



CHAPTER NINE

Weathering

Syllabus

Weathering and Denudation*

Meaning, types and effects of weathering.

Types: Physical Weathering — block and granular disintegration, exfoliation;

Chemical Weathering — oxidation, carbonation, hydration and solution;

Biological Weathering — caused by humans, plants and animals.

The internal forces operating in the interior of the earth are described as 'Constructive Forces' because they lead to the formation of landforms on the surface of the earth. Some forces also operate on the surface of the earth. They are known as *exogenic forces* (*exo* in Greek means outside). These external forces act on the surface of the earth through several processes such as weathering, mass wasting, erosion, transportation, deposition and formation of

soils. These forces derive their energy from the sun. In all these cases, climate acts as the driving agent.

WEATHERING

Weathering is the process of breaking down of rocks but not its removal. It is described as *disintegration or decomposition of a rock in size by natural agents at or near the surface of the earth*. It is so called because the disintegration or decomposition of rocks take place only by being exposed. It is the change in weather conditions like temperature, moisture, precipitation that disintegrate or break down the rocks. Weathering cannot take place on the moon's surface where such conditions do not exist. The footprints left on the moon by astronauts will last for millions of years. Thus, weathering is the basic process and an essential phase of denudation as described above.

Chief Characteristics of Weathering

1. Weathering involves disintegration or decay of solid rocks.



Fig. 9.1(a). A mountain range before weathering.



Fig. 9.1(b). A mountain range after weathering.

* This topic is dealt with in the next Chapter.

2. It depends on climatic elements and on the characteristics of rocks. For example, the rock's chemical composition, hardness, texture and its permeability (allowing water to penetrate) determines the weathering pattern.
3. Weathering affects the surface of the earth.
4. Weathering causes formation of soil.
5. Weathering involves not one but several processes to cause disintegration of rocks.
6. Weathering changes hard massive rocks into finer materials.
7. It prepares rock materials for transportation by agents of gradation.

TYPES OF WEATHERING

Weathering, as already stated, is a static process. The disintegration of rocks may occur through physical forces, chemical forces or by roots of plants, animals, insects, etc. Weathering is of three types—*physical*, *chemical*, and *biological*.

Physical Weathering

Physical weathering is also known as *Mechanical Weathering*. It involves rock disintegration without any change in the chemical constituents of the rock. Main factors responsible for physical weathering are temperature changes, moisture, frost action and wind.

Weathering due to changes in temperature is more rapid in hot deserts. It is because temperature changes are sharpest in a desert.

Block Disintegration: The sudden rise and fall of temperature causes expansion and

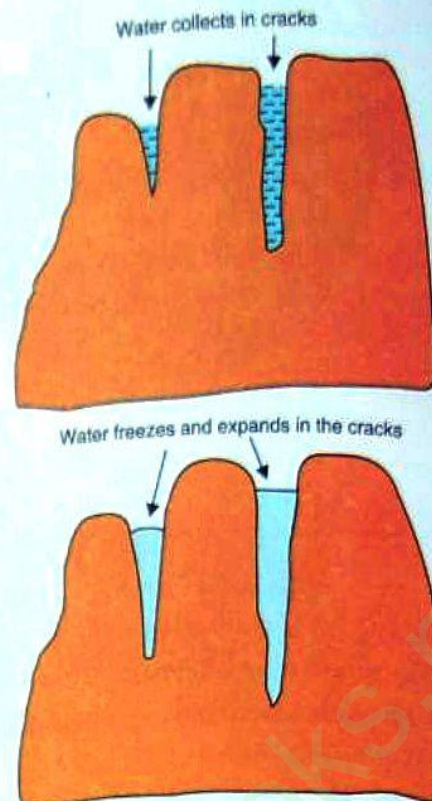
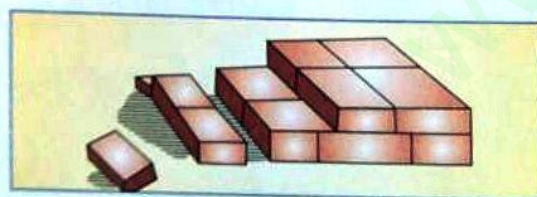


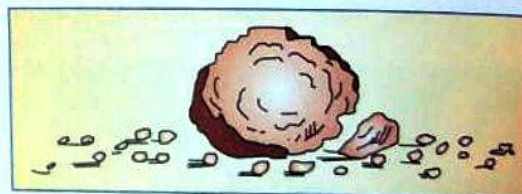
Fig. 9.2. Mechanics of Weathering (Physical Weathering)

contraction of rocks. The repeated action causes their breakdown. At night the temperature suddenly falls and during the day it rises suddenly. This leads to tension and splitting of rocks known as *block disintegration*.

