***Weathering and Soil***

**Weathering: summary in haiku form**

Rocks brought to surface
decompose to sediment
and that's weathering.

**Weathering**

- Weathering involves the physical breakdown and chemical alteration of rock at or near Earth's surface
  - Two types:
    - Mechanical weathering—physical forces breaking rocks into smaller pieces
    - Chemical weathering—chemical transformation of rock into new compounds
  - Both types work simultaneously and reinforce each other

**Mechanical Weathering Increases Surface Area**

**Mechanical Weathering**

- Types of Mechanical Weathering
  - Frost wedging
  - Salt crystal growth
  - Sheeting/Unloading
  - Biological activity

**Mechanical Weathering**

- Types of Mechanical Weathering
  - Frost wedging
    - Two different methods
      - Water works its way into cracks in rocks and the freezing enlarges the cracks in the rocks
      - Lenses of ice grow larger as they attract liquid water from surrounding areas

**Ice Breaks Rock**

**Unloading Leads to Sheeting**

**Mechanical Weathering**

- Types of Mechanical Weathering

- Biological activity
  - Plant roots grow into fractures in a rock, causing the cracks to expand
  - Burrowing animals break down rocks by moving fresh material to the surface, enhancing physical and chemical weathering
  - Human impacts (rock blasting) is very noticeable
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19 **Plants Can Break Rock**

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21 **Chemical Weathering**

- The Most Important Agent Is Water
  - Responsible for transport of ions and molecules involved in chemical processes
- Types of Chemical Weathering
  - Dissolution
  - Oxidation
  - Hydrolysis
  - Spheroidal weathering
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22 **Chemical Weathering**

- Types of Chemical Weathering
  - Dissolution
    - Certain minerals dissolve in water
      - Halite is one of the most water-soluble minerals
    - A small amount of acid in water increases the corrosive force of water, causing dissolution
      - Carbonic acid is created when carbon dioxide dissolves in raindrops
      - Calcite is easily attacked by weakly acidic solutions
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23 **Acidic Waters Create Caves**

24 ***Dissolution Cavity, Grand Canyon***

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27 **Chemical Weathering**

- Types of Chemical Weathering
  - Oxidation
    - Oxygen combines with iron to form iron oxide
    - Process is slow in dry environments
    - Water increases the speed of the reaction
    - Important in decomposing ferromagnesium minerals like olivine, pyroxene, hornblende, and biotite

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28 ***Oxidation of Iron***

Hematite
(= $Fe_2O_3$,
or “rust”)

29 **Iron Oxides Add Color**

30 **Chemical Weathering**

- Types of Chemical Weathering
  - Hydrolysis
    - The reaction of any substance with water
    - A hydrogen ion attacks and replaces another ion
    - Silicates primarily decompose by hydrolysis
      - Clay minerals are the most abundant product of weathering
      - Clay minerals are very stable under surface conditions

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31 ***Weathering Cavities in Granite, Mortero Wash***

32 **Chemical Weathering**

- Types of Chemical Weathering
  - Spheroidal weathering
    - Weathering attacks edges from two sides and corners from three sides
    - Sharp edges gradually wear down and become rounded
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33 **The Formation of Rounded Boulders**

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35 ***Joint-controlled weathering in igneous rocks***

36 ***Joint-controlled weathering in igneous rocks***

37 **Rates of Weathering**

- The rate of weathering is influenced by rock type (composition) and climate
  - Different minerals weather at different rates
  - Warm, moist climates enhance (and cold, dry climates inhibit) chemical weathering
  - Variations in local climate and the composition of the rock formation will produce uneven weathering of the rock called differential weathering
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38 **Monuments to Weathering: An Example of Differential Weathering**

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40 ***Products of weathering***

41 **Weathering of common silicate minerals**

42 **Soil**

- Soil is “the bridge between life and the inanimate world”
  - The bridge between the various Earth systems
  - Earth’s land surface is covered by a layer of rock and mineral fragments produced by weathering, called regolith
  - Soil is a combination of mineral and organic matter, water, and air and is the portion of the regolith that supports the growth of plants
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43 **Controls of Soil Formation**

- Parent material, time, climate, plants and animals, and topography interact to control soil formation

44 **Controls of Soil Formation**

- Parent material
  - The source of weathered material that forms soil
    - Residual soils—soils form from the underlying bedrock
    - Transported soils—soils that form in place from unconsolidated sediment
- Time
  - Weathering over a short period of time forms thin soils that closely resemble the parent material
  - Soils that have weathered for a long period of time are generally thick and do not resemble the parent material

45 **Controls of Soil Formation**

- Climate
  - The most influential control of soil formation
  - Key factors are temperature and precipitation
- Plants and Animals
  - Influence the soil chemistry
  - Remains are converted into humus, which is an important part of the organic component of soils

46 **Plants Influence Soil**

47 **Controls of Soil Formation**

- Topography
  - Steep slopes have poorly developed soils
    - Moisture content of these areas is often insufficient for plant growth
  - Flat and undulating surfaces are optimal for soil formation
    - Good drainage and minimal erosion
  - Slope orientation is also important in soil formation
    - Southern-facing slopes in the Northern Hemisphere receive the most sunlight are are optimal for soil formation

48 **The Soil Profile**

- Soil-forming processes operate from the surface downward
  - Soil is divided into horizontal layers called horizons
  - A vertical section through all the soil horizons is called a soil profile
    - A mature soil has well-developed horizons
    - An immature soil may lack soil horizons

49 **The Soil Profile**

- O soil horizon—organic matter
  - The lower portion is composed of humus
  - This horizon includes bacteria, fungi, algae, and insects
- A soil horizon—organic and mineral matter
  - High biological activity
- O and A horizons make up the topsoil

50 **The Soil Profile**
- E horizon—little organic matter
  - Light-colored layer
  - Eluviation (washing out fine soil components to lower soil layers) is common in this layer
  - Soluble inorganic components are washed to lower layers in a process called leaching
- B horizon (subsoil)—zone of accumulation
  - Material washed down from the E horizon accumulates in this layer
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51 **The Soil Profile**
- Collectively, the O, A, E, and B horizons make up the solum, or "true soil"
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- C horizon—partially altered parent material
  - Parent material is difficult to identify in the O, A, E, and B horizons
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52 **Soil Horizons**

53 **Classifying Soils**
- Variations in soil formation over time and distances has led to a great variety of recognized soil types
- Groups have been established using common characteristics
- In the United States, a system was devised and called the Soil Taxonomy
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54 **Basic Soil Orders**

55 **Global Soil Regions**

56 **The Impact of Human Activity on Soils**
- The agricultural productivity of soils can be improved through fertilization and irrigation
- Soils can be damaged or destroyed by careless activities
  - Soils are crucial for providing food, fiber, and other basic materials
  - Soils are one of the most abused resources

57 **The Impact of Human Activity on Soils**
- Clearing the Tropical Rain Forest – a Case Study
  - Tropical forests are cleared for logging and agricultural use
  - Soils in tropical forests are poor in nutrients and unsuitable for agriculture
    - Most of the nutrients in tropical rain forests are found in the trees
  - Clearing tropical rain forests also promotes soil erosion

58 **Tropical Deforestation**

59 **The Impact of Human Activity on Soils**
- Soil Erosion
  - Soil erosion is a natural process in the rock cycle
  - Erosion rates are dependent on climate, slope, and type of vegetation
    - Human activities such as deforestation and farming practices can enhance soil erosion

60 **Examples of Soil Conservation**

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