



Principles of Soil Science Introduction



Soil Definitions

- An **agricultural** definition of soil is : a dynamic natural body on the surface of the earth in which plants grow, composed of mineral, organic materials and living organisms form.
- An **engineering** definition of soil is : all the fragmented mineral material at or near the surface of the earth, the moon, or other planetary body, plus the air, water, organic matter, and other substances which may be included therein.
- **Geological** definitions of soil depend on the interest of the geologist. "Hard rock" geologists tend to view soil as regolith, employing the engineering definition. Geomorphologists, however, are interested in soil forming processes and adopt definitions and classification systems developed primarily for agriculturists

Soil Science

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graph TD; A[Soil Science] --> B[Pedology]; A --> C[Edaphology]
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Pedology

Edaphology

Pedology

- Pedology is a Greek word and it is a branch of soil science which is dealing with the laws of **origin formation** and **geographic distribution** of the soil as a body, it has three dimensions (length, width, and depth) in the nature
- **Pedology** comprises soil sciences below:
 1. **Soil Genesis**
 2. **Soil Morphology**
 3. **Soil Survey and Classification**
 4. **Soil Mineralogy**

Edaphology

Edaphology is a Greek word and it is another branch of soil science which is dealing with the influence of soils on living things, particularly -chiefly- plants, including human use of land for plant growth or deals with the study of soil in relation to growth of plants, nutrition & yield of crops. Edaphology comprises soil sciences below:

- 1. Soil Chemistry.**
- 2. Soil Physics .**
- 3. Soil Fertility & Plant nutrition.**
- 4. Soil Microbiology.**
- 5. Soil Conservation.**

Traditional Division of Soil Science

SOIL SCIENCE	PEDOLOGY	Soil Genesis
		Soil Morphology
		Soil Survey & Classification
		Soil Mineralogy
	EDAPHOLOGY	Soil Chemistry
		Soil Physics
		Soil Microbiology
		Soil Fertility and Plant Nutrition
		Soil Conservation

Modern Division of Soil Science

D1. 1. Soil In Space and Time	C1. 1. Soil Morphology
	C1. 2. Soil Geography
	C1. 3. Soil Genesis
	C1. 4. Soil Classification
D2. 2. Soil Properties and Process	C2.1. Soil Physics
	C2.2. Soil Chemistry
	C2.3. Soil Biology
	C2.4. Soil Mineralogy

Continued

D3. 3. Soil Use and Management	C3.1. Soil Evaluation and Land use
	C3.2. Soil and Water Conservation
	C3.3. Soil Fertility and Plant nutrition
	C3.4. Soil Engineering and Technology
	C3.5. Soil Degradation Control, Remediation and Reclamation
D4. 4. The Role of Soils in Sustaining Society and the Environment	C4.1. Soils and the Environment
	C4.2. Soils, Food Security, and Human Health
	C4.3. Soils and Land Use Change
	C4.4. Soils Education and Public Awareness
	C4.5. History, Philosophy, and Sociology of Soil Science

Related Disciplines of Soil Science

Soil science is very much related to some basic sciences and applied science courses like:-

Basic sciences such as: **Physics**, Chemistry, **Mathematics**, Biology, **Statistics**, Computer Science, **Geology**, Geography, **Soil Mechanics**, Geophysics, Watershed Planning and Management.

Applied sciences such as:

Land use Planning, Environmental Science, GIS and Remote Sensing, Hydrology, Agronomy, Plant Physiology, and Microclimatology.

