Ch. 4 "Weathering, Soil, and Mass Wasting"

I. Earth's External Processes
   A. Weathering - disintegration/decomposition of rock at or near the earth's surface
      1. All materials & rock are subject to weathering
         a) (ex. sidewalks, roads, tombstones, etc.)
      2. rocks at surface are subject to weather elements
      3. Mechanical weathering - available for chemical attack: (ex. sugar cube vs. spoonful)
         a) ________________ - freezing and thawing of water in rocks
            (1) water expands when it freezes and creates a huge outward force
            (2) water works its way in cracks and expands and breaks up rock (Fig. 3.3)
            (3) most pronounced in mountains & mid-latitudes
            (4) talus slopes -
         b) unloading - when large masses of rock are exposed at surface by erosion, slabs break loose like layers of an onion called "sheeting"
            (1) creates "exfoliation domes" (Fig. 3.4)
            (2) pressure is reduced as rock slabs fall off
         c) ________________ - daily temp. changes cause stress on rocks
            (1) deserts - hot days, cool nights
            (2) heat expands, cool contracts
         d) biological activity - weathering by organisms, plants, animals, and humans
            (1) tree roots grow into rocks and sidewalks wedging them apart
            (2) decaying organisms add acids to rocks
      4. Chemical weathering - involves the complex processes that alter the internal structures of minerals by removing and/or adding elements
         a) water and carbonic acid
            (1) water is most important chemical agent
            (2) CO₂ and H₂O make H₂CO₃ (carbonic acid) same stuff in soft drinks
            (3) carbonic acid ionizes to produce very reactive (H⁺) and bicarbonate ions (HCO₃⁻)
      5. how granite weathers
         a) quartz is tougher and resists chemical weathering
         b) feldspar turns into clay and quartz remains which gets carried away to sea
      6. ________________ - weathering attacks edges and corners of rocks more readily because there is greater surface area, so the rocks become rounded
         a) more circular rocks are usually older
   B. Mass Wasting -
   C. Erosion - incorporation and transportation of material by a mobile agent, usually water, wind, or ice.

II. Rates of Weathering
   A. mineral makeup
      1. quartz is strong and more resistant to weathering
2. marble composed of calcite is easily dissolved with water
   a) 
B. climate
   1. climatic factors are particularly important in determining weathering rate
   2. temp. and moisture are most important
   3. regions with lush vegetation have a highly chemically active soil for weathering
   4. optimum environment for chemical weathering is a warm humid region
   5. polar regions are ineffective because frigid temps. keep water always locked up as ice.
   6. 
      a) 3500 years in Egypt with little weathering
      b) 75 years in NY many words missing
C. ________________ - rocks exposed at earth's surface usually do not weather at the same rate

III. Soil - "bridge between life and the inanimate world"
A. An interface in the in the Earth System
   1. soil forms where the solid earth, the atmosphere, the hydrosphere, and biosphere meet
   2. soil is sensitive to environmental changes (climate, vegetative cover, animal (human) activity)
B. What is soil?
   1. regolith -
   2. soil - combination of mineral & organic matter, water and air, - that portion of the regolith that
      supports the growth of plants.
   3. composed of (Fig. 3.11)
      a) 45% mineral matter - disintegrated & decomposed rock
      b) 25% water - provides moisture & nutrients
      c) 25% air - provides the oxygen and CO₂
      d) 5% organic matter (humus) - decayed remains of plant/animal life (enhances the soil's ability to
         retain water.)
C. soil texture and structure
   1. soil texture - particle sizes in soil
      a) determines drainage
         (1) sandy soils drain too rapidly
         (2) clay soils inhibit drainage
   2. Fig. 3.12
IV. Controls of soil formation
A. Parent material -
   1. can be underlying bedrock or it can be a layer of unconsolidated deposits
   2. residual soils - parent material is bedrock
   3. transported soils - developed on transported sediments
   4. influences rate of weathering and soil’s fertility
B. 
   1. short time - parent material defines the soil
2. long time - weathering factors determine a soil’s characteristics, esp. climate
   a) thicker soil becomes and it less resembles the parent material

C. Climate
   1. most influential factor of soil formation
   2. temp. and precipitation primary elements

D. plant and animals
   1. types and abundance of organisms present have a strong influence on physical and chemical properties
      of soil
   2. chief function is to furnish organic matter
      a) swamps max., desert minimum
   3. plants are primary source
   4. decaying organisms are next major source
   5. enhances the water-holding ability of soil
   6. earthworms mix up soil keeping it fertile and porous

