G202 Soils and Mass Wasting

I. SOIL - a very important product of weathering at the earth's surface

A. Basic Definitions:

1. Regolith - a layer of rock and mineral fragments produced by physical and chemical weathering.

2. Soil - combination of mineral and organic matter, water, and air - that portion of the regolith that supports the growth of plants. (mixture of decomposed rock in form of sand, silt, and clay; and humus, also contains, air, water and pore spaces)

   a. Soil Texture: measure of percent sand, silt, clay, gravel, and organic matter in soil
      (1) e.g. clayey soils vs. sandy soils

3. Humus - the decayed remains of animal and plant life (organic matter made up of carbon compounds)
   a. importance of humus: source of plant nutrients, enhances ability of soil to retain water.

4. Soil Water - complex solution containing many soluble ionic species of atoms/molecules which act as plant nutrients. Water necessary for performance of vascular systems of plants.

   a. Vertical infiltration and percolation of soil water
      (1) transports dissolved soil chemicals and sediment downward under the influence of gravity

B. SOIL PROFILES

1. Soil Horizons: Throug the weathering process, soil tends to segregate into vertically characteristic layers in response to chemical and physical processes

   a. Horizons: distinctively recognizable soil layers with unique chemical and physical properties

   b. Soil growth and formation viewed as progressing in a downward direction, i.e. thickness of soil profile increases from surface downward with time (thickening downward).

2. Soil Profile: characteristic horizons

   a. O horizon: immediate surface layer composed of organic matter
   b. A horizon: organic + mineral horizon, dark brown to black in color
      (1) "Zone of Leaching" - removal of dissolved ions by solution

   c. B horizon: "Zone of Accumulation" - receiving zone of transported iron,

aluminum and clay from above, often a reddish clayey horizon.

d. C horizon: regolith or unconsolidated parent material, below root zone, weathered bedrock, in decay

e. Base of Soil = consolidated / unweathered bedrock

II. MASS WASTING

A. Stages of weathering and crustal denudation

1. Weathering, fragmentation, diminution of bedrock
   a. Chemical Processes
   b. Physical Processes

2. Mass Wasting- mass movement of weathered rock materials downslope under the force of gravity: "gravity transfer"

3. Erosion and transportation of sediment by surface waters.

   a. This process can be viewed as a continuum, at any given time there exists unweathered material, hill slope material in storage on slopes, sediment in transport and sediment in temporary storage along drainage system networks.

B. Components of mass wasting process

1. Gravity and potential energy created by crustal relief.

   a. Generally tectonics is responsible for uplifting the earth's crust, and setting gravitational and weathering process in action.

2. Weathered/fragmented earth materials (from clay, to sand, to boulder and/or including soil).

   a. As the term "mass" suggests, these materials are often subject to mass movement downslope, during slope failure.

   b. Clay has a property of readily absorbing water, to the point at which it can become very slippery and semi-plastic in nature (capable of flow).

3. Rainfall or seismic shocks can set clays into an almost liquid state, facilitating slope failure.

4. Steepness of slope.

   a. Loosened earth materials will lie at rest on a slope under the resistive force of friction.

   b. Angle of Repose- the steepest angle that can be assumed by loos fragments on a slope without downslope movement.

(1) at the base of a slope = 35-40 degrees common

5. Moisture/water included in pore spaces and fractures within weathered material.

   a. > water content of "soil" during rains, leads to slope failure

6. Gravity: driving force for moving materials downslope

C. Types of Mass Wasting Processes

1. Rock Fall: free fall of loosened rock fragments downslope, generally viewed as occurring at the base of a cliff or steep bedrock embankment. Frost wedging perhaps an important physical process in generating rockfall debris.

   a. Scree or Talus- pieces of rock fragments subject to fall.

   b. Talus Slope- cone-like accumulatiions of rock debris at the base of bedrock cliffs, generally a temporary accumulation of rock fall debris.

2. Slide: movement of large masses of rock and other earth materials (e.g. soil) abruptly downslope during massive slope failure. Sliding along planar surface of failure.

   a. Debris slides: coarse bouldery debris
   b. Earth slides: fine sand, silt, clay material

3. Landslide Morphology:
   a. Landslide scar on upslope portion where slide originated
   b. Lobate/hummocky pile of debris at downslope resting point.
   c. A possible damming of lower valley drainage and subsequent lake development.

4. Slump- considered a type of slide: slope collapse along a basal, concave upward rupture surface, with subsequent downslope movement and backward rotation of the slump block. The nose of the slump commonly experiences flow conditions resulting in a lobate form to the debris.

5. Flow- slope failure under water saturated conditions, and gradually flows down slope as semi-solid/fluid. Results in a lobate form at the nose of the flow.
   a. Debris Flow: coarse admixiture
   b. Earth Flow: fine admixture

6. Creep- very slow, imperceptible, movement of slope materials. Gradual downslope creeping of soil and regolith (partially weathered rock). Involves the entire area of the hillslope under the force of gravity.

   a. creep is enhanced by water saturated conditions, and freeze/thaw process with the upheaving and compressing of materials on a slope, slowly pushing material down-slope.

b. Factors influencing creep process:
   (1) > slope > creep rate;
   (2) > vegetative cover/rooting < creep rate;
   (3) > moisture content > creep rate.

