curved surface
3. Along oversteepened slopes

b. Rockslide

1. Rapid
2. Blocks of bedrock move down a slope

c. Debris / Mudflow

1. Rapid
2. Flow of <sup>Mud: Soil or ash</sup> debris with water
3. Often confined to channels
4. Serious problem in dry areas with heavy rains
5. Debris flows composed mostly of volcanic materials on the flanks of volcanoes are called lahars.

d. **Earthflow**

Avalanche - snow moving downslope

1. Rapid
  2. On hillsides in humid regions
  3. Water saturates the soil
  4. Liquefaction- a special type of earthflow sometimes associated with earthquakes.
- 

Slow

e. **Creep**

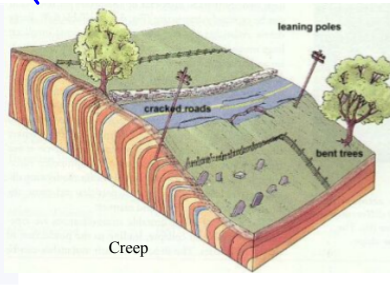
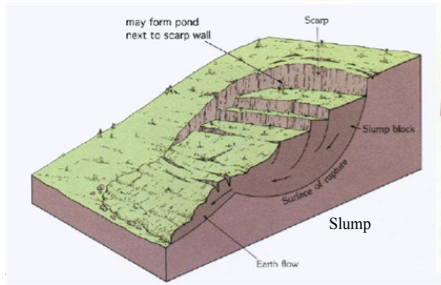
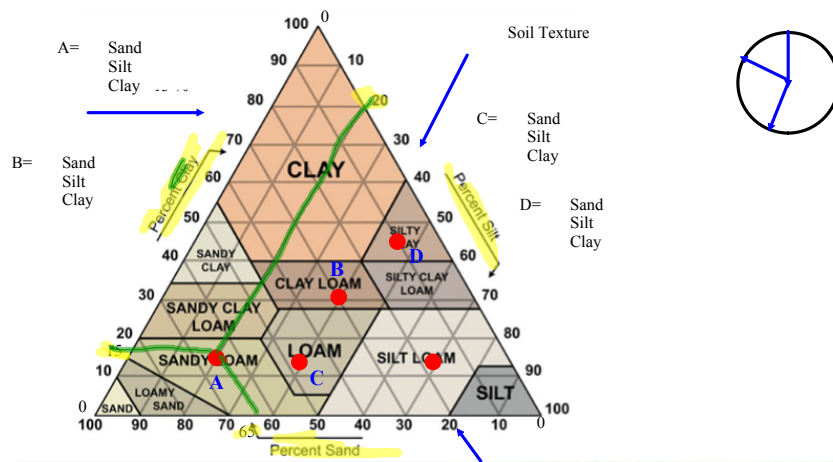
Most Common  
and Widespread

Insurance - most  
expensive

1. Slow movement of soil and regolith downhill
2. Causes fences and utility poles to tilt

f. **Solifluction**

1. Slow
2. In areas underlain by permafrost
3. Upper (active) soil layer becomes saturated and slowly flows over a frozen surface below.



The level of carbon dioxide in the atmosphere has been increasing for more than a century. Should this increase tend to accelerate or slow down the rate of chemical weathering of Earth's surface rocks? What exactly is the link between chemical weathering and carbon dioxide?

Describe some possible sources of this increasing level of carbon dioxide.

## Attachments

---

clipboard.bmp