E. Slope
   1. steep slopes are poorly developed
      a) soils are thin or non-existent (Fig. 3.13)
   2. bottom lands thick, dark, poorly drained
   3. ideal conditions are flat to undulating surface
      a) provides good drainage, little erosion
   4. slope orientation is important
      a) south facing slope get most sun
   5. all soil forming factors work together

V. The Soil Profile
   A. Horizons - zones or layers soil profile
      1. soil-forming processes operate surface downward
         a) top looks different than bottom
   B. Profile - vertical cross section of soil
      1. a) O horizon
         (1) decayed plants, loose leaves
         (2) life including bacteria, fungi, algae
         (3) Very thin layer.
         b) A horizon
         (1) largely mineral matter
         (2) biological activity is high
         (3) O and A together make up "topsoil"
         c) E horizon
         (1) light colored layer
         (2) little organic matter
Finer particles get carried away in this zone by percolating water. ("eluviation") Organic matter also gets washed downward called “leaching”

d) B horizon
   (1) called "subsoil" or "zone of accumulation"
   (2) contains clay so good water retention
   (3) sometimes called "hardpan".

e) C horizon - unaltered parent material

2. O, A, E, and B constitute the solum ("true soil") which contains all the soil forming processes and living animals and root systems
3. horizons may be very distinct or blend
4. mature soil - well developed soil
5. immature soil - undeveloped and lack horizons
   a) soil building going on for a short time
   b) steep slopes have immature soils

VI. Soil Types
A. Pedalfer
   1. red-brown color
   2. found in the central U.S. mid-latitudes
B. Pedocal
   1. drier Western states
C. Laterite
   1. hot, wet tropical climates
   2. soils are deeper than others
   3. red color soil
   4. soil contains practically no humus
   5. poor for growing crops
D. Soil Erosion
   1. natural process, part of the rock cycle
   2. raindrops fall so hard, they impact ground
   3. water carries away loose particles
   4. water move particles in sheet (sheet erosion)
   5. tiny water channels carve out soil (rills)
   6. deeper channels are called gullies
E. Rates of erosion
   1. more erosion occurs now than in past b/c vegetation
   2. farming, logging, and construction increase erosion
   3. without plants soil is easily swept away
   4. before humans 9 billion, after 24 billion ton/year
   5. wind erosion is much less than water, except during periods of drought
   6. many regions erosion is greater than production which results in lower productivity, poor crop quality
F. Sedimentation and Chemical pollution
1. each year more sediment is deposited in lakes, rivers, and reservoirs
   a) reduces hydroelectric power generation
   b) useful flood control is diminished
   c) navigation can become restricted
2. pesticides can contaminate soil as they get into water supplies
3. excessive natural nutrients can kill a lake

G. Weathering creates ore deposits
1. Bauxite
   a) principal ore of aluminum is created from weathering
2. Other deposits
   a) copper and silver
   b) pyrite weathers into sulfuric acid

VII. Mass Wasting
A. gravity causes materials to move down slope
   1. many times can't really see the movement
   2. other times it can be a huge rock slide
B. landslides cause 600 deaths/yr. worldwide
C. most occurrences are from natural forces not human
D. can't predict when slide will occur

VIII. Controls and Triggers of Mass Wasting
A. Gravity
   1. the biggest factor
B. The role of water
   1. tends to slide
   2. little water makes strong soil (sand castle)
   3. water adds weight to soil
C. Over steepened Slopes
   1. angle of repose - the steepest slope a hill can have before material falls (25-40 degrees)
   2. largest particles maintain steepest slopes
D. Vegetation
   1. plants protect against erosion
   2. farming and forest fires remove plants
E. Earthquakes as Triggers
   1. stable hill may slide if triggered by a quake
   2. quakes loosen enormous volumes of rock

IX. Falls, Slides, and Flows
A. Falls - free-fall of individual pieces of any size
B. Slides - material remains fairly coherent
   1. occurs along joints and faults
C. Flows - when materials moves down slope as a viscous fluid
   1. most are saturated with fluid
D. most movement very slow
E. Slump - slipping of a mass of rock along a curved surface
   1. does not travel fast or far (Fig. 3.20)
F. Rockslide - when blocks of bedrock break loose
   1. fastest and most destructive events
G. Mudflow - flowage of debris containing a large amount of water
   1. common in semiarid mountainous regions
   2. common on slope of volcanoes (lahars)
H. Earthflow
   1. material leaves a scar or teardrop (Fig. 3.24)
   2. liquefaction - earthflow assoc. with an earthquake
I. Slow movements
   1. slow downward movement create more overall mass wasting than fast moving slides. Fast movements
      are catastrophic and make headlines, but slow movements is more common
   2. Creep - gradual downhill movement of soil and regolith
      a) (Fig. 3.25)
J. Solifluction
   1. mass wasting in regions underlain by permafrost