

# **Bioecology**

## **Module: Soil Science**

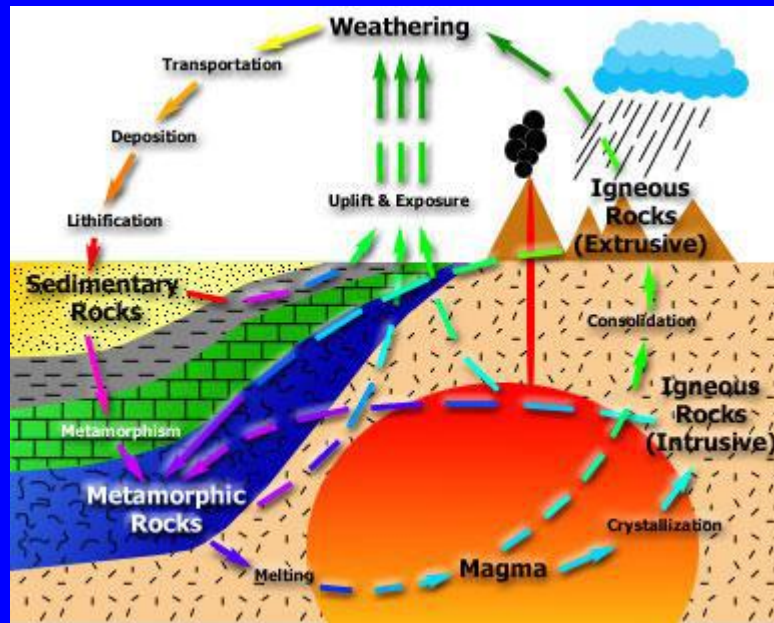
### **Lecture 2.**

### **Weathering**

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# Weathering

- 1) A process of disintegration and decomposition of rocks and minerals which are brought about by physical agents and chemical processes, leading to the formation of Regolith (unconsolidated residues of the weathering rock on the earth's surface or above the solid rocks).
- 2) The process by which the earth's crust or lithosphere is broken down by the activities of the atmosphere, with the aid of the hydrosphere and biosphere.
- 3) The process of transformation of solid rocks into parent material or Regolith.



# Different agent of weathering

Physical/ Mechanical (disintegration)	Chemical (decomposition)	Biological (disint + decomp)
1. Physical condition of rock	1. Hydration	1. Man & animals
2. Change in temperature	2. Hydrolysis	2. higher plants & their roots
3. Action of H <sub>2</sub> O	3. Solution	3. Micro organisms
-fragment&transport	4. Carbonation	
- action of freezing	5. Oxidation	
- alter. Wet & drying	6. Reduction	
- action of glaciers		
4. Action of wind		
5. Atmosp. electric pheno		

# Physical weathering

The rocks are disintegrated and are broken down to comparatively smaller pieces, without producing any new substances

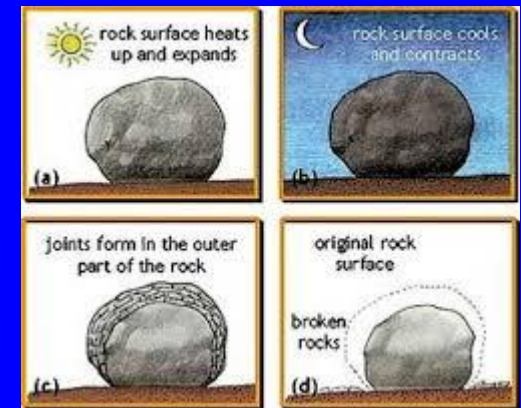
## 1. Physical condition of rocks

The permeability of rocks is the most important single factor. Coarse textured (porous) sand stone weather more readily than a fine textured (almost solid) basalt. Unconsolidated volcanic ash weather quickly as compared to unconsolidated coarse deposits such as gravels.

## 2. Action of Temperature

The variations in temperature exert great influence on the disintegration of rocks.

The differential expansion of minerals in a rock surface generates stress between the heated surface and cooled un expanded parts resulting in fragmentation of rocks. This process causes the surface layer to peel off from the parent mass and the rock ultimately disintegrates. This process is called *Exfoliation*



# Physical weathering

## 3. Action of Water

Water acts as a disintegrating, transporting and depositing agent.

