PEDOLOGICAL AND EDAPHOLOGICAL CONCEPTS OF SOIL

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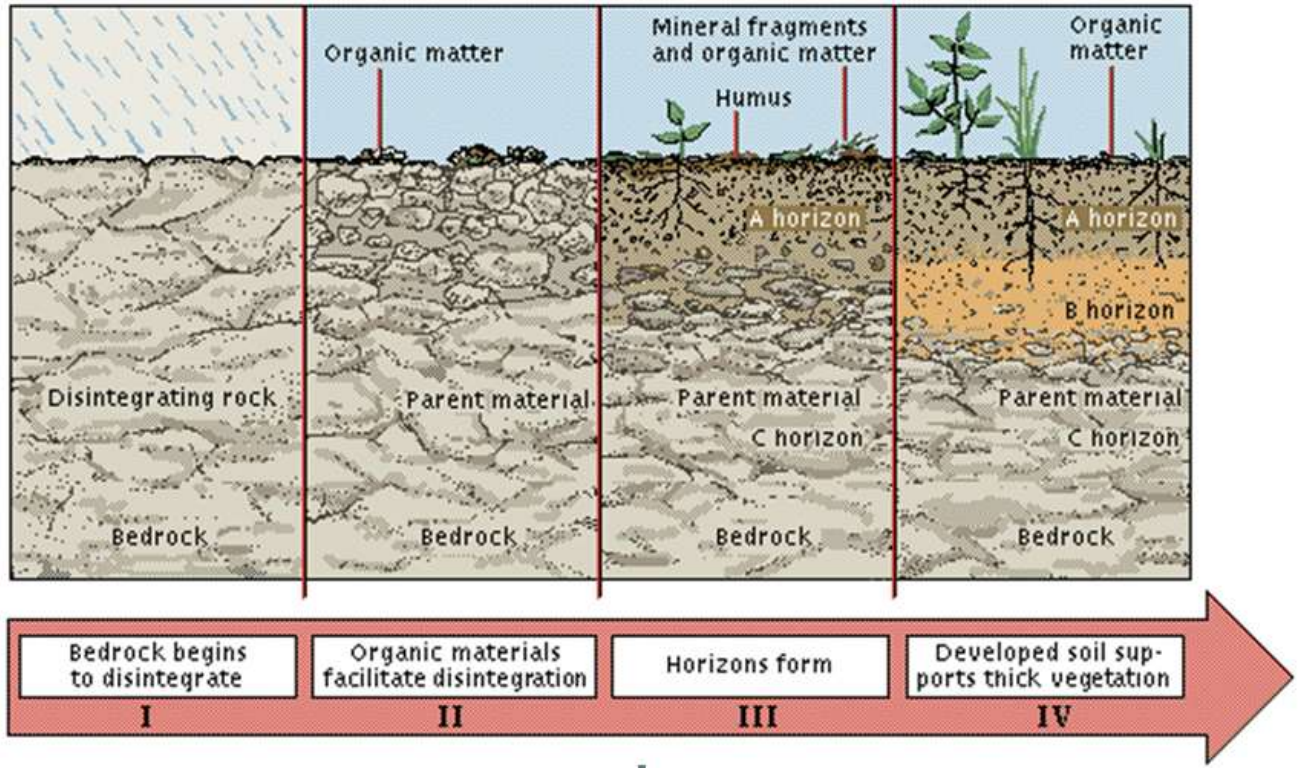


