Weathering, Erosion and Deposition

Shaping the Earth’s Surface

Weathering
- the process of ___________ rocks into smaller fragments

Erosion
- the __________ of rock fragments from one location to another

Deposition
- the __________ of rock fragments in a new location

Weathering
- Breakdown of earth materials, brought about by __________ at the earth’s surface
  
  • There are three types of weathering:
    1. __________
    2. __________
    3. __________

Physical Weathering (Disintegration)

rocks are broken down by __________ means (there is no change in the __________ making up the rock)

  • Ice Wedging
    ▪ Water fills cracks in rocks, then __________
    ▪ As water freezes, it __________ and pushes the rock apart.

  • Wetting and Drying
    ▪ Clays __________ and __________, causing rocks to fall apart.

  • Wind and water effects
    ▪ Wind and water move sand and small rocks around, __________ them against each other until they gradually __________ into smaller fragments.
**Chemical Weathering**
Rocks are broken down by chemical __________, which causes the rocks to change their __________ and become weaker.

- __________ in rain, snow and air break down some minerals in rocks.
- Minerals such as feldspar, hornblende and augite react with water to form __________ (hydrolysis).
- Oxygen from air combines with __________ in some minerals to form rust (resulting in red soil).
- Many minerals, such as limestone and marble, dissolve easily in weak __________ such as rainwater. Rainwater is usually slightly acidic because _______________ dissolves in it to form carbonic acid.
- Acid rain forms stronger acids which can __________ up the rate of chemical weathering.

**Biological Weathering**
If physical or chemical weathering has been caused by a __________ or __________, the process is sometimes referred to as biological weathering.

- Plant seeds or roots may _____ in tiny cracks in rocks.
- As the plant grows, it __________ the rock.
- __________ animals move rocks around and can expose new rock surfaces to weathering.
- Rotting vegetation forms __________ which also lead to chemical weathering.
Weathering and Climate

The type of weathering that dominates in an area depends on the climate in that area. The major factors that control climate are precipitation (rain and snow) and temperature. The graph below shows the relationship between precipitation, temperature and weathering. For example, a climate with an average yearly temperature (AYT) of 20°C and average yearly precipitation (AYP) of 150 cm would have strong chemical weathering. Use the graph to answer the questions.

1. Determine the major type(s) of weathering that occur in Vancouver, BC with an AYT of 11°C and an AYP of 115 cm.

2. Determine the major type(s) of weathering that occur in Yellowknife, NWT, AYT -5°C, AYP 27 cm.

3. Determine the major type(s) of weathering that occurs in Washington, DC, AYT 23°C, AYP 104 cm.

4. If the AYT in Washington, DC dropped 26°C, but the AYP stayed the same, what kind(s) of weathering would dominate?

5. Phoenix, Arizona has an AYT of 18°C and an AYP of 36 cm. How would the climate in Athens have to change for moderate chemical weathering to become dominant?

6. According to the graph, no frost action occurs at a mean annual temperature above 13°C. What is a possible reason?

7. What type of weathering would you expect to dominate in a tropical rain forest? Explain your reasoning.

8. In general, how does a climate with strong chemical weathering differ from a climate with strong mechanical weathering?
Weathering and Minerals

• Quartz is very ________ to weathering (doesn’t react with water, oxygen or acids, and has no cleavage).

• Other rock-forming minerals (feldspar, hornblende, mica, augite, calcite) are ________ mechanically weathered into small fragments and chemically weathered into clay.

• Calcite, gypsum and halite can also be ________ in water.

Weathering and Rocks

• IGNEOUS ROCKS weather ________ in wet climates due to ice wedging and hydrolysis. They generally weather into clay minerals with quartz pebbles and sand.

• SEDIMENTARY ROCKS are only as durable as the ________ that hold them together; calcite cement weathers quickly while silica cement is VERY durable.