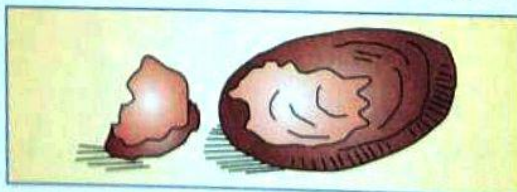
Granular Disintegration: Since rocks are made up of different minerals, weathering may also reduce rocks to pieces and fragments. This type of disintegration is called *granular disintegration*. The granular disintegration may also take place in cold places and at high altitudes. The cracks and joints of rocks are



(a) Block disintegration



(b) Granular disintegration



(c) Exfoliation

Fig. 9.3. Types of Mechanical Weathering

filled with water during the day and at night the water freezes leading to rupture of rocks on account of repeated actions of melting and freezing. This is called *frost action*.

Exfoliation: Sudden temperature changes may also cause fissures into which water penetrates which in turn stimulates chemical weathering. Most rocks are not good conductors of heat. The sudden contraction and expansion peels off the outer layer known as *exfoliation*.

Chemical Weathering

In chemical weathering, some or all of the minerals in the rocks suffer decay or alteration by such agents as water, oxygen, carbon or various organic acids. It leads to *decomposition* of rocks and minerals as chemical reaction transform them into different chemical combinations.

The chemical weathering of rocks is accomplished in a number of ways and each one is given a name to distinguish the different processes involved. Four main processes are — *oxidation, carbonation, hydration and solution*.

(i) **Oxidation:** It means reaction of minerals in rocks to atmospheric oxygen. The rainwater also contains atmospheric oxygen. On coming in contact with iron-compounds in rocks, the iron starts rusting or crumbling. The colour of the rock also changes to red, yellow or brown.

(ii) **Carbonation:** Many mineral constituents of rocks such as carbon dioxide while coming in contact with water produce acidic effect on rocks. This action dissolves most calcareous rocks such as gypsum, marble and limestone. However,

this action should not be mistaken for solution. In the case of carbonation, rainwater converts calcium carbonate into calcium bicarbonate which is soluble and is taken away by the ground water.

(iii) **Hydration:** In this process, expansion of minerals occurs on coming into contact with rainwater. These minerals become heavy and start disintegrating. This action, though can be termed as physical or mechanical, its effect in hydration is a chemical process. Rocks like feldspar are converted into kaolin.

(iv) **Solution:** It is the process in which minerals in the rocks dissolve in water. All rocks are subjected to solution to some extent. The rate at which solution takes place is affected not only by the mineral composition of the rock but also by its structure. For example, sedimentary rocks have pore-spaces between the grains in which air and water can lodge and thus attack the rocks. Some rock minerals such as salts are more soluble in water than others. For example, rainwater causes chemical disintegration of rock-salt and gypsum.

Biological Weathering

It is also known as *Organic Weathering*. Its main agents are animals, insects, plants and man. In all the cases, however, both physical disintegration and/or chemical decomposition are involved. This is because all biological matter is made up of oxygen and water, the two substances that set off reaction of minerals in rocks.

Table 9.1. Difference between Mechanical and Chemical Weathering.

Mechanical (Physical) Weathering	Chemical Weathering
1. Disintegration of rocks take place without any change in chemical constituents of rocks.	1. Decomposition of rocks take place with changes in the chemical constituents of rocks.
2. Factors such as temperature, moisture, frost action and wind cause physical break-up of rocks.	2. Temperature, moisture, etc., cause minerals in rocks to either dissolve in water or change their composition.
3. It is more rapid in desert climates.	3. It occurs in moist and cold climates
4. Rocks are affected to great depths.	4. It mostly takes place near the surface of the earth.
5. Its agents are temperature and moisture.	5. Its agents are water, oxygen, carbon and various organic acids.