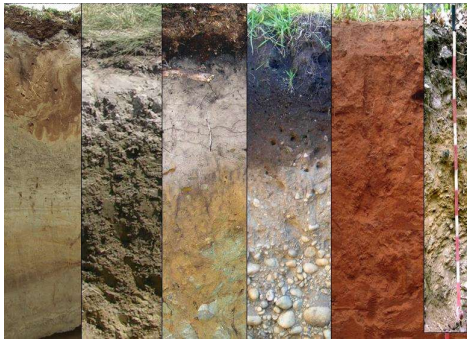
Soil

- Soil science is the study of soil as a natural resource on surface of the earth
  - including soil formation, classification and mapping;
  - physical, chemical, biological, and fertility properties of soils;
  - and these properties in relation to the use and management of soils
- Sometimes terms which refer to branches of soil science, such as:
  - pedology (formation, chemistry, morphology & classification of soil)
  - & edaphology (influence of soil on organisms, especially plants),
  - used as if synonymous with soil science
- Diversity of names associated with this discipline
  - related to the various associations concerned

Soil

- Indeed, engineers, agronomists, chemists, geologists, physical geographers,
  - ecologists, biologists, microbiologists, sylviculturists, sanitarians, archaeologists,
  - & specialists in regional planning,
  - all contribute to further knowledge of soils
  - & the advancement of the soil sciences

- Soil scientists have raised concerns about
  - how to preserve soil & arable land in a world with a growing population,
  - possible future water crisis,
  - increasing per capita food consumption,
  - & land degradation



Soil

- Soil occupies the pedosphere, one of Earth's spheres
  - that the geosciences use to organize the Earth conceptually
- This is the conceptual perspective of pedology & edaphology,
  - the two main branches of soil science
- Pedology is the study of soil in its natural setting
- Edaphology is the study of soil in relation to soil-dependent uses
- Both branches apply a combination of soil physics, soil chemistry, and soil biology
- Due to the numerous interactions b/n the biosphere, atmosphere and hydrosphere
  - that are hosted within the pedosphere,
  - more integrated, less soil-centric concepts are also valuable
- Many concepts essential to understanding soil
  - come from individuals not identifiable strictly as soil scientists
- This highlights the interdisciplinary nature of soil concepts

Soil Science

- "The science dealing with soil as a natural resource on surface of the earth, including
  - Pedology (soil genesis, classification & mapping),
  - physical, chemical, biological and fertility properties of soil
  - & these properties in relation to their management for crop production"
- Soil Science has 6 well defined and developed disciplines:
  - Soil fertility : Nutrient supplying properties of soil
  - Soil chemistry :
    - Chemical constituents, chemical properties & the chemical reactions
  - Soil physics : Involves the study of physical properties
  - Soil microbiology : Deals with micro organisms, its population, classification,
    - its role in transformations

Soil Science

- **Soil conservation : Dealing with protection of soil against physical loss**
  - **by erosion or against chemical deterioration**
  - **i.e. excessive loss of nutrients either natural or artificial means**
- **Soil Pedology : Dealing with the genesis, survey and classification**

Views on Soil (Science)

- **As early as 5000BC, the Vedas and Upanishad**
  - **as well as other Indian literature mentioned soil as synonymous with land**
  - **the Mother – supporting and nourishing all life on earth**
- **The term SOIL was derived from the Latin Word "SOLUM" Means FLOOR**
- **For an Agriculturist soil is a habitat for plant growth (to grow crops)**

Views on Soil (Science)

- For a Home Owner soil is a mellow or loamy or hard material
- For a laymen it is the dirt and dust on the surface of the earth
- To the farmer, soil is that portion of the earth's surface
  - which he can plough and grow crops to provide him with food and fiber
  - for his own needs and that of animals, to the poor man
- For a mining engineer soil is debris covering the rocks
- For engineers soil is any unconsolidated material removed in excavations
  - & used for filling or provide foundation structure

Definitions

- Generally soil refers to the loose surface of the earth as identified from the original rocks and minerals from which it is derived through weathering process
- Whitney (1892):
  - Soil is a nutrient bin which supplies all the nutrients required for plant growth
- Hilgard (1892):
  - Soil is more or less a loose & friable material in which plants, by means of their roots, find a foothold for nourishment as well as for other conditions of growth"
- Dokuchaiev (1900):
  - Russian scientist - Father of soil science
  - Soil is a natural body composed of mineral & organic constituents, having a definite genesis and a distinct nature of its own

