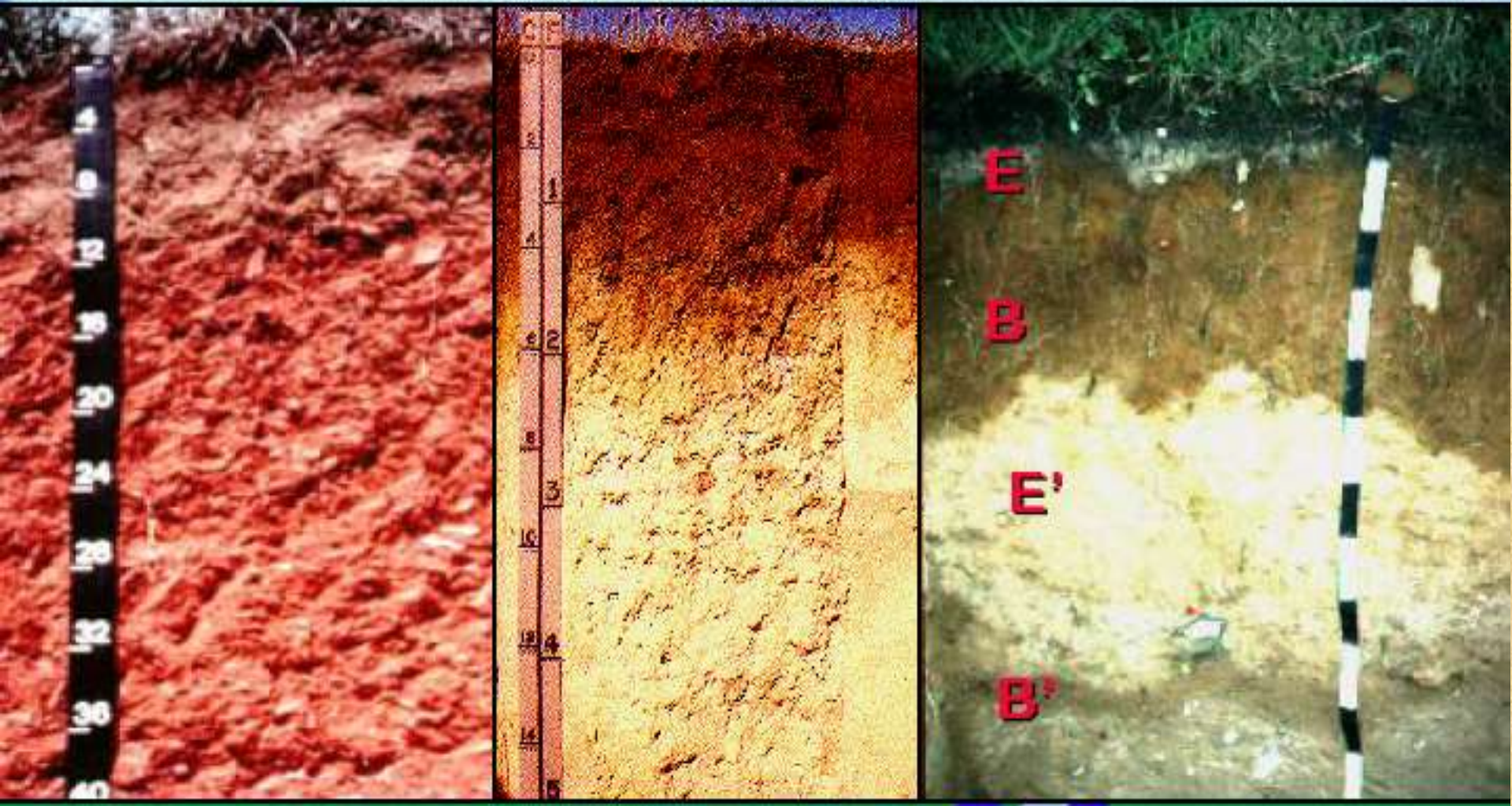
Soil Forming Processes

Why are these soils different?



