

CHAPTER 4 WEATHERING AND MASS MOVEMENTS

Objectives

After studying this chapter, students should be able to:

- (i) define denudation.
- (ii) mention the stages of denudation.
- (iii) name and explain the two main types of weathering.
- (iv) define mass wasting.
- (v) list and explain the major types of mass movement/wasting.
- (vi) outline the effects of mass wasting.

4.0 Denudation

Denudation denotes all the external processes which attack and wear away rock outcrops and landforms on or immediately below the Earth's surface. It can also be defined as the process of lowering and leveling of the general landscape by gradual breaking and wearing away of such land.

Denudation also raises the level of the land by deposition. The factors affecting denudation include nature of relief, structure of the Earth, influence of man and local climate of the area.

Stages of Denudation

Denudation consists of:

1. **Weathering:** It refers to the gradual disintegration or breakdown of rocks which lie exposed to the weather.
2. **Erosion:** This process involves the actions of wind, ocean waves, moving ice and running water in breaking up and wearing away

- exposed rock outcrops and weathered debris.
3. **Transportation:** This involves the process of transfer or carrying away of loose materials which have been produced by weathering and erosion.
 4. **Deposition:** It refers to the laying down of rock particles by the agents of erosion at lower levels.

4.2 Weathering: Definition and Types

Weathering is the gradual disintegration of rocks by physical (mechanical) and chemical forces.

There are many ways in which rocks weather. Rocks sometimes break up into blocks and further into smaller fragments, without their mineral components being changed.

Types of weathering

The two main types of weathering are physical or mechanical and chemical weathering. Their ways of operation are described below.

Physical or mechanical weathering

- (i) By temperature changes: In arid regions, such as hot deserts, rock surfaces heat up rapidly when exposed to the sun and the surface layers expand and break away. At night, when temperature falls rapidly, the same layers contract and more cracks develop. The outer layers of the rocks would then peel off (screes) and fall to the ground. Rock break-up of this type is called exfoliation.

The granite domes that are left standing are known as exfoliation domes or inselbergs. Exfoliation domes are common in the Kalahari and Sinai deserts.

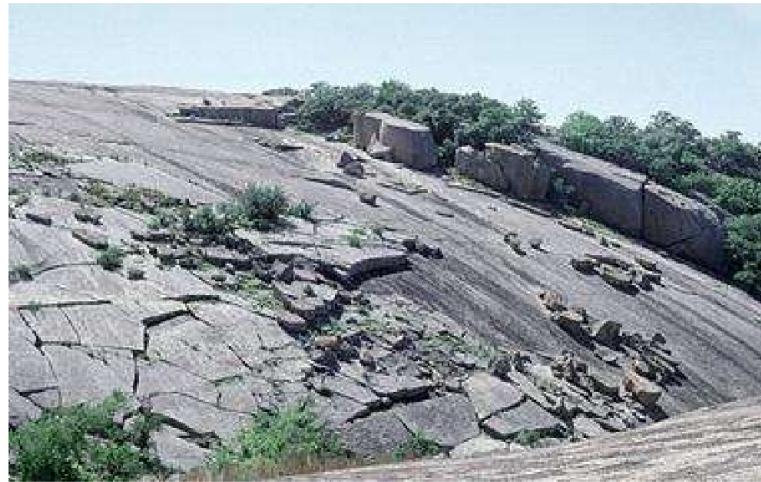


Fig. 4.1: Exfoliation domes

- (ii) By frost action: In cold regions, particularly on high mountains, cracks occur in the rocks. The cracks get filled up with rain water during winter. Temperatures fall below 0°C and the water freezes. When water freezes, its volume increases, the cracks in the rocks are widened and such rocks are broken up by frost action into large angular blocks. These blocks are further broken down into smaller fragments.

The way in which the rock outcrops break up into large rectangular – shaped blocks is known as block disintegration: the pieces of rocks which peel off from the rock surface accumulate at the base of the mountain to form screes.