Definitions

- **Joffe (1936):**
  - **"Soil is a natural body of mineral & organic constituents differentiated into horizons - usually unconsolidated - of variable depth which differs among themselves as well as from the underlying parent material in morphology, physical makeup, chemical properties & composition & biological characteristics"**
- **Jenny (1941):**
- **Soil is a naturally occurring body that has been formed due to combined influence of climate and living organisms acting on parent material as conditioned by relief over a period of time**
- **Ruffin and Simonson (1968): Soil is a mixture of Earth's uppermost mantle of weathered rock and organic matter**

Definitions

- **Buckman and Brady (1969):**
  - **Soil is a dynamic natural body on the surface of the earth in which plants grow, composed of mineral and organic materials and living forms**
- **Soil Science Society of America**
- **(i) Soil is the unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors of parent material, climate (including moisture and temperature effects), macro and microorganisms and topography, all affecting over a period of time and producing a product, that is "SOIL" that differs from the material from which it is derived in many, physical, chemical, biological and morphological properties and characteristics**
- **(ii) The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants**

Definitions

- **Dr. W.E.H. Blum**
- **Soils not only serve for agriculture & forestry, but also for filtering, buffering & transformation activities b/n the atmosphere & the ground water, protecting the food chain and drinking water against pollution & biodiversity**
- **As soil provides nutrients, water, air and anchorage and supports life on Earth, it can be called as Soul Of Infinite Life (SOIL)**

Land and Soil

- Land & soil are often confused by students as synonymous
- Land is broadly defined as total natural environment of the areas of the earth
  - not covered by water
- In addition to soil, its attributes include:
  - all the living organisms, the air & water bodies with in or on it and rocks below
- Soil forms a part of an ecosystem
  - which is the base functional unit of ecology
  - including both biotic & abiotic environment mutually influencing each other
  - to maintain dynamics of life on earth
- The biotic component comprises all the living organisms
  - whereas the abiotic component consists of the solid mineral matter on earth,
  - the water in the oceans, lakes, river etc.,

Land and Soil

- the gaseous mixture in the air and radiant solar energy.
- Soil as natural body:
  - The scientist considers the soil to be a natural body
    - having both depth & surface (L X B) area
- In fact, the soil is product of nature
  - resulting from both destructive and synthetic forces
- Weathering of rocks & minerals & decomposition of the organic matter
  - the examples of destructive processes
- Whereas, formation of various minerals, clays
  - & development of different horizons are synthetic processes
- Thus, a scientist considers the soil as a habitat for the plants
- He recognizes the contribution of plants in the development of soil
  - & also its importance in crop production

Major component of soil

- **Soil is composed of partly weathered, unweathred, transformed products of rocks, rock minerals & organic matter**
- **The mineral soil consists of four major components/phases:**
  - **mineral material and organic matter (solid), water (liquid) and air (gases)**
- **In an ideal surface soils these components are observed in amounts as follows**
  - **(by volume, Fig.2),**