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Pedogenic processes

- Pedogenic processes, work faster than the geological processes in changing parent material into true soil full of life.
- Pedogenic processes are extremely complex & dynamic involving many chemical & biological reactions & usually operate simultaneously in a given area.
- One process may counteract another, or two different processes may work simultaneously to achieve the same result

- Different processes or combination of processes operate under varying natural environment.
- The collective interaction of various soil forming factors under different environmental conditions set a course to certain recognized soil forming processes

- **Basic process involved in soil formation (Simonson, 1959) includes the following**:
- Gains or Additions of water, mostly as rainfall, organic & mineral matter to the soil.
- Losses of the above materials from the soil.
- Transformation of mineral & organic substances within the soil.
- Translocation or the movement of soil materials from one point to another within the soil. It is usually divided into movement of solution (leaching) and
- movement in suspension (eluviation) of clay, organic matter and hydrous oxides

A. Fundamental Soil forming Processes

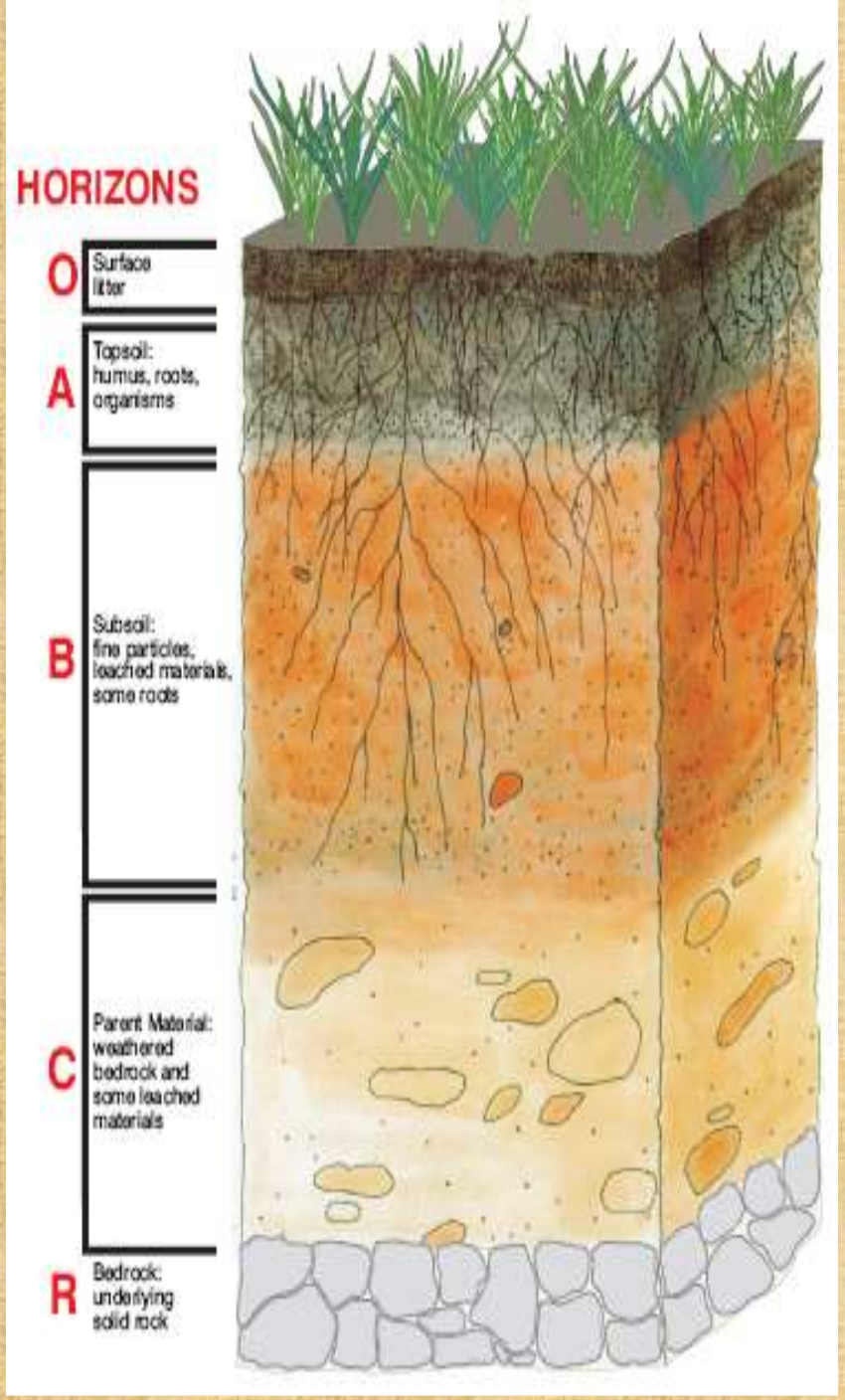
- Humification
- Eluviation
- Iluviation
- Horizonation

