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Soil Origin (Formation):

The process has two stages:

i) **Weathering:** (breakdown of bigger rocks into fine, smaller mineral particles)
ii) **Pedogenesis** or soil development: modification of the mineral matter through interaction between biological, topographic and climatic effect, which lead to development of soil.

i) Weathering:

a. Physical weathering: (We have already discussed)

b. Chemical weathering: Chemicals react in the environment all the time, and these cause chemical weathering. Major chemical reactions include carbonation, dissolution, hydration, hydrolysis, and oxidation-reduction reaction. All of these reactions have water involved with them.

- **Hydration:** Due to uptake of water reversible change result in conversion of haematite to limonite. The rock swells and swelling causes the disruption of sandstone etc.

- **Carbonation** when water reacts with carbon dioxide, it creates carbonic acid, which can dissolve softer rocks.

- **Dissolution-** limestone and rocks high in salt dissolve when exposed to water. The water carries away the ions.

- **Hydrolysis-** minerals in the rock react with water and surrounding acids. Elements such as potassium and surplus silicon are washed out which give rise to simpler mineral matter like clay alumino-silicates.
- **Oxidation-Reduction** - water and rock particles react with oxygen. This causes the minerals and materials to rust and turn red.

- **Chelation:** It requires a bio agent e.g. plants (chelates/ organic acid) and animal excretion. The decomposition of minerals in the rock leads to the crumbling of rock. Humic acid, derived from the decomposition of vegetation (humus), contains important elements such as calcium, magnesium and iron. The action of bacteria and the respiration of plant roots tend to increase carbon dioxide levels which helps accelerate solution processes, especially carbonation. Lichen can also extract iron from certain rocks through the process of reduction. High lichen and algae help in the development of the lithosphere.

  If the area is hot and humid, chemical weathering is more prevalent. If it is drier, physical weathering is more predominant.

ii) Pedogenesis

Weathered material undergoes complex process known as pedogenesis. It is largely a biological phenomenon where living organisms such as lichens, bacteria, fungi, algae, micro-orthropods, molluscs etc. are involved. Secretion of organic acids, enzymes, CO2 production and addition of organic matter after death, bring about geochemical, biochemical and biophysical process. It can be defined as the process of soil development, the kinds of soils that develop in a particular area are largely determined by five interrelated factors: climate; living organisms; parent material; topography; and time. Due to further mineralization of dead organic matter and gradual addition to different layers of developing soil, the fully developed soil is having a number of layers-horizons known as soil profile.

Principal Pedogenic Processes

A large number of processes are responsible for the formation of soils. This fact is evident by the large number of different types of soils that have been classified by soil scientists.However, at the macro-scale we can suggest that there are five main principal pedogenic processes acting on soils. These processes are ***laterization, podzolization, calcification, salinization***, *and* ***gleization***.

Laterization is a pedogenic process common to soils found in tropical and subtropical environments. High temperatures and heavy precipitation

result in the rapid weathering of rocks and minerals. Movements of large amounts of water through the soil cause eluviation and leaching to occur. Almost all of the by products of weathering, very simple small compounds or nutrient ions, are translocated out of the soil profile by leaching if not taken up by plants for nutrition. The two exceptions to this process are iron and aluminum compounds. Iron oxides give tropical soils their unique reddish coloring. Heavy leaching also causes these soils to have an acidic pH because of the net loss of base cations and nutrient poor. The tropical red forest soil developing by this process is called **latosol**.

Podzolization is associated with humid cold mid-latitude climates and coniferous vegetation. Decomposition of coniferous litter (high lignin and nutrient less) inhibits microbial activity and heavy summer precipitation create a soil solution and litter that is strongly acidic known as **mor litter**. This acidic soil solution enhances the processes of eluviation and leaching causing the removal of soluble base cations and aluminum and iron compounds from the "A" horizon. This leached material reaches to the lower horizons and form hard layer in the "B" horizon. A horizon turns to light gray in color process is known as podsolization and soil as **podsols** which is nutrient poor soil.

Calcification occurs when evapotranspiration exceeds precipitation causing the upward movement of dissolved alkaline salts from the groundwater. At the same time, the movement of rain water causes a downward movement of the salts. The net result is the deposition of the translocated cations in the B horizon. In some cases, these deposits can form a hard layer called caliche. The most common substance involved in this process is calcium carbonate. Calcification is common in the prairie grasslands. The soils are known as **Chernozem** or **black earth** soils.

Salinization is a process that functions in the similar way to calcification. It differs from calcification in that the salt deposits occur at or very near the soil surface. Salinization also takes place in much drier climates.

Gleization is a pedogenic process associated with poor drainage. This process involves the accumulations of organic matter in the upper layers of the soil. In lower horizons, mineral layers are stained blue-grey because of the chemical reduction of iron. These minerals along with decomposed organic matter form sticky layer of soil is known as **gley.**