WEATHERING AND MASS WASTING

Denudation- any process that wears away landforms.

Differential weathering- tendency of Earth material to weather at different rates depending on different resistance of rocks, presence of joints, orientation of slope, presence of vegetation, climate, variation of weathering processes and duration of exposure.

Weathering

- breakdown of rock due to physical, chemical and/or biological agents.
- Occurs in place

Erosion

- removal and transport of weathered rock materials
- accomplished primarily through wind, ice and running water

Mass Wasting/Movement

- downslope movement of large masses of weather rock material due to gravity
- typically occurs on hillslopes

<u>Types of Weathering</u>

1. Physical (Mechanical) Weathering- physical processes involved in the breakdown of rock materials.

A. *Frost Wedging/Frost Action*

- Breakdown due to freezing and thawing of water in cracks and joints; aka 'freeze-thaw cycle'
- Effective in semi-arid to moist, higher altitudes where temps frequently drop to below freezing over night and warm to above freezing during day.
- Mtns of California prone to weathering due to frost wedging.

B. *Salt Wedging/Crystallization*

- Breakdown due to growth of salt crystals.
- Effective in arid and semi-arid climates where high evap. rates lead to build-up of salts around freshwater seeps and springs.
- Sandstone cliffs in Utah and Co. plateau

C. *Hydration*

- Breakdown due to swelling of minerals when wet and shrinking when dry
- Effective in semi-arid to moist climates where there is ample time between rain events to allow for mineral dry out.

D. *Pressure Release Jointing*-

- breakdown due to expansion of plutonic rock bodies in response to a release in pressure that accompanies uplift.
- Involves large scale exfoliation of plutonic rocks through "sheeting"
- Not climate-specific, but typical of mountain environments i.e. Domes of Sierras

2. Chemical Weathering-results from chemical reaction between minerals and weathering agents such as water, oxygen and other reactive compounds. Rocks that have been chemically weathered often look “spheroidal” b/c their edges and corners have been rounded.

A. Hydrolosis

- breakdown of rock materials due to a chemical reaction w/water.

B. Oxidation

- breakdown of rock materials due to a chemical reaction with oxygen

Note:
*chemical reactions that result from *hydrolosis* and *oxidation* weaken rock materials (especially granite) and lead to granular disintegration
*granite- feldspar and mica minerals breakdown into clay, while quartz is more resistant
*if iron is present, clay will rust and turn red.
*both types are characteristic of tropical and temperate climates.

C. Carbonation and Solution

- Breakdown of carbonate rocks (rocks rich in calcium carbonate- $CaCO_3$- ex limestone, dolomite, marble, gypsum) due to a chemical reaction with weak carbonic acid (water that has dissolved CO_2).
- Important process in development of caves and other solution features
- Effective in warm and humid climates where decomposition rates are high

<u>Karst Topography- A Landscape Produced by Carbonation and Solution</u>
Karst- area with many sinkholes (dolines) and caves and a lack of surface streams; named after an area of Yugoslavia bordering the Adriatic Sea.

Necessary Conditions for Karst Topography:

1) limestone formation
2) patterns of joints in the limestone
3) an aerated zone between the ground surface and water table
4) vegetation cover to supply varying amounts of organic acids for solution process

Caverns- naturally formed underground chambers; formed by groundwater which dissolves carbonate rocks; fractures enlarge and form caverns. Some caverns’ roofs collapse and break through to surface causing *sinkholes.*

- Some caves have dripstone formations made of travertine (calcite precipitated from water); aka speleothems

- Stalactites- top; stalagmites- bottom; column- top & bottom; flowstone- walls and floors

MASS MOVEMENT (also known as MASS WASTING)

Mass Movement- downslope movement of material (rock and soil) due to gravity. May be slow or fast, wet or dry, gentle or steep. Driving force in mass movement is gravity, but depends on the weight, size, and shape of the surface material, slope angle and amount of moisture.

Angle of Repose- how steeply loose objects will stack before they begin to roll and slide; approx. 30 ^{o}.

Controlling Factors: slope angle, local relief, thickness of debris, orientation of planes of weakness, climatic factors, vegetation.

Causes: Earthquakes, added weight to upper slope, undercutting of bottom slope, water.

Classes of Mass Movements

1)Fall – movement involves free-fall of detached individual pieces of any size

- *Rockfall*- rock falling through air and hits a surface; movement occurs along surfaces of weakness in bedrock (e.g. foliation, joints, faults). Rocks at base are called *talus.*
- *Debris avalanche* – moving mass of rock, soil, snow usually assoc. with volcanic eruption

2) Slide- movement involves material that remains fairly coherent & moves along a well-defined surface

- *Landslide* 1) translational (planar surface); and 2) rotational (concave slippage)

3) Flow- material moves downslope as a viscous fluid since it has a high moisture content

- *Earthflow* (grass-covered movement); 2) *Debris/mudflow*; 3) *Lahar* (volcanic mudflow)

4) Creep- slow movement of soil and rock debris by gravity which is usually not perceptible except through extended observation

- *Soil creep* – slow glacier-like movement of shallow soil downslope with surface levels moving fastest and rate of movement decreasing with depth. Due to expansion and contraction; also due to gravity and rainfall and slight vegetation. Most common type of mass wasting.
- *Solifluction* – rising up of soil due to alternate freezing and thawing over permafrost (ground that remains below freezing – underlies 20% of land surface on Earth).