A. Fundamental Soil forming Processes

- **1.Humification:** Humification is the process of transformation of raw organic matter into humus.
- It is extremely a complex process involving various organisms.
- First, simple compounds such as sugars & starches are attacked followed by proteins & cellulose & finally very resistant compounds, such as tannins, are decomposed & the dark coloured substance, known as humus, is formed.

2.Eluviation

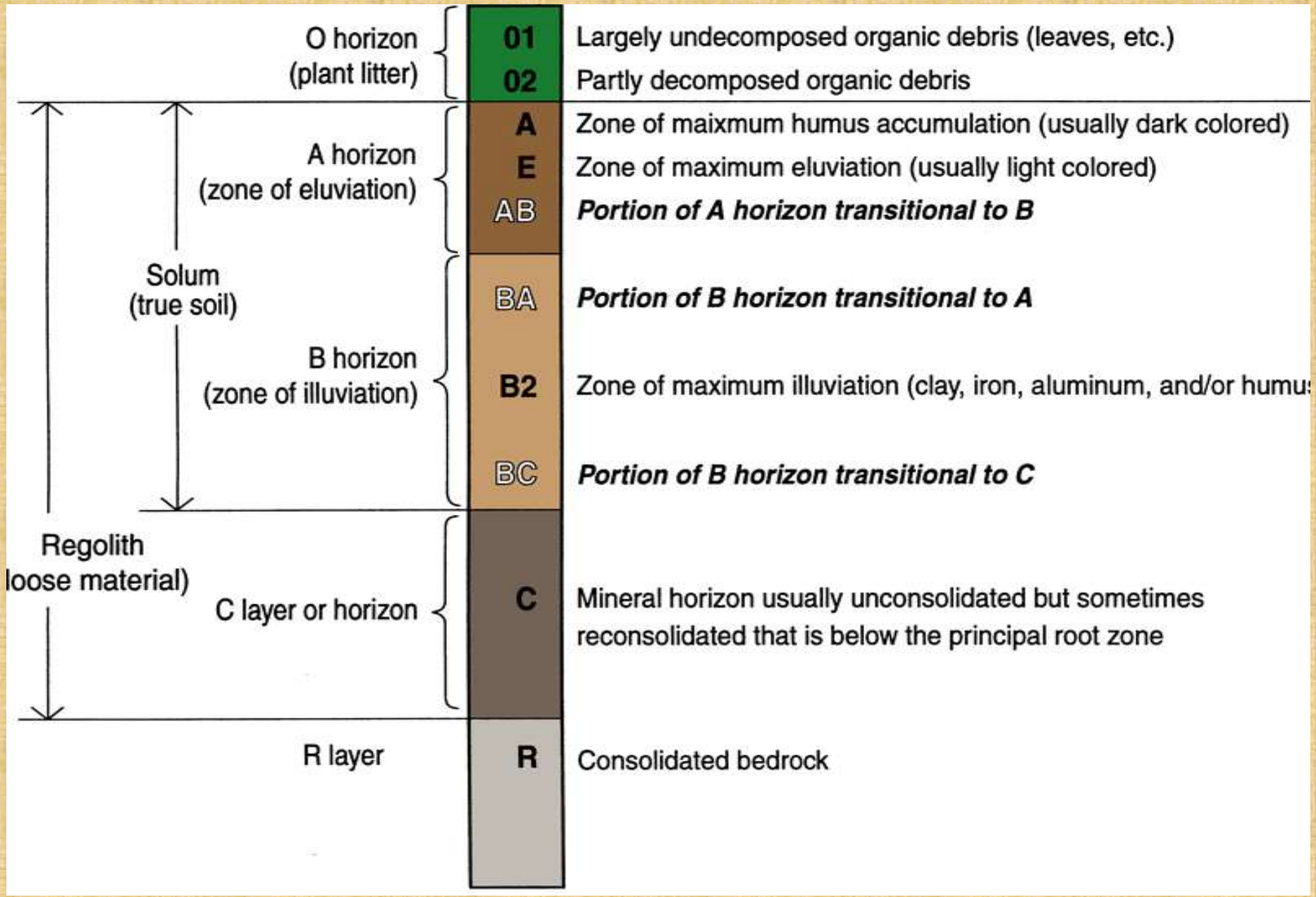
- It is the mobilization & translocation of certain constituent's viz. Clay, Fe_2O_3, Al_2O_3, SiO_2, humus, $CaCO_3$, other salts etc. from one point of soil body to another.
- Eluviation means <u>washing out</u>. It is the process of removal of constituents in suspension or solution by the percolating water from the upper to lower layers.
- The eluviation encompasses mobilization & translocation of mobile constituents resulting in textural differences.
- The horizon formed by the process of eluviation is termed as **<u>eluvial horizon (A2 or E horizon)</u>**.
- Translocation depends upon relative mobility of elements & depth of percolation.