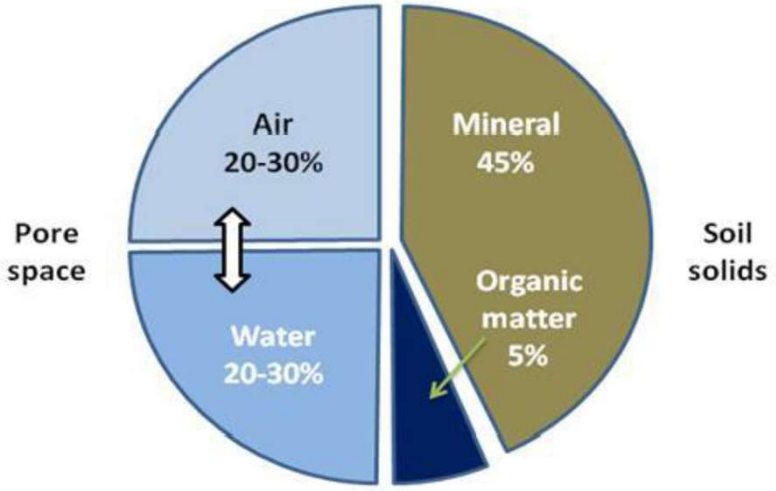
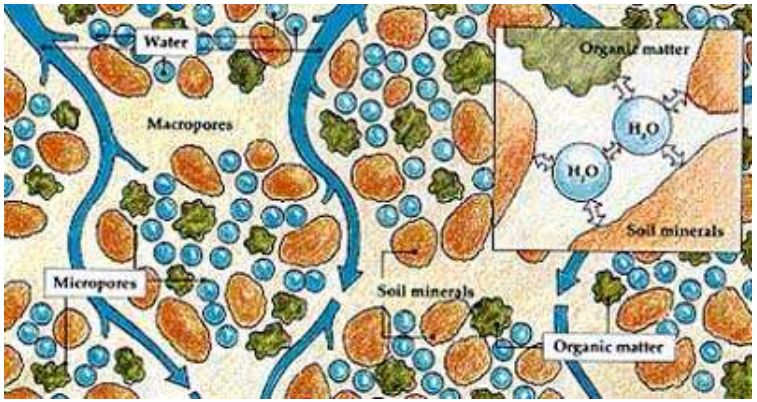
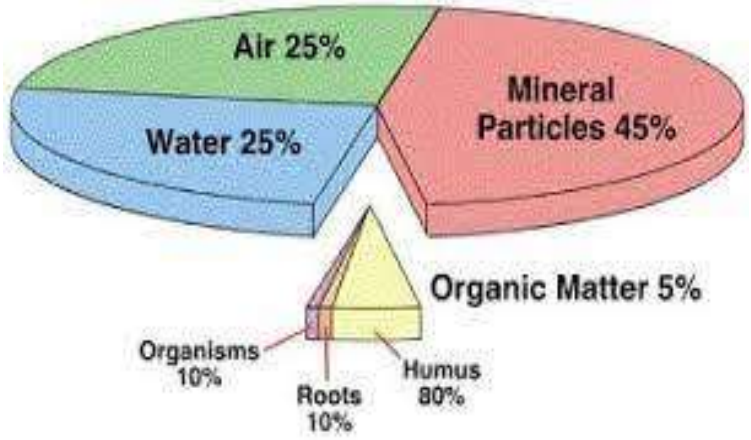


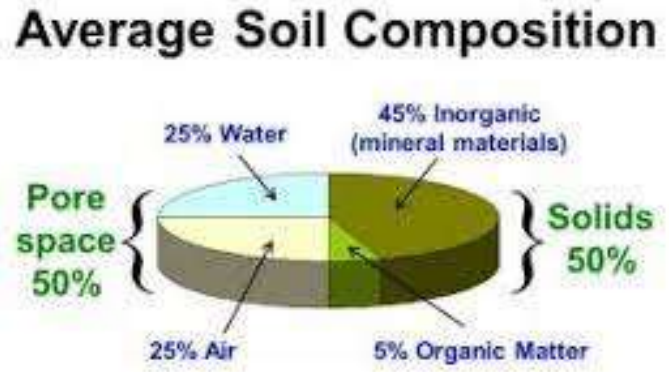
Fig.2. Composition of ideal surface soil

Soil as a three dimensional body

- Soil is a three dimensional body having length, breadth and depth
- They form a continuation over the land surface
  - & differ in properties from place to place
- Its upper boundary is air or water
  - & lower boundary is the rock lithosphere
- Composition of soil on volume basis (Soil components)
- Mineral matter : 45%
- Organic matter : 5%
- Soil water : 25%
- Soil air : 25%







