Weathering

Weathering is the process of disintegration and decomposition of rocks while erosion is the process of removal, transportation and deposition of the weathered particles. These processes together are known as “Denudation.”

Weathering is defined as mechanical disintegration and chemical decomposition of rocks through the actions of various elements of weather and climate. Weathering process brings mechanical disintegration and chemical decaying of rocks. Weather conditions are the most decisive phenomenon hence the name weathering. However the type and rate of weathering are also influenced by rock structure, topography and vegetation. Weathering is a static process. It is also the process of soil genesis.

It is of three types:

1. **Mechanical Weathering:** When a region undergoes mechanical weathering, rocks are broken into small pieces. Physical or mechanical weathering processes depend on some applied forces. The applied forces could be:

(i) gravitational forces such as overburden pressure, load and shearing stress;

(ii) expansion forces due to temperature changes, crystal growth or animal activity;

(iii) water pressures controlled by wetting and drying cycles. Many of these forces are applied both at the surface and within different earth materials leading to rock fracture. Most of the physical weathering processes are caused by thermal expansion and pressure release. These processes are small and slow but can cause great damage to the rocks because of continued fatigue the rocks suffer due to repetition of contraction and expansion.

This mechanical disintegration takes place in different ways.

- **Frost Action:** Frost weathering occurs due to growth of ice within pores and cracks of rocks during repeated cycles of freezing and melting. This process is most effective at high elevations in mid-latitudes where freezing and melting is often repeated. Glacial areas are subject to frost wedging daily. In this process, the rate of freezing is important. Rapid freezing of water causes its sudden expansion and high pressure. The resulting expansion affects joints, cracks and small inter granular fractures to become wider and wider till the rock breaks apart.
- **Thermal Expansion and Contraction:** Various minerals in rocks possess their own limits of expansion and contraction.

With rise in temperature, every mineral expands and pushes against its neighbour and as temperature falls, a corresponding contraction takes place. Because of diurnal changes in the temperatures, this internal movement among the mineral grains of the superficial layers of rocks takes place regularly. This process is most effective in dry climates and high elevations where diurnal temperature changes are drastic. Though these movements are very small they make the rocks weak due to continued fatigue.

The surface layers of the rocks tend to expand more than the rock at depth and this leads to the formation of stress within the rock resulting in heaving and fracturing parallel to the surface. Due to differential heating, the resulting expansion and contraction of surface layers and their subsequent exfoliation from the surface results in smooth rounded surfaces of rocks.

In rocks like granites, smooth surfaced and rounded small to big boulders called tors form due to such exfoliation. In the area of hot deserts, the diurnal range of temperature brings the expansion and contraction of surface rocks, leading to their disintegration into smaller pieces.

- **Exfoliation:** This is the expansion by unloading process. Unloading occurs when large igneous bodies are exposed through the erosional removal of overlying rock and the reduction in the pressure. On being exposed to the surface they expand slightly in volume. This leads to the peeling of thick shells like an onion's layers from the parent rock.
- **Spalling:** When there is a sudden shower in the hot desert area, the highly heated rocks when struck by sudden drizzle develop numerous cracks.
- **Cavernous Weathering:** It occurs generally in hot arid region and also in the rocks of coastal area.
- **Salt Weathering:** Salts in rocks expand due to thermal action, hydration and crystallization. Many salts like calcium, sodium, magnesium, potassium and barium have a tendency to expand. Expansion of these salts depends on temperature and their thermal properties. High temperature ranges between 30°C and 50°C of surface temperatures in deserts favour such salt expansion.

Salt crystals in near-surface pores cause splitting of individual grains within rocks, which eventually fall off. This process of falling off of individual grains may result in granular disintegration or granular foliation.

Salt crystallization is most effective of all salt-weathering processes. In areas with alternating wetting and drying conditions salt crystal growth is favoured and the neighbouring grains are pushed aside. Sodium chloride and gypsum crystals in desert areas heave up overlying layers of materials and with the result polygonal cracks develop all over the heaved surface. With salt crystal growth, chalk breaks down most readily, followed by limestone, sandstone, shale, gneiss and granite etc.

- **Sheeting:** The development of cracks and fractures, parallel to the ground surface, caused by removal of superincumbent load.
- **Cambering process:** Due to expansion caused by unloading of super-incombitant load and consequent release of confining pressure. (i) Flaking: Different heating of outer and lower shells of a rock mass causes flaking.

2…Chemical Weathering:

It changes the basic properties of the rock. Principal processes of chemical weathering are:

- **Solution:** Here the rocks are completely dissolved. This process involves removal of solids in solution and depends upon solubility of a mineral in water or weak acids.

