



FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

WEATHERING

Weathering is the process of disintegration and decomposition of rocks and minerals, brought about by physical and chemical means, respectively, leading to the formation of **regolith** (Unconsolidated residues of the weathering rock on the earth's surface or above the solid rocks)

Types of Weathering

- 1 Physical/ Mechanical Weathering (Disintegration)
- 2 Chemical Weathering (Decomposition)
- 3 Biological Weathering (Disintegration and decomposition)

Physical Weathering

Physical weathering is a mechanical process, causing disintegration of consolidated massive rocks into smaller pieces. In this weathering rock size will be reduced without any change in chemical composition of rock. The agents responsible for physical weathering are: the physical condition of rock, changes in temperature, action of water, action of wind and atmospheric electric phenomena.

Physical condition of rock:- The permeability of rock is probably the most important single factor which determines the rate at which the rocks weather. Ex: - Coarse textured sand stone (porous) weathers more rapidly than a fine textured (almost solid) basalt. Unconsolidated fine deposits of volcanic ash weather rather quickly as compared with unconsolidated coarse deposits, such as gravels, which may take much longer, because the water percolates between and not through the gravels.

Temperature : As a result of diurnal temperature changes the rocks heated during day and cooled during night. Different minerals in poly-mineral rocks have different coefficient of expansion and thus heating and cooling of rocks results in differential expansion and contraction of rocks, which eventually produce cracks in rocks, thus facilitating mechanical break down. Ex: The cubical expansion of quartz is twice as that of feldspars; the

dark colored rocks are subjected to fast changes in temperature as compared to light colored rocks.

More over, the temperature of rocks at its surface is very different from that of the part beneath. This creates stress and strain between heated surfaces and the cooled unexpanded parts, resulting in fragmentation of rocks. This process with time may cause the surface layer to peel off from the parent mass and the rock may ultimately disintegrate.

This phenomenon is called '**Exfoliation**'

Water: Of all the agents of physical weathering the effect of water is more pronounced and widespread. Water acts as disintegrating, transporting and depositing agent. A current moving at a speed of 15cm, 30cm, 1.2m and 9.0m per second can carry fine sand, gravel, stones, and boulders of several tonnes respectively. The greater the amount of suspended matter the quicker will be the disintegration of rocks. Hence the disintegration of rocks is greater near the source of a river than at its mouth.

In cold regions, the water in the cracks and crevices freezes in to ice, which increases the volume of water by nine percent. If the space is not available to accommodate the increased volume, it exerts pressure on rock equivalent to 1465 Mgm^{-2} , which leads to widening of cracks in huge boulders and dislodging of mineral grains from smaller fragments.

In colder regions, the moving glaciers cause great deal of cutting and crushing of bed rocks.

Wind: Wind has both erosive and transporting effect. Wind when laden with fine particles (fine sand, silt and clay) has a serious abrasive effect on the rocks.

Atmospheric Electric Phenomena: This is also an important phenomenon, during rainy season, when lightning breaks up rocks and / or widens cracks.

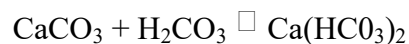
Chemical Weathering

Chemical weathering is more complex in nature and involves the transformation of the original material in to some new compounds by bringing about alteration in minerals.

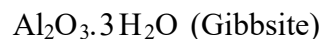
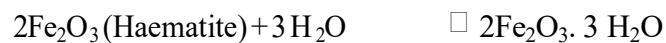
Chemical weathering takes place mainly at the surface of the rocks. Chemical weathering is highly pronounced in humid tropical regions. Its effectiveness is closely

related to the mineral composition of rocks. The plants and animals also contribute directly or indirectly to chemical weathering as they produce O₂, CO₂, and certain acids that react with earth materials. Various chemical processes are:

Solution : Water is a universal solvent. Its solubility action is enhanced when it contains dissolved CO₂, organic and inorganic acids or salts in it. Most of the minerals are affected by solubilizing action of water, though by varying degrees. When the soluble substances are removed by the continuous action of flowing or percolating waters, the rock no longer remains solid and develops holes, rills or rough surface and ultimately decomposes. Solubilization of rock minerals under the influence