Soil Scientists

List of International Soil Scientists

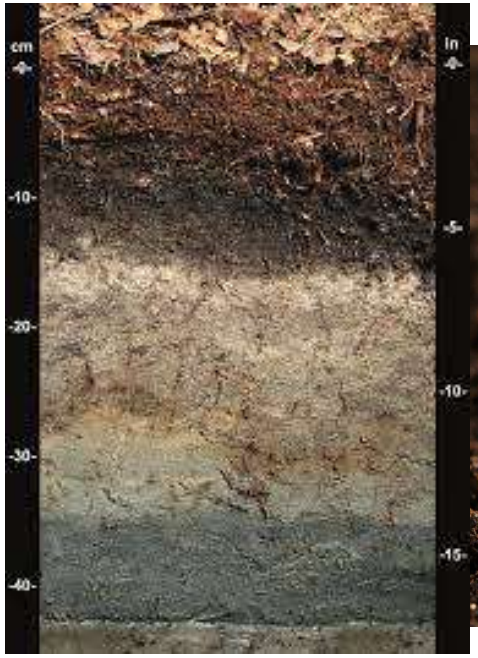
- 1. Van Helmont (1577 – 1644), 2. Theoder De Saussure,
- 3. John Woodward, 4. Boussingault (1802 – 1882),
- 5. J.V. Liebig (1803 – 1873, 6. J.B.Laws & J.H. Gilbert (1855),
- 7. J.T.Way (1856), 8. R.Warrington (1876), 9. E.W. Hilgard (1860),
- 10. V. V. Dokuchaiev (1846-1903), 11. K.D.Glinga (1914),
- 12. C.F.Marbut (1927), 13. Hens Jenny (1941)

Indian Scientists

- 1. J.W.Leather (1906), 2. Madam Scholasky (1932), 3. Wadia et al. (1935),
- 4. Viswanath & Ukil (1943)

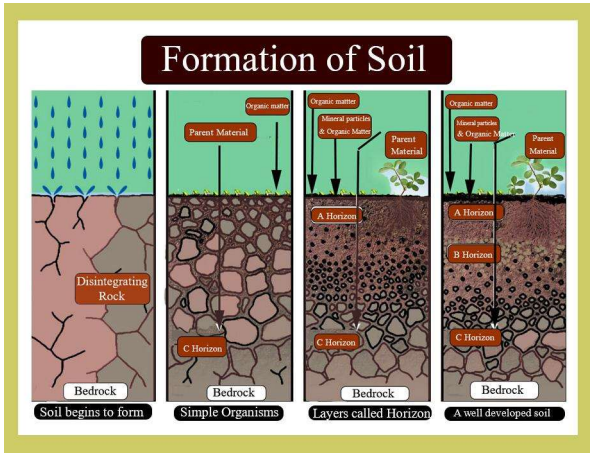
Soil can be compared to various systems of animals

- **Digestive system : Organic matter decomposition**
- **Respiratory system : Air circulation & exchange of gases**
- **Circulatory system (blood) : Water movement within the soil**
- **Excretory system : Leaching out of excess salts**
- **Brain : Soil clay**
- **Colour : Soil colour**
- **Height : Soil depth**