** Postgraduate students in soil science should be exposed to fundamentals of the above related basic science and applied science courses.*

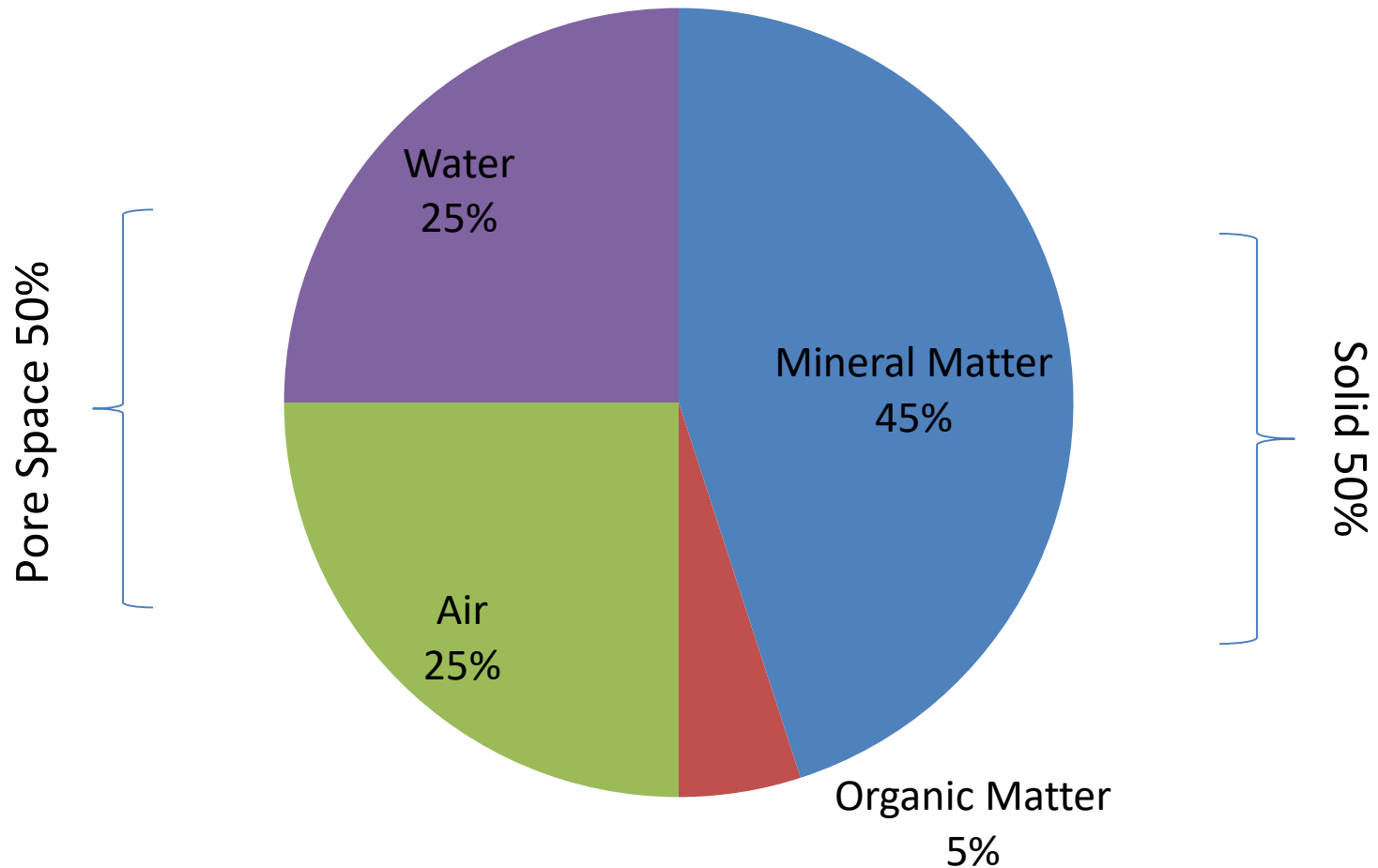
Functions of Soil in the Global Ecosystem

Soils perform five key function in the global ecosystem:

- 1) Medium for plant growth.
- 2) Regulator of water supplies.
- 3) Recycler of raw materials.
- 4) Habitat for soil organisms
- 5) Landscaping and engineering mediums.

Components of Soil

Soil consists of a solid phase (minerals and organic matter) as well as a porous phase that holds gases and water. Accordingly, soils are often treated as a three-state system.



Soil profile

Soil profile : Is a suction of soil from soil surface to bed rock. Consists of layers called **horizons**.

or a vertical exposure of a soil consisting of the horizons is a soil profile

Soil horizon: Is a layer of soil parallel to soil surface.