HORIZONS
O
Surface litter
A
Topsoil: humus, roots, organisms
B
Subsoil: fine particles, leached materials, some roots
C
Parent Material: weathered bedrock and some leached materials
R
Bedrock: underlying solid rock

3.Illuviation

- The process of deposition of soil materials (removed from the eluvial horizon) in the lower layer (or horizon of gains having the property of stabilizing translocated clay materials) is termed as **Illuviation**. The horizons formed by this process are termed as **illuvial horizons** (B-horizons, especially Bt).
- The process leads to textural contrast between E (Eluvial) and Bt horizons, and higher fine: total clay ratio in the Bt horizon.

Transitional Horizons



4.Horizonation

- It is the process of differentiation of soil in different horizons along the depth of the soil body. The differentiation is due to the fundamental processes, humification, eluviation & illuviation.

B. Specific Soil Forming Processes

Basic pedologic processes provide a framework for later operation of more specific processes

- Calcification
- Decalcification
- Podzolisation
- Laterization
- Gleization
- Salinisation
- Desalinisation
- Solonization or Alkalization
- Solodization or dealkalization
- Pedoturbation

1.Calcification

- It is the process of precipitation & accumulation of calcium carbonate ($CaCO_3$) in some part of the profile. The accumulation of CaCO3 may result in the development of a **calcic horizon.**
- Calcium is readily soluble in acid and when CO_2 concentration is high in root zone as:
- $CO_2 + H_2O \rightarrow H_2CO_3$
- $H_2CO_3 + Ca \rightarrow Ca(HCO_3)_2$ (soluble)
- Temp.
- $Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$ (precipitates)
- CO_2
- The process of precipitation after mobilization under these conditions is called **calcification** and the resulting illuviated horizon of carbonates is designated as **Bk horizon (Bca)**.