Frost Wedging

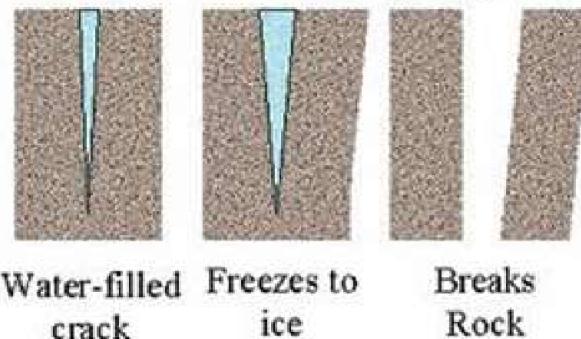


Fig. 4.2: Block disintegration by frost action

- (iii) By plant and animal action: The roots of plants, especially trees, can force joints and cracks apart in rocks. Some animals by burrowing, also help to break up rocks.



Fig. 4.3: Action of plants

- (iv) Alternate wetting and drying: In tropical areas, surface rocks absorb water resulting in swelling of outer layers. The rock layer shrink back when the absorbed water dries up. The rocks are weakened by the continued wetting and drying of the surface layers which later crack and break up into small fragments.

Chemical Weathering

Chemical weathering is a dominant feature of heat and wet tropical areas, but it operates to some extent in other parts of the Earth's surface. Chemical weathering is the gradual disintegration of rocks due to their exposure to air and water.

- (i) By rain action: Rain is really a weak acid because it dissolves oxygen and carbon dioxide as it falls through the air. Some minerals especially carbonates are dissolved out of rocks by rain water. These rocks are therefore weakened and begin to break up.
- (ii) By plants and animals: Bacteria in the presence of water, break down certain minerals in the soil. All plants absorb minerals from the soil. Decaying vegetation produces organic acids which cause a further breakdown of minerals. All these actions help to weaken and break up the rocks.

Agents of Chemical Weathering

The main chemical reactions operate in the following ways:

1. Hydration: It occurs when water penetrates the rocks, certain minerals absorb it and expand. This action causes internal stress which leads to fracture in the rock e.g. the conversion of iron to rocks, ten to hydrated rocks.
2. Carbonation: Atmospheric carbon dioxide mixes with rain water to form a weak carbonic acid. The acid dissolves rocks, resulting in the breakdown.
3. Oxidation: It is a reaction that occurs when oxygen dissolved in water combines with iron in rocks. Iron oxides are thus formed most actively in the zone above the water table in the ground. Oxidation is often preceded or accompanied by hydrolysis before new minerals are formed.

4. Hydrolysis: This is the reaction of water with rock minerals to produce a rock entirely different from the original one e.g. olivine rock is changed to serpentine.
5. Solution: Rain water attacks and dissolves rock salts to form solution e.g. rain water dissolves calcium carbonate of limestone, thereby widening the cracks and joints of the rocks.

4.3 Mass Movement or Mass Wasting – Definition and Types

Mass movement or mass wasting is the process by which soil or loose rocks fall down a slope under the force of gravity. This may occur in soil creep, mud flow, landslide, slumping, rock fall and solifluction.

The factors affecting mass wasting are human activities, gradient of the slope, presence of vegetation, pressure of lubricating and nature and weight of materials.

Types of Mass Movement

The major types of mass movement include:

1. Soil creep: It is the slow downward movement of soil and fine particles on very gentle slopes. Soil creep can be observed over wide areas especially where the vegetation cover is not dense. Some of the factors that may promote it include wetting and drying of the soil trampling of soils by animals and the action of burrowing animals in the soil.
2. Solid fluxion: It occurs mainly in mountain and cool temperate lands where surface layers are saturated by thawing. Solid fluxion is also a slow movement of moderate slopes of saturated soil gravel and weathered rock. The rock materials brought down are deposited by huge ice sheets.