### i) Fragmentation and transport

Water beats over the surface of the rock when the rain occurs and starts flowing towards the ocean.

Moving water has the great cutting and carrying force. It forms gullies and ravines and carries with the suspended soil material of variable sizes.

The transporting power of stream varies as the sixth power of its velocity i.e the greater the speed of water, more is the transporting power and carrying capacity.

Speed/Sec	Carrying capacity
15 cm	Fine sand
30 cm	Gravel
1.2 m	Stones (1kg)
9.0 m	Boulders (several tons)

### ii) Action of freezing

Frost is much more effective than heat in producing physical weathering. In cold regions, the water in the cracks and crevices freezes into ice and the volume increases to 1/10. As the freezing starts from the top there is no possibility of its upward expansion. Hence, the increase in volume creates enormous out ward pressure which breaks apart the rocks.

# Physical weathering

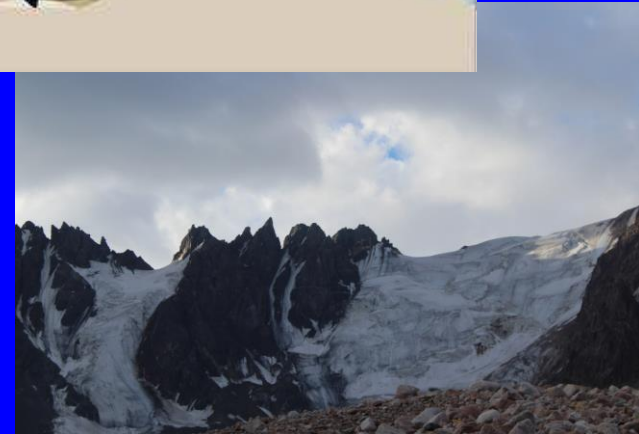
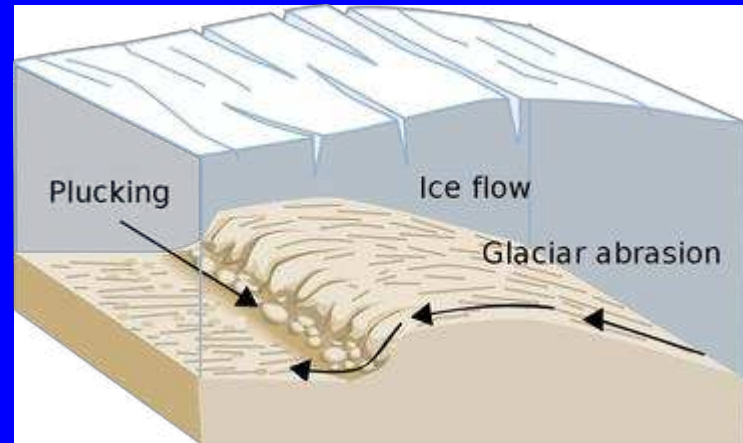
## 3. Action of Water

### iii) Alternate wetting and Drying

Some natural substances (smectite, montmorillonite) increase considerably in volume on wetting and shrink on drying. During dry weather – these clays shrink considerably forming deep cracks or wide cracks. On subsequent wetting, it swells. This alternate swelling and shrinking/ wetting or drying of clay enriched rocks make them loose and eventually breaks

### iv) Action of glaciers

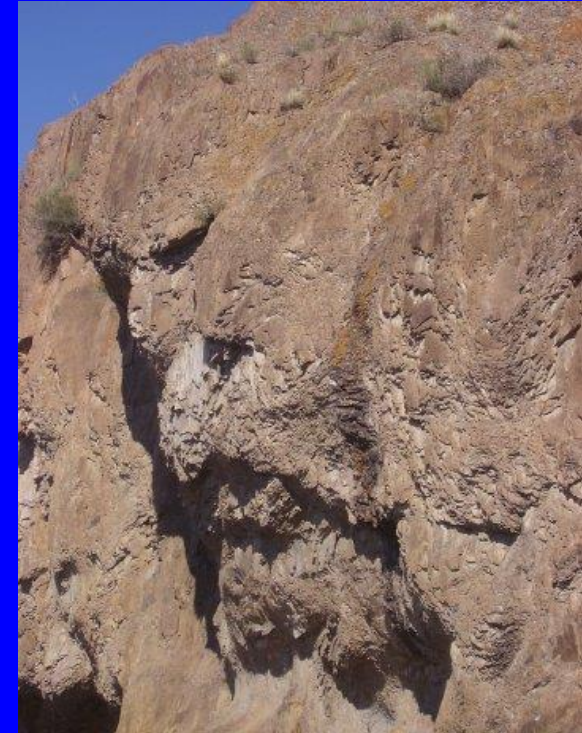
In cold regions, when snow falls, it accumulates and change into a ice sheet. These big glaciers start moving owing to the change in temperature and/or gradient. On moving, these exert tremendous pressure over the rock on which they pass and carry the loose materials These materials get deposited on reaching the warmer regions, where its movement stops with the melting of ice