2.Decalcification

- It is the reverse of calcification that is the process of removal of $CaCO_3$ or calcium ions from the soil by leaching
- Temp.
- $CaCO_3 + CO_2 + H_2O \rightarrow$ Ca (HCO3)2 (soluble)
- (insoluble) CO_2

3.Podzolization

- It is a process of soil formation resulting in the formation of Podzols and Podzolic soils.
- In many respects, podzolization is the negative of calcification. The calcification process tends to concentrate calcium in the lower part of the B horizon,whereas podzolization leaches the entire solum of calcium carbonates.
- Apart from calcium, the other bases are also removed and the whole soil becomes distinctly **acidic**.

Spodosol with a leached E horizon

4. Laterization:

- The term laterite is derived from the word later meaning brick or tile and was originally applied to a group of high clay Indian soils found in Malabar hills of Kerala, Tamil Nadu, Karnataka and Maharashtra.

- Laterisation refers specifically to a particular cemented horizon in certain soils which when dried, become very hard, like a brick.
- Such soils (in tropics) when massively impregnated with sesquioxides (iron and aluminium oxides) to extent of 70 to 80 per cent of the total mass, are called **laterites** or **latosols (Oxisols)**. The soil forming process is called **Laterization or Latozation**.

5. Gleization

- The term *glei* is of Russian origin means blue, grey or green clay.
- The Gleization is a process of soil formation resulting in the development of a glei (or gley horizon) in the lower part of the soil profile above the parent material due to poor drainage condition (lack of oxygen) and where waterlogged conditions prevail. Such soils are called hydromorphic soils.
- The process is not particularly dependent on climate (high rainfall as in humid regions) but often on drainage conditions. This is responsible for the production of typical **bluish to grayish horizon** with **mottling of yellow and or reddish brown colors**.

6. Salinization

- It is the process of accumulation of salts, such as SO_4 and Cl's of Ca, Mg, Na and K, in soils in the form of a **salty (salic) horizon**. It is quite common in arid and semi arid regions. It may also take place through capillary rise of saline ground water and by inundation with seawater in marine and coastal soils. Salt accumulation may also result from irrigation or seepage in areas of impeded drainage.

7. Desalinization

- It is the removal by **leaching** of excess soluble salts from horizons or soil profile (that contained enough soluble salts to impair the plant growth) by ponding water and improving the drainage conditions by installing artificial drainage network.

8. Solonization or Alkalization

- The process involves the accumulation of sodium ions on the exchange complex of the clay, resulting in the formation of sodic soils (Solonetz).
- All cations in solution are engaged in a reversible reaction with the exchange sites on the clay and organic matter particles. The reaction can be represented as:
- $Ca.Mg.2\ NaX \rightarrow Ca^{++} + Mg^{++} + 2\ Na^{+} + x^{-6} + 3CO_3^{2-} \rightarrow Na_2CO_3 + MgCO_3 + CaCO_3$
- (Where X represents clay or organic matter exchange sites)

9. Solodization or dealkalization

- The process refers to the removal of Na+ from the exchange sites.
- This process involves dispersion of clay. Dispersion occurs when Na+ ions become hydrated.
- Much of the dispersion can be eliminated if Ca++ and or Mg++ ions are concentrated in the water, which is used to leach the solonetz. These Ca and Mg ion can replace the Na on exchange complex, and the salts of sodium are leached out as
- $2NaX + CaSO_4 \rightarrow Na_2SO4 + CaX$

  (leachable)

10. Pedoturbation

The process that may be operative in soils is pedoturbation. It is the process of mixing of the soil. Mixing to a certain extent takes place in all soils. The most common types of pedoturbation are:

- **Faunal pedoturbation**: It is the mixing of soil by animals such as ants, earthworms, moles, rodents & man himself
- **Floral pedoturbation** : It is the mixing of soil by plants as in tree tipping that forms pits and mounds
- **Argillic pedoturbation:** It is the mixing of materials in the solum by the churning process caused by swell shrink clays as observed in deep Black Cotton Soils.