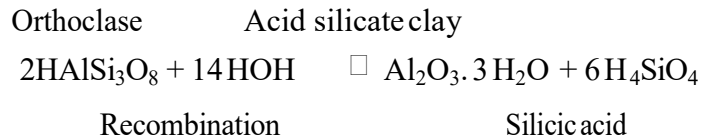
Hydration : It is the chemical combination of water molecules with a mineral to form a new mineral. Owing to hydration, the mineral swells, loses luster, becomes softer and tend to fall apart. This is a major chemical weathering process in secondary minerals



Hydrolysis: Hydrolysis is one of the most important processes in chemical weathering and results in complete disintegration or drastic modification (in structure and composition) of minerals. It is a major chemical process in primary minerals.

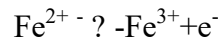
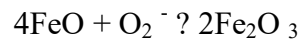
Hydrolysis involves the partial dissociation of water in to H⁺ and OH⁻ ions, which combine with minerals and bring about changes such as exchange, decomposition of crystalline structure and formation of new minerals. . The hydrolytic activity of water gets accelerated in the presence of dissolved CO₂, minerals and organic acids. In a way, hydrolysis reactions may be considered as the forerunners of the clay formation.





Muscovite \square **Illite** : Muscovite is a 2:1 primary mineral with a non-expandable crystal structure and with a formula of KA13 Si3O10 (OH)2 . As weathering occurs, the mineral is broken down in size to the colloidal range; part of K is lost and some silica is added from weathering solutions. The net result is illite mineral with a less rigid crystal structure and an electronegative charge.

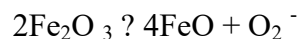
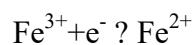
Oxidation: The process of combination of oxygen is known as oxidation. Moisture aids in oxidation process and this process mostly occur after hydrolysis



Oxidation of iron reduces its size and increased the electrical charge and creates electrical and structural imbalance in iron containing minerals such as pyroxenes, amphiboles and biotite.

Reduction:

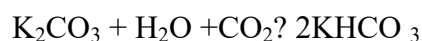
The process of removal or loss of oxygen is called reduction. It occurs in submerged areas. In reduction reaction iron reduces to highly soluble ferrous form.



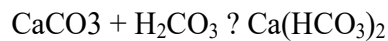
Oxidation and reduction are more common in minerals with Fe, Mn and S

Carbonation:

Combination of carbon dioxide with any base. This effectively decompose the minerals of rocks and organic matter accelerates this due to more CO_2 production.



In this way the bases present in rocks can be solubilized and removed making the rock weak.



The carbonic acid or carbonated water has an etching effect on rocks like limestone or other rocks containing calcium or magnesium carbonates as cementing materials leading to their breakage and formation of new minerals.

It may be concluded that chemical weathering involves destruction of rocks and minerals into simple new compounds.

Biological Weathering

Unlike physical and chemical weathering, the biological or living agents are responsible for both decomposition and disintegration of rocks and minerals. The biological life is controlled largely by the prevailing environments.

Man, animals, higher plants, earth worms, termites and micro-organisms are responsible for biological weathering.

FAUNA:

- The disintegration of rocks by cutting action of hills and rocks to build dams, roads etc., by humans
- The animals, insects live in rocks make burrows and holes in rocks leading to weakening of rocks. Their excreta and other materials lead to chemical decomposition of rocks.
- Ants and termites built galleries and passages and carries material from lower to upper horizons. Water percolate through the channels and galleries and help in weathering of materials in subsurface horizons. They secrete some acids like formic acid, which aid in decomposition of rocks

FLORA :

- The roots of the plants penetrate into small cracks of rocks. As they grow they exert disruptive force due to which even hard rocks break into pieces.
- Some roots grow deep in to soil and make open channels for percolation of water in to deeper layers.
- Roots produce acids, which have solubilizing action of constituents of rocks making them weak.
- The decomposition of organic matter due to microbial activity also produces several products which play a role in chemical weathering.

The physical, chemical and biological weathering processes occur simultaneously in nature. Likewise different chemical weathering processes occur simultaneously and are interdependent.