Fig. 9.4. Biological Weathering due to roots.

- (i) **Humans:** Man is the most active agent of both physical and chemical weathering of rocks. For example: mining, excavations, construction of roads, buildings, etc. cause physical disintegration of rocks. Agriculture, dumping of chemicals and wastes underground promote both physical and chemical weathering.
- (ii) **Plants:** Roots of large trees reach deep into rocks and cause physical disintegration due to pressure. Most of vegetation, however, prevents disintegration of rocks because it binds the surface layer and does not allow exposure of rocks beneath to the elements of weathering.
- (iii) **Animals and Insects:** Animals like rabbits, worms, moles and insects bring large quantities of fine material to the surface. Burrowing animals help to loosen the surface materials around the rocks facilitating their physical disintegration. Upon death, the decaying animals also provide many chemicals and acids for rock disintegration.

WEATHERING IN DIFFERENT CLIMATIC REGIONS

From the processes of weathering discussed above, it is clear that climate is the most important factor. For example physical weathering is more rapid in desert climates and chemical weathering occurs in moist and cold climates.

- (i) *In Equatorial climates*, humidity and temperature are constantly high. Weathering specially chemical weathering is more active in these regions.
- (ii) *In Tropical climates*, there is a marked dry season and wet season. Differences in heating leads to consistently high rate of evaporation. During wet season, precipitation of oxides of iron and aluminium takes place from rocks. This promotes formation of laterite soils.
- (iii) *In Dry climates or deserts*, mechanical weathering is most dominant due to high diurnal range of temperature.
- (iv) *In Mid-latitudes or Temperate Climates*, the most powerful agent of weathering is the frost action. In limestone areas, 'Solution' or chemical weathering operates on a large scale.
- (v) *In Polar climates*, physical weathering due to frost action is more prevalent. Chemical and biological weathering in these areas is negligible. However, recent studies have shown that the melting water of polar regions contains more carbonic acid content because carbon dioxide is more soluble at low temperatures than at high temperatures. This suggests that chemical weathering is more active in polar regions.

Terms to Remember

Weathering	: Breaking down but not removal of rocks.
Exfoliation	: Peeling off of the outer layer of rocks by sudden contraction and expansion.
Physical Weathering	: Disintegration of rocks without any change in their chemical constituents.
Chemical Weathering	: Decomposition of rocks due to chemical reaction that transforms the chemical constituents of rocks.
Biological Weathering	: The weakening and subsequent disintegration of rocks by humans, plants and animals.

EXERCISES

I. Short Answer Questions

1. What is weathering?
2. Name three types of weathering.
3. Give two differences between physical and chemical weathering.
4. What is known as exfoliation? Name the processes involved in it.
5. Name the four processes involved in chemical weathering.
6. What is known as oxidation? What effect does it have on the colour of rocks?

II. Give a technical term for each of the following:

1. Disintegration or decomposition of rocks.
2. Peeling off of the outer layer of rock through contraction and expansion.
3. Expansion of minerals in rocks on coming into contact with rainwater.

III. Distinguish between each of the following:

1. Block Disintegration and Exfoliation.
2. Carbonation and Solution.

IV. Structured Questions

1. (a) Define weathering and describe the chief characteristics of weathering.
(b) Distinguish between physical and chemical weathering.
(c) Give a geographical reason for each of the following:
(i) Physical weathering is also called mechanical weathering.
(ii) Physical weathering is more rapid in desert climates.
(iii) Chemical weathering occurs in moist and cold climates.
(d) Draw a well labelled diagram to show the process of physical weathering.
2. (a) Describe chemical weathering mentioning the processes involved in it.
(b) What is biological weathering? State the main agents of biological weathering.
(c) Give a geographical reason for each of the following:
(i) Biological weathering is also known as organic weathering.
(ii) Vegetation prevents disintegration of rocks.
(iii) Chemical and biological weathering is negligible in polar climates.
(d) Describe the chief characteristics of weathering in different climates.

V. Practical Work

1. Collect rock samples. Perform experiments to study physical and chemical weathering. Write down your report.
2. Observe the process of weathering active in your surroundings. State its chief characteristics. Draw, paint or take pictures.