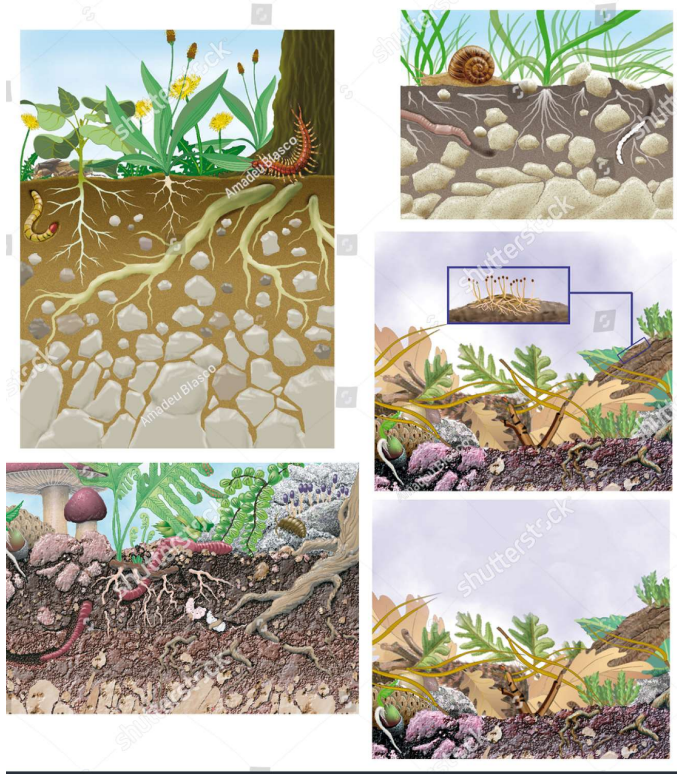
Approaches of Soil Study

- **Two Concepts:**
  - **One treats soil as a natural body,**
    - **weathered and synthesized product in nature (Pedology)**
    - **while other treats soil as a medium for plant growth (Edaphology)**
- **Pedological Approach:**
  - **The origin of the soil, its classification & its description are examined in Pedology**
  - **(From Greek word *pedon*, means soil or earth)**
  - **Pedology is the study of soil as a natural body**
    - **& does not focus on the soil's immediate practical use**
  - **A pedologist studies, examines & classifies soil**
    - **as they occur in their natural environment**



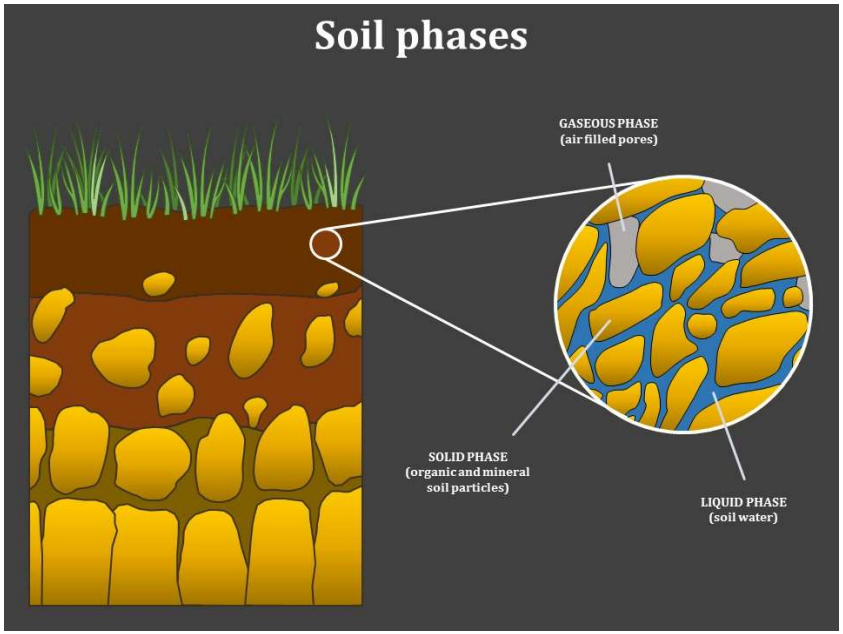
Approaches of Soil Study

- **Edaphological Approach:**
  - **Edophology (from Greek word *edaphos*, means soil or ground)**
    - **the study of soil from the stand point of higher plants**
  - **Edaphologists consider the various properties of soil**
    - **in relation to plant production**
  - **They are practical**
    - **& have the production of food**
    - **& fibre as their ultimate goal**
  - **They must determine the reasons**
    - **for variation in the productivity of soils**
    - **& find means for improvement**