# Physical weathering

## 4. Action of wind

- ✓ Wind has an erosive and transporting effect. When the wind is laden with fine material (fine sand, silt or clay particles), it has a serious abrasive effect and the sand laden winds itch the rocks and ultimately breaks down under its force
- ✓ The dust storm may transport tons of material from one place to another. The shifting of soil causes serious wind erosion problem and may render cultivated land as degraded (Rajasthan desert)



## 5. Atmospheric electrical phenomenon

- ✓ It is an important factor causing break down during rainy season and lightning breaks up rocks and or widens cracks



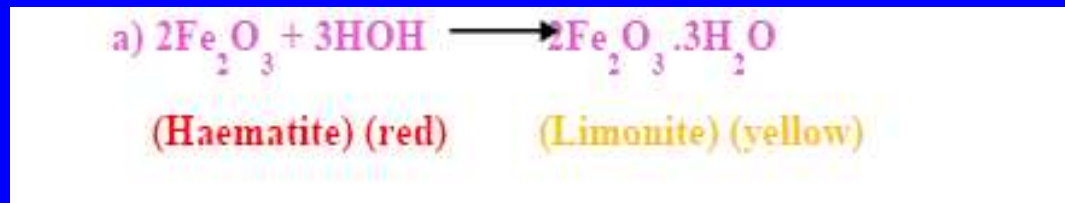
# Chemical Weathering

Decomposition of rocks and minerals by various chemical processes is called chemical weathering. It is the most important process for soil formation.

Chemical weathering takes place mainly at the surface of rocks and minerals with disappearance of certain minerals and the formation of secondary products (new materials). This is called **chemical transformation**.

## 1. Hydration

Chemical combination of water molecules with a particular substance or mineral leading to a change in structure. Soil forming minerals in rocks do not contain any water and they undergo hydration when exposed to humid conditions. Upon hydration there is swelling and increase in volume of minerals. The minerals lose their luster and become soft. It is one of the most common processes in nature and works with secondary minerals (aluminium oxide and iron oxide minerals and gypsum).

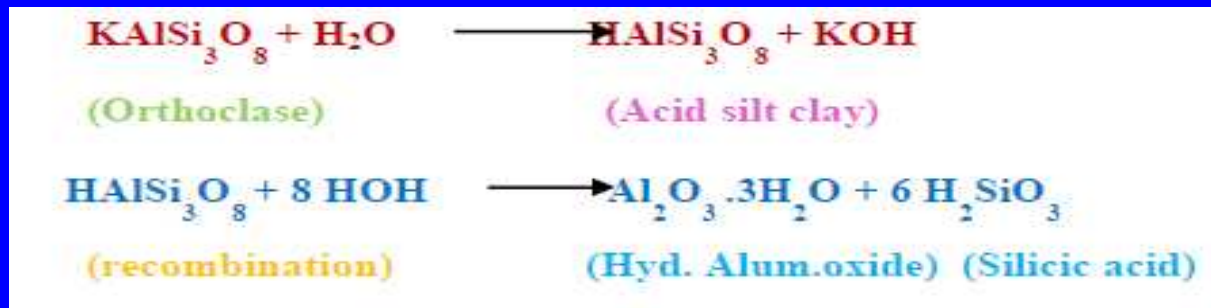




# Chemical Processes of weathering:

## 2. Hydrolysis

Most important process in chemical weathering. It is due to the dissociation of  $H_2O$  into  $H^+$  and  $OH^-$  ions which chemically combine with minerals and bring about changes, such as exchange, decomposition of crystalline structure and formation of new compounds. Water acts as a weak acid on silicate minerals.