• METAMORPHIC ROCKS are resistant to mechanical weathering, but susceptible to ________weathering; for example, marble is a great building material in a dry climate, but not a wet one!

RATE OF WEATHERING DEPENDS ON:

1. type of ________
2. amount of rock ________ exposed
3. ________ (warm and wet vs. cold and dry)
Weathering vs. Erosion (pg. 131-136)

1. Fill in the blanks. Select from the following list:

<table>
<thead>
<tr>
<th>Composition</th>
<th>Air</th>
<th>Weathering</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>Clay</td>
<td>Oxidation</td>
<td>Hydrolysis</td>
</tr>
<tr>
<td>Chemical</td>
<td>Fire</td>
<td>Erosion</td>
<td>Exfoliation</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Frost Wedging</td>
<td>Abrasion</td>
<td>Biological</td>
</tr>
</tbody>
</table>

Rock is continually being broken down by a process called ____________, and the fragments get further broken down and transported by ____________.

___________ weathering happens when the ____________ of minerals change. This usually happens when rocks are exposed to ____________ and ____________.

For example, feldspar reacts with water to form ____________ minerals in a process called ____________. ____________ weathering is when rocks are broken apart, but their composition doesn't change. ____________ and ____________ are examples. Weathering directly due to the activities of living things is called ____________ weathering.

2. Match each statement with the appropriate term.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide dissolved in rain water</td>
<td>A) Hydrolysis</td>
</tr>
<tr>
<td>Chemically combining minerals with water</td>
<td>B) Frost wedging</td>
</tr>
<tr>
<td>Combining minerals with oxygen</td>
<td>C) Abrasion</td>
</tr>
<tr>
<td>A result of atmospheric pollution</td>
<td>D) Acid Rain</td>
</tr>
<tr>
<td>Grinding and scraping rock materials</td>
<td>E) Oxidation</td>
</tr>
<tr>
<td>Rock expanding and flaking off in sheets</td>
<td>F) Carbonic acid</td>
</tr>
<tr>
<td>Water seeps into cracks and freezes</td>
<td>G) Exfoliation</td>
</tr>
</tbody>
</table>

3. List 4 agents of erosion.
4. **Questions a to e: True/False Plus** - Indicate if each statement is true or false. If it is false, change the underlined word or phrase to make it true.

   a. The amount of mechanical weathering **has no impact** on the rate of chemical weathering chemical weathering.
   b. A warm, humid climate favors a **rapid** rate of chemical weathering.
   c. **Weathering** involves the movement of rock materials.
   d. Biological weathering **could have** both mechanical and chemical components
   e. Chemical weathering **happens** on the moon.

5. Describe the steps involved in exfoliation.

6. What types of minerals are especially susceptible to oxidation? Why?

7. Which mineral is most susceptible to attack by acid solutions? Why?

8. Name two reasons why rainwater may be acidic.

9. Supply one example of biological weathering by chemical means.

10. Supply one example of biological weathering by mechanical means.
SOILS

- loose, weathered ________ and _________ material in which plants with roots can grow.
- Composed of sand, silt and clay.
- Composition varies by _________
- Always a _________ resource!

_______ material – rock from which the soil is formed
_______ soil – soil formed from underlying bedrock
_______ soil – deposited by wind, rivers or glaciers.

Types of Soil
• Sandy soil allows _______ to pass quickly through it
• Clay-rich soil _______ water, forming a thick mud
• Soil with some clay and some sand is called _______
• Loam is usually the best soil for _________
Soil Profile

- Cross-section of earth which shows the _____ of soil
- ____ distinct zones in mature soils:

A- Horizon: __________
  - ________ coloured (gray or black)
  - contains _________ (remains of plants and animals broken down by bacteria)

B-Horizon: __________
  - ________-coloured (red or brown)
  - Often has more _______ than topsoil, since rainfall has washed it downwards

C-Horizon: ________ rock
  - Mixture of ________ and weathered _________ directly above bedrock
Weathering and Soils