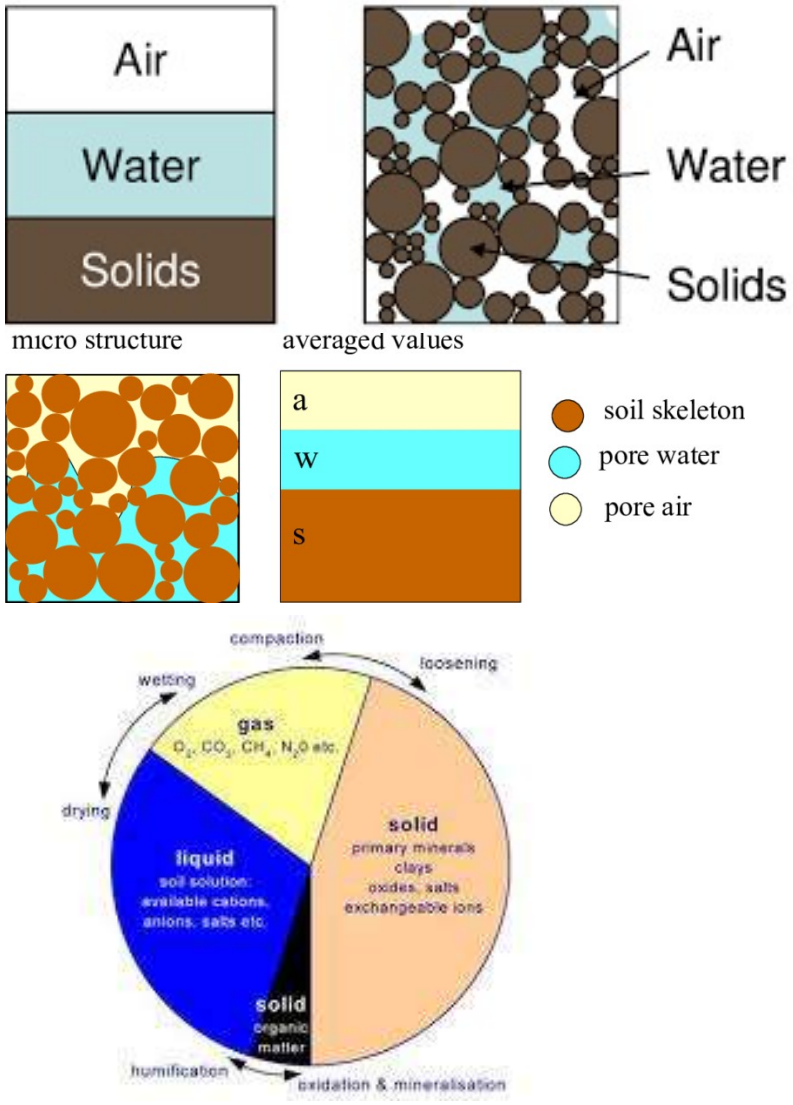
Soil Phases

- **Soild Phase (Mineral matter):**
  - The solid phase is broadly composed of inorganic and organic constituents
  - The inorganic constituents which forms bulk of solid phase of soil
  - Includes:
    - silicates, carbonates, soluble salts
    - & free oxides of Fe, Al and Si in addition to some amorphous silicates
  - Only a small fraction of the solid phase is of organic origin
  - The sources of organic constitutes are plant and animals
  - Of total volume, about half is solid space,
    - 45 % mineral matter & 5 % organic matter