7. Solifluction- special case of creep in cold climate areas. Involves the downslope movement (at slow rates) of partially thawed/water saturated soil and regolith over an impermeable "permafrost" layer.

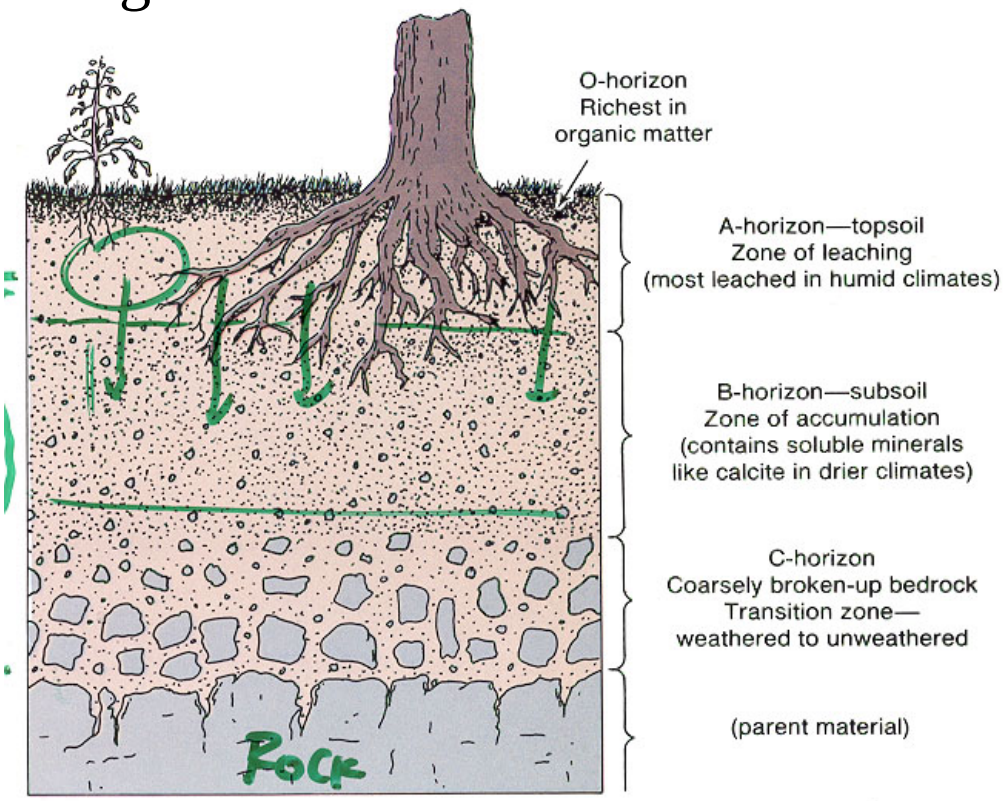
   a. permafrost- permanently frozen subsoil in cold climate areas. Forms an impermeable layer relative to the overlying "active layer" of soil which experiences thawing during the warm weather/summer season.