On coming in contact with water many solids disintegrate and mix up as suspension in water. Soluble rock forming minerals like nitrates, sulphates and potassium etc. are affected by this process. So, these minerals are easily leached out without leaving any residue in rainy climates and accumulate in dry regions. Minerals like calcium carbonate and calcium magnesium bicarbonate present in limestones are soluble in water containing carbonic acid (formed with the addition of carbon dioxide in water), and are carried away in water as solution. Carbon dioxide produced by decaying organic matter along with soil water greatly aids in this reaction. Common salt (sodium chloride) is also a rock forming mineral and is susceptible to this process of solution.

- **Oxidation and Reduction:** In weathering, oxidation means a combination of a mineral with oxygen to form oxides or hydroxides. Oxidation occurs where there is ready access to the atmosphere and oxygenated waters. The minerals most commonly involved in this process are iron, manganese, sulphur etc. Though it is a universal phenomenon but it is more apparent in rocks containing iron.

In the process of oxidation rock breakdown occurs due to the disturbance caused by addition of oxygen. Red colour of iron upon oxidation turns to brown or yellow. When oxidized minerals are placed in an environment where oxygen is absent, reduction takes place. Such conditions exist usually below the water table, in areas of stagnant water and waterlogged ground. Red colour of iron upon reduction turns to greenish or bluish grey.

- **Hydration:** Hydration is the chemical addition of water. Most of the rock-forming minerals absorb water. Minerals take up water and expand. This not only increases their volume but also produces chemical changes resulting in the formation of new minerals which are softer and more voluminous. E.g. this process converts hematite into limonite. Calcium sulphate takes in water and turns to gypsum, which is more unstable than calcium sulphate.

This process is reversible and long, continued repetition of this process causes fatigue in the rocks and may lead to their disintegration. Many clay minerals swell and contract during wetting and drying and a repetition of this process results in cracking of overlying materials. Salts in pore spaces undergo rapid and repeated hydration and help in rock fracturing. The volume changes in minerals due to hydration will also help in

physical weathering through exfoliation and granular disintegration.

- **Carbonation:** Carbonation is the reaction of carbonate and bicarbonate with minerals and is a common process helping the breaking down of feldspars and carbonate minerals. Carbon dioxide from the atmosphere and soil air is absorbed by water, to form carbonic acid that acts as a weak acid. Calcium carbonates and magnesium carbonates are dissolved in carbonic acid and are removed in a solution without leaving any residue resulting in cave formation.
- **Hydrolysis:** The mineral of the rocks and water molecules react in such a way that new mineral compounds are formed. Silicate minerals are most affected by defrosts.
- **Chelation:** Chelation is a complex organic process by hydrocarbon molecules. Chelation is form of Chemical weathering by plants. These weathering processes are interrelated. Hydration, carbonation and oxidation go hand in hand and hasten the weathering process.

III. Biological Weathering:

This type of weathering is performed by the tree roots, animals and human beings. As the plant roots grow, they wedge the rocks apart and cause the widening of joints and other fractures. Micro animals like earthworms, ants, termites and other

burrowing animals move materials to or near the surface where they are more closely subjected to chemical weathering.

Erosion

Erosion is concerned with the various ways in which the mobile agencies acquire and remove rock debris. The acquisition of materials by the mobile agencies and their transport, i.e. corrasion and transportation are considered to be the integral part of erosion. The principal erosional agents are running water, groundwater, glaciers, wind and coastal waves. Each of the agents does erosion by distinctive processes and gives rise to distinctive landforms.

There are five common aspects of erosion by the above mentioned agents.

(1) The acquisition of rocks fragments.

(2) Wearing away of rocks fragments.

(3) The breaking down of the rock particles by mutual wear while in transit.

(4) Transportation of the acquired rock debris.

(5) Ultimately the deposition in the low lying areas.

Mass Wasting

Mass wasting is the movement of material down a slope under the influence of gravity. It is a transitional phenomenon between weathering and erosion. Mass Wasting is of Various Types: Land-slide, Debris avalanche, Earth-flow, Mud-flow, and Sheet-flow etc.

(a) Soil creep: In soil covered slope extremely slow downslope movement of soil and over burden may be found. This process is called as soil creep.

(b) Talus cones: Steep rocks walls of gorges and high mountains shed countless rock particles under the attack of physical weathering processes.

(c) Earth Flows: In humid climate region, if slope are steep, masses of water-saturated soil due to over burden or weak bedrock may side down slope during a period of few hours.

(d) Mud flow: Rapid flowage of mud stream down a canyon floor and spreading out on plain at the foot of a mountain range is called as mud flow.

(e) Landslide: The downslope movement of regolith of bed rock is called as landslide.