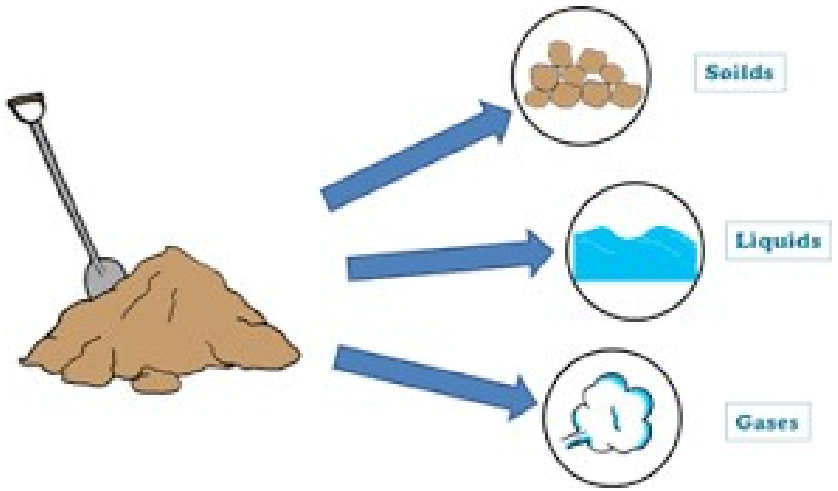
Soil Phases

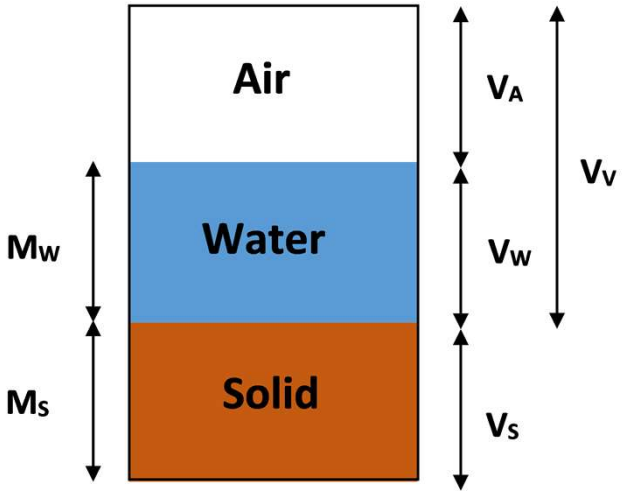
- **Liquid phase (Soil water):**
  - **40 to 50 % of the bulk volume of soil body**
    - **occupied by soil pores,**
    - **which may be completely and partially filled with water**
  - **The soil acts as a reservoir for supplying water to plants for their growth**
  - **The soil water keeps salts in solution which act as plant nutrients**
  - **Thus, liquid phase is an aqueous solution of salts**



Soil Phases

- **Gaseous Phase (Soil air):**
  - **The air filled pores constitutes the gaseous phase of the soil system**
  - **The volume of the gaseous phase is thus dependent on that of liquid phase**
  - **The nitrogen & oxygen contents of soil air**
    - **almost same as that of atmospheric air**
    - **but concentration of carbon dioxide**
    - **much higher**





Soil Phases

- Four major components of a typical soil exist mainly in an intimately mixed condition
- Proportion of these components may vary from time to time & from place to place
- Volume composition of sub- soil is different from the surface soil
- Compared to top soils they are lower in organic matter content,
  - lower in total pore space and contain a higher percentage of small pores
- This means they have a higher percentage of mineral & water
  - & considerable lower content of organic matter and air

Definitions

- **Soil is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment.**
- **The upper limit of soil is the boundary b/n soil & air, shallow water, live plants, or plant materials that have not begun to decompose**
- **Areas are not considered to have soil if the surface is permanently covered by water too deep (typically more than 2.5 meters) for the growth of rooted plants**
- **The lower boundary that separates soil from the non-soil underneath is most difficult to define. Soil consists of horizons near the Earth's surface that, in contrast to the underlying parent material, have been altered by the interactions of climate, relief, and living organisms over time**
- **Commonly, soil grades at its lower boundary to hard rock or to earthy materials virtually devoid of animals, roots, or other marks of biological activity**
- **For purposes of classification, the lower boundary of soil is arbitrarily set at 200 cm**