1. **Fill in the blanks. Select from the following list:**

<table>
<thead>
<tr>
<th>Dark</th>
<th>Light</th>
<th>Transported</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>Silt</td>
<td>Fertilizer</td>
<td>Humus</td>
</tr>
<tr>
<td>Residual</td>
<td>Sand</td>
<td>Soil horizons</td>
<td>Soil Profile</td>
</tr>
<tr>
<td>A-Horizon</td>
<td>B-Horizon</td>
<td>C-Horizon</td>
<td>D-Horizon</td>
</tr>
</tbody>
</table>

Fragments of weathered rock eventually become ________________. Soil always includes ________________, ________________, ________________ and some organic material called ________________. If the soil is sitting upon the bedrock from which it was derived, it is called ________________ soil. If the soil’s parent material was located elsewhere, the soil is called ________________ soil. The top layer is called the ________________, and the humus it contains makes the color appear ________________. The middle layer is the ________________ and it has more clay than the top layer. The bottom layer is the ________________ which is composed of large chunks of slightly weathered rock.

2. **Match each statement with the appropriate term.**

<table>
<thead>
<tr>
<th>Definition</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>The A-Horizon</td>
<td>A) Parent material</td>
</tr>
<tr>
<td>Parent material is the bedrock below</td>
<td>B) Residual soil</td>
</tr>
<tr>
<td>The middle layer in a soil profile</td>
<td>C) Transformed soil</td>
</tr>
<tr>
<td>Decaying plant and animal remains</td>
<td>D) Soil profile</td>
</tr>
<tr>
<td>The rock from which soil is derived</td>
<td>E) Topsoil</td>
</tr>
<tr>
<td>Parent material is located elsewhere</td>
<td>F) Subsoil</td>
</tr>
<tr>
<td>A soil cross-section, exposed by</td>
<td>G) Humus</td>
</tr>
<tr>
<td>diggin</td>
<td></td>
</tr>
</tbody>
</table>

3. How does climate affect the composition of soil?
4. Why does the B-Horizon have more clay than the A-Horizon?

5. Most soil in the Hawaiian Islands has a characteristic reddish color. Why do you think this is so? (Hint: Think of the parent material which formed the Hawaiian Islands).

6. Consider the soil in Delta, BC. Do you think it is residual or transported?
Erosion, Deposition and The Landscape

- **Erosion** is the _______ of weathered rock from one place to another.

- **Causes of erosion** include moving water, moving ice (glaciers), wind and gravity (i.e., landslides).

- moving water, glaciers and wind can also _______ the materials they pick up

- **Deposition** is when eroded rock material stops moving and _______ (making “deposits”).

Landscapes formed by Moving Water

- _______ (bits of weathered rock) can be carried long distances by moving water before being deposited at another location

- Over millions of years, _______ can transport billions of tonnes of sand, gravel and mud.

- Running water, using sand and pebbles as _______ tools, wears away at the river bed in a process called _______.

- Rivers abrade the land on its _______ as it flows, making a deeper and deeper _______ over time.

River Valleys

- _______ river valleys are narrow, fast-flowing and straight.

- Old river valleys have ________ sides and are ___-shaped

- When a river crosses a flat region, it _______ down and develops wide, shallow valleys

Rate of erosion of the river valley depends on:
  - _______ of the valley
  - Amount of _______
  - _______ of the water
  - Type of _______ in the valley
Floods and Flood Plains

• A flood plain is the _______ land beside a river that is covered by water during ________

• As flood water drains away, fine _____ from the floodwater is deposited on the flood plain.