3. Mudflow: It is a rapid type of mass wasting which involves the slumping of semi-liquid mud accompanied with gravel and boulders. A mudflow can also occur on the slopes of an active volcano.
4. Talus creep: It is another slow, downward movement of angular rock fragments of different sizes. The fallen rocks are collectively called talus or screes.
5. Rock fall: This type of mass wasting is the most rapid of all. It occurs when large mass of rocks fall from a steep cliff.
6. Landslide: It is the movement of large rock debris over underlying weak rocks. Landslides are caused by the pull of gravity, earthquake or volcanism, activities of man on steep of the slope during, farming, etc.

Effects of Mass Wasting

The effects of mass wasting include:

1. Mass wasting can lead to the loss of soil fertility.
2. It can also lead to loss of farmlands.
3. Mass movement can cause disruption of transportation network.
4. Electric poles and telegraph poles can be tilted by mass movement.
5. Displacement of settlements can occur as a result of this mass wasting.
6. Damming of rivers can be made possible by mass wasting.

Summary

Denudation is the process of lowering and leveling of the general landscape by gradual breaking and wearing away of such land.

Stages of denudation include weathering, erosion, transportation and deposition.

Weathering is the gradual disintegration of rocks by physical and chemical forces.

Physical weathering is characterized by temperature changes, frost action, plant and animals action, and alternate wetting and drying.

The main chemical reactions operate in the following ways: hydration, carbonation, oxidation, hydrolysis and solution.

Mass movement is the process by which soil or loose rocks fall down a slope under the force of gravity.

The types of mass movement include soil creep, soilfluction, mudflow, rock fall and landslide.

The disadvantages of mass wasting are that it can lead to the loss of soil fertility, loss of farmlands, cause disruption of transportation network, lead to displacement of settlement, etc.

Damming of rivers can be made possible by mass wasting.

Revision Questions

Objectives

1. The plains formed when the slopes of mountains are worn back in arid and semi-arid regions by mechanical weathering is called
 - A. pediplains.
 - B. deflation plains.
 - C. alluvial plains.

- D. outwash plains.
2. All the following are causes of mechanical weathering except
- temperature changes.
 - rain action.
 - alternate wetting and drying.
 - frost action.
3. Which of the following represents the correct sequence in which denudation occurs?
- weathering → erosion → deposition
 - deposition → weathering → erosion
 - erosion → weathering → deposition
 - weathering → deposition → erosion
4. Exfoliation is weathering process associated with
- hot, arid regions.
 - hot, humid regions.
 - cold dry regions.
 - cold, wet regions.
5. Mechanical weathering due to changes in temperature occurs mainly in
- coastal areas.
 - desert regions.
 - wet equatorial regions.
 - polar regions.
6. Physical weathering is expected to be most active in the
- tropical continental regions.
 - hot desert regions.
 - warm temperate region.
 - arctic region.
7. The process of weathering in limestone region is mainly

- A. hydration.
 - B. exfoliation.
 - C. solution.
 - D. oxidation.
8. The process which causes exposed rock surface to break and crumble is best described as
- A. denudation.
 - B. weathering.
 - C. transportation.
 - D. folding.
9. Chemical weathering takes place most effectively where it is
- A. dry all the time.
 - B. cold and wet.
 - C. warm and dry.
 - D. hot and wet.
10. All the following are processes of physical weathering except alternate
- A. heating and cooling.
 - B. freezing and thawing.
 - C. wetting and drying.
 - D. oxidation and hydrolysis.

Answers

1. A 2. B 3. A 4. A 5. B 6. B 7. C 8. B 9. D 10. D

Essay

- 1a. Differentiate between denudation and weathering.
 - b. Describe four agents of denudation.
 - c. List the two types of weathering.
- 2a. Explain the term weathering.

- b. Name any two processes of mechanical weathering and describe each of them.
 - c. Name one climatic region in which mechanical weathering is most common. (SSCE 1990)
- 3a. Define weathering.
 - b. List five factors affecting the weathering of rocks.
 - 4a. Define the term ‘mass wasting’
 - b. Mention and explain the types of mass movement.
 - c. What are its effects on man?
- 5. Write short notes on any two of the following:
 - (i) Factors affecting mass movement
 - (ii) Agents of chemical weathering
 - (iii) Types of mass movement (iv) Stages of denudation