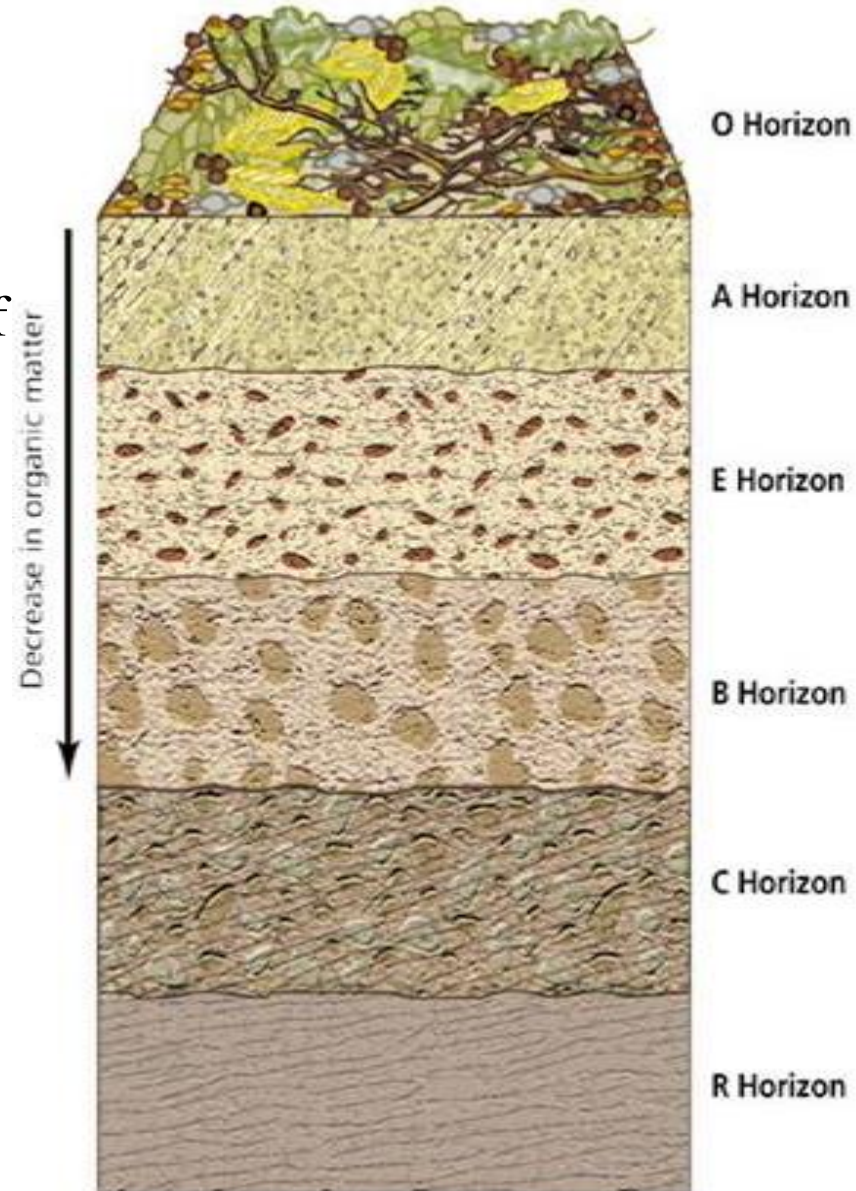
Simplest:

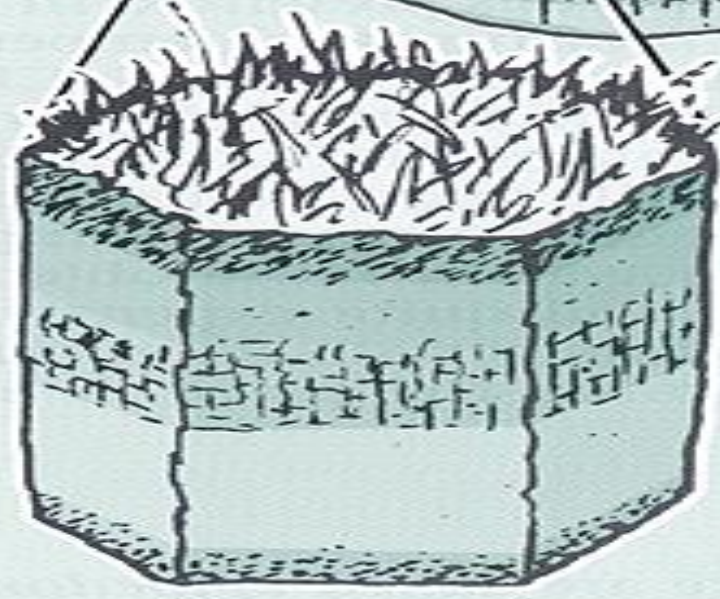
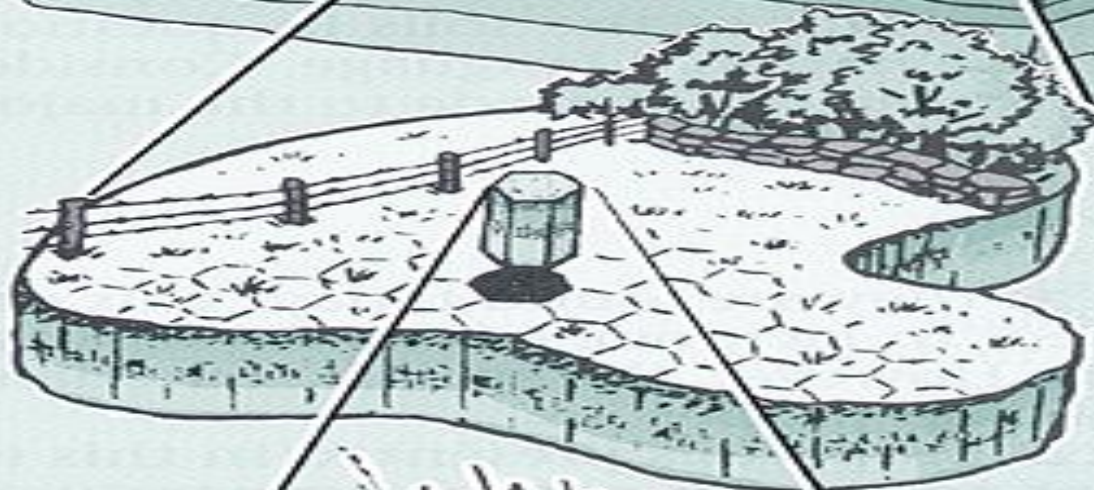
A = topsoil

B = subsoil

C = parent material

But most have **O**, **A**, **E**, **B**, **C**, and **R**





Soil Profile

O Horizon: Organic or litter layer.

A Horizon: Topsoil. Mostly inorganic minerals with some organic material and humus mixed in, Crucial (vital) for plant growth

Eluvial horizon -Eluviations horizon-loss of minerals by **leaching**, a process whereby solid materials are dissolved and transported away.

B Horizon: Subsoil. Zone of accumulation or deposition of leached minerals – Illuviation horizon- and organic acids from above.

C Horizon: Slightly altered parent material

R Horizon: Bedrock.