• The buildup of mud produces a rich ______ which can be valuable for agriculture

• Dams and raised banks (_________) are often used to prevent flooding, but if water rises too high the flood may break through them

Deltas

• As rivers flow into lakes and oceans, the flow of water suddenly ________ down

• Sediments are _________ when the water slows

• The sediments build up at the mouth of the river and fan out into a giant triangle shape called a ____
Landscapes formed by Glaciers

• 2/3 of Earth’s fresh water is trapped in large masses of snow and ice called __________

• glaciers form when more snow falls than ______ every year, causing it to build up over time

• Glaciers “_________” when ice builds up faster than it melts so that the ice creeps further down into a valley

• Glaciers “_________” when temperatures begin to shrink glaciers. NOTE: they don’t actually ‘retreat’…the leading edge melts away.

Types of Glaciers

• Large ice sheets, called __________ glaciers, cover both the Earth’s poles, in Greenland and Antarctica

• __________ (or __________) glaciers form in mountain areas, and slowly slide down the mountain due forces of gravity

Ice Ages

• Periods of time when the __________ was cooler than it is today

• Ice sheets and glaciers covered __________ areas of Europe and North America
Landscapes shaped by Gravity

• sediments on slopes slowly work their way downwards by the force of gravity – “_________

• if wet soil and rock on a slope becomes too heavy, ________ may result

Landscapes Shaped by Wind

• _____ currents can carry rock particles with it.

• The size of the particles that can be moved depends on the ________ of the wind

• Wind erosion is most common in _____ climates and in ______, open areas
Chapter 10: Stream Divides and River Systems

Every second, over 14 million litres of water pour from the Mississippi River into the Gulf of Mexico. All this water originally fell as precipitation in places as far away as Montana and Pennsylvania. Over time, the water flowed through the various rivers and tributaries of the Mississippi River system, working its way to the Gulf.

In this exercise, you will be examining the drainage basins for the Mississippi and other major river systems in the United States.

Materials
Textbook (pg. 654-655)
Outline map of the major US rivers (attached)
Coloured pencils

Procedure:
1. Work with a partner. Open your textbook to the Physical Untied States map on pg. 654-655 in your textbook.

2. Locate the mouth of the Mississippi River on the river map. Use the Physical US map as a reference. Use a coloured pencil to trace the Mississippi River and all of its tributaries on your river map.

3. Draw a continuous line around all the rivers you have traced in step 2. The area inside this line should include all of the rivers that flow into the Mississippi River system. The line should not cross any rivers. Label the enclosed area Mississippi River System. Use the same coloured pencil to lightly shade the area.

4. Locate the Colorado River. Use a different coloured pencil to outline, label, and shade the Colorado River system. (NOTE: There are two Colorado rivers on your maps. Be sure to use the one that starts in Colorado).

5. Repeat Step 4 for the Columbia River system, the Rio Grande system, and the St. Lawrence River System.

6. Draw a line to show the location of the Great Continental Divide (refer to pg. 174 in text).

Analysis:
1. In the continental United States, what happens to rain that falls west of the Great Continental Divide? Rain that falls east?

2. The headwaters of three river systems are located in Colorado along the Great Continental Divide. Identify these three systems.
3. Identify the river systems in which each of the following rivers are found:
   a) Snake River ______________________
   b) Platte River ______________________
   c) Green River ________________________
   d) Wabash River ______________________
   e) Cumberland River __________________ 
   f) Gila River _________________________

4. What is the source of the water in the St. Lawrence River? In which general direction does the river flow?

5. Identify 3 rivers for which the Mississippi River is the base level. For the definition of base level, refer to page 172 Topic 6 in your text.

6. Identify the bay, sound, or gulf that serves as base level for:
   a) the Sacramento and San Joaquin rivers
   b) the Alabama River system
   c) Connecticut River System

7. Locate and label the James, Roanoke, and Savannah rivers. In what topographic feature do these rivers originate?

8. Locate the rivers shown in central Nevada. Why are these rivers not part of the larger river systems?

9. Name the largest river that flows through the Vancouver area. Where does that river originate and what is its base level (be specific)? (You can use the internet if you’d like to help find this answer).