Soil Forming Processes

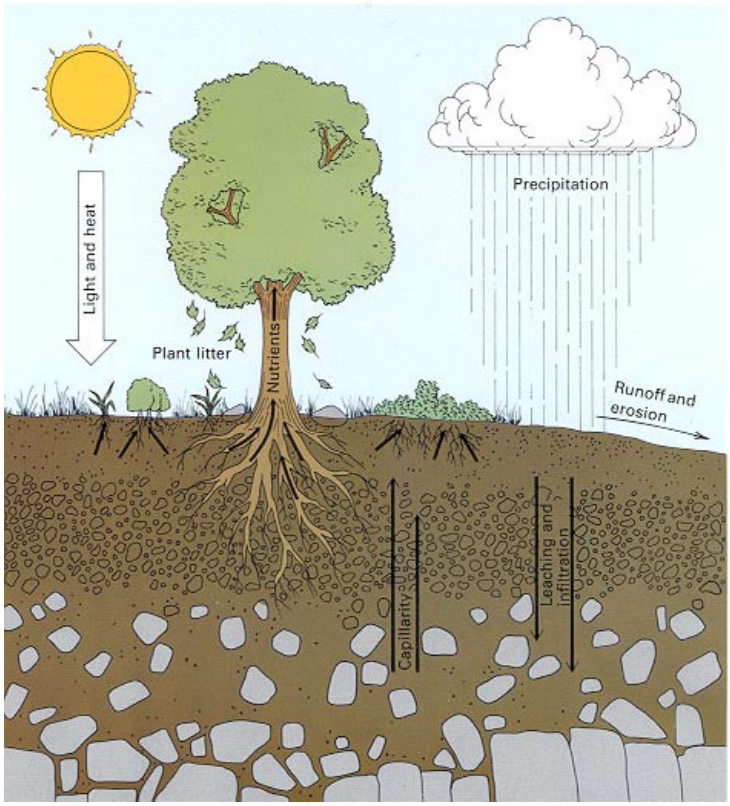
A Horzon

B Horizon

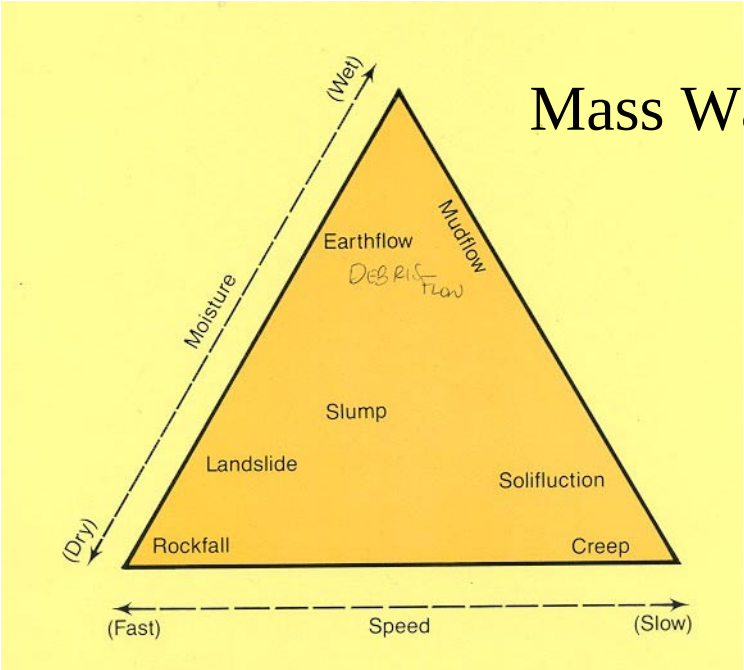
C Horizon



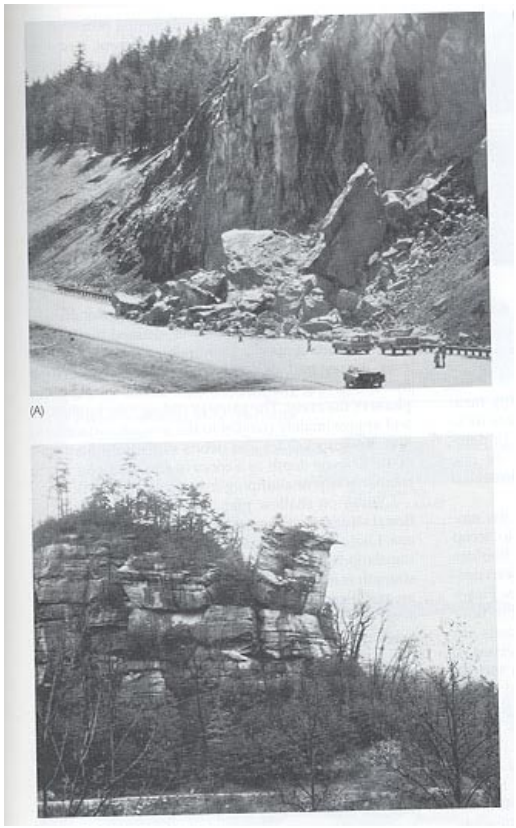
Soil development: interactions of physical and biological processes T4



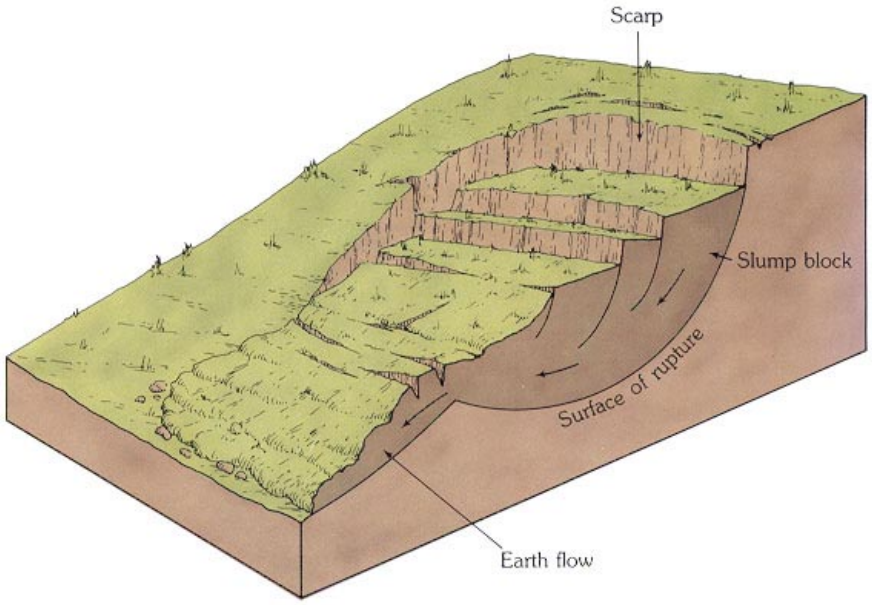
Mass Wasting Types



Rock Fall / Topple



Creep Examples



Combined Slump and Flow