**This reaction is important because of two reasons**

- clay, bases and silicic acid - the substances formed in these reactions - are available to plants
- water often containing  $CO_2$  (absorbed from atmosphere), reacts with the minerals directly to produce insoluble clay minerals, positively charged metal ions ( $Ca^{++}$ ,  $Mg^{++}$ ,  $Na^+$ ,  $K^+$ ) and negatively charged ions ( $OH^-$ ,  $HCO_3^{3-}$ ) and some soluble silica – all these ions are made available for plant growth.

# Chemical Processes of weathering:

## 3. Solution

Some substances present in the rocks are directly soluble in water. The soluble substances are removed by the continuous action of water and the rock no longer remains solid and form holes, rills or rough surface and ultimately falls into pieces or decomposes. The action is considerably increased when the water is acidified by the dissolution of organic and inorganic acids. (e.g) halites, NaCl



## 4. Carbonation:

Carbon di oxide when dissolved in water it forms carbonic acid.

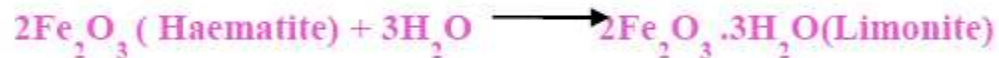
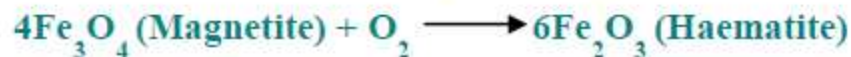
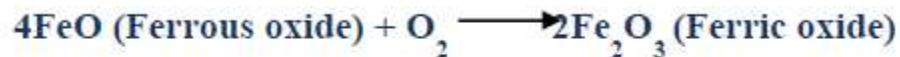


This carbonic acid attacks many rocks and minerals and brings them into solution. The carbonated water has an etching effect up on some rocks, especially lime stone. The removal of cement that holds sand particles together leads to their disintegration.

# Chemical Processes of weathering:

## 5. Oxidation

The process of addition and combination of oxygen to minerals. The absorption is usually from  $O_2$  dissolved in soil water and that present in atmosphere. The oxidation is more active in the presence of moisture and results in hydrated oxides. (e.g) minerals containing Fe and Mg.



## 6. Reduction

The process of removal of oxygen and is the reverse of oxidation and is equally important in changing soil colour to grey, blue or green as ferric iron is converted to ferrous iron compounds. Under the conditions of excess water or water logged condition (less or no oxygen), reduction takes place.



# Biological Weathering

The biological or living agents are responsible for both decomposition and disintegration of rocks and minerals. The biological life is mainly controlled largely by the prevailing environment.

## 1. Animals

- A large number of animals, birds, insects and worms, by their activities they make holes in them and thus aid for weathering.
- In tropical and sub tropical regions, ants and termites build galleries and passages and carry materials from lower to upper surface and excrete acids. The oxygen and water with many dissolved substances, reach every part of the rock through the cracks, holes and galleries, and thus brings about speedy disintegration.
- Rabbits, by burrowing in to the ground, destroy soft rocks. Moles, ants and bodies of the dead animals, provides substances which react with minerals and aid in decaying process.
- The earthworms pass the soil through the alimentary canal and thus brings about physical and chemical changes in soil material.



# Biological Weathering

## 2. Higher Plants and Roots

The roots of trees and other plants penetrates into the joints and crevices of the rocks. As they grew, they exert a great disruptive force and the hard rock may broken apart.

The grass roots form a sponge like mass, prevents erosion and conserve moisture and thus allowing moisture and air to enter in to the rock for further action.

Some roots penetrate deep into the soil and may open some sort of drainage channel. The roots running in crevices in lime stone and marble produces acids. These acids have a solvent action on carbonates. The dead roots and plant residues decompose and produce carbon dioxide.



## 3. Microorganisms

Microorganisms (bacteria, fungi and actinomycetes) extract nutrients from the rock and N from air and live with a small quantity of water. In due course of time, the soil develops under the cluster of these micro-organisms. These organisms closely associated with the decay of plant and animal remains and thus liberate nutrients for the use of next generation plants and also produces  $\text{CO}_2$

*Thank you for attention!*