A SOIL PEDON

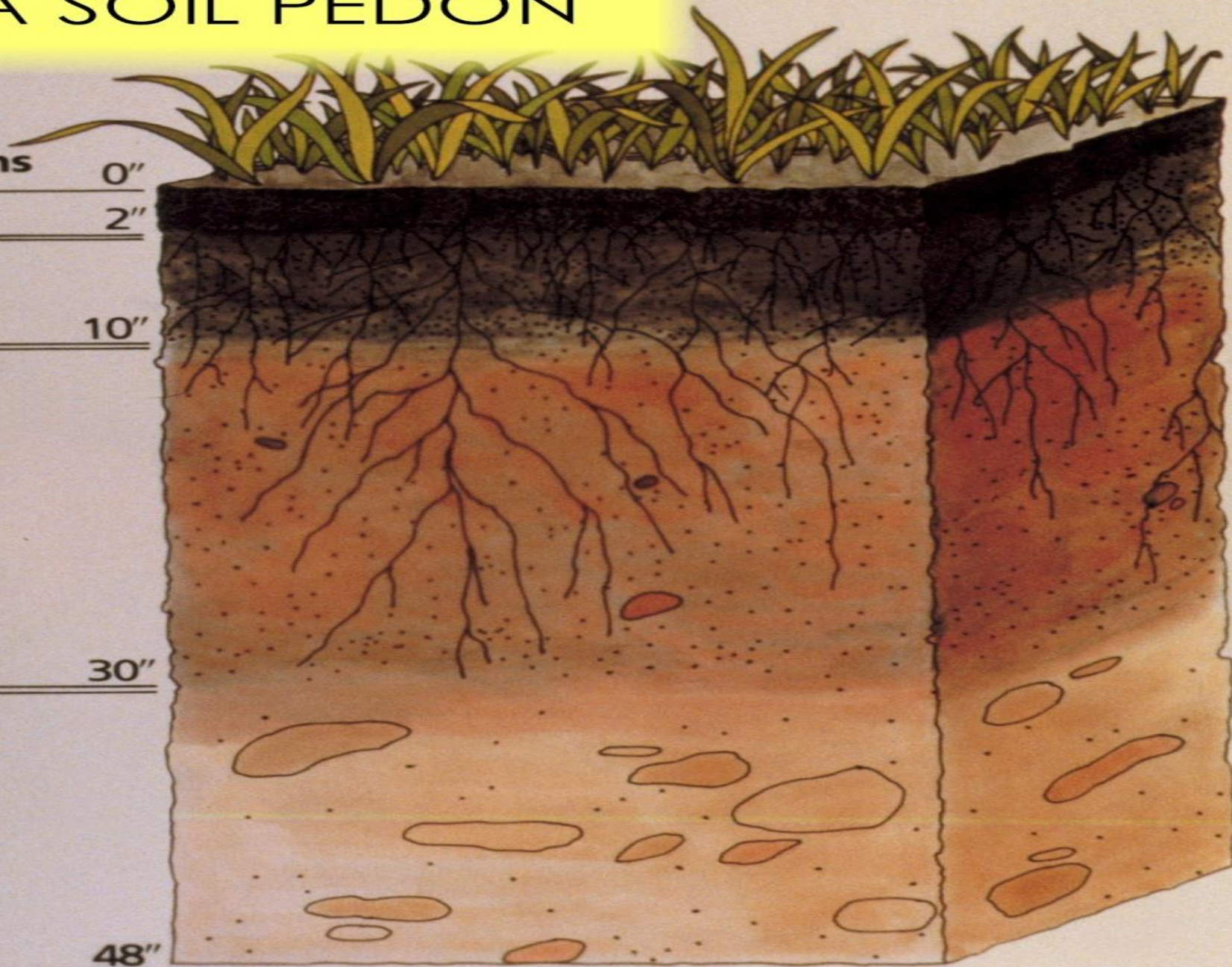
Horizons

O { 0" - 2"

A { 2" - 10"

B { 10" - 30"

C { 30" - 48"



SOIL FORMATION

Soil layers are approximately parallel to the land surface and several layers may evolve simultaneously over a period of time.

The layers in a soil are genetically related; however, the layers differ from each other in their physical, chemical, and biological properties.

In soil terminology, the layers are called **horizons**. Because soils as natural bodies are characterized by genetically developed horizons, soil formation consists of the evolution of soil horizons.

Soil formation is a slow and complex process

Parent material = The base geologic material of soil , Lava, volcanic ash, rock, dunes

Bedrock = Solid rock comprising the Earth's crust

Weathering = Processes that form soil

Physical (mechanical) = Wind and rain; no chemical changes in the parent material

Chemical = Substances chemically interact with (PM) (chemically changed)

Biological = Organisms break down (PM) and produce soil through physical or chemical means

Humus = Spongy, fertile material formed by partial decomposition of organic matter

Weathering produces soil



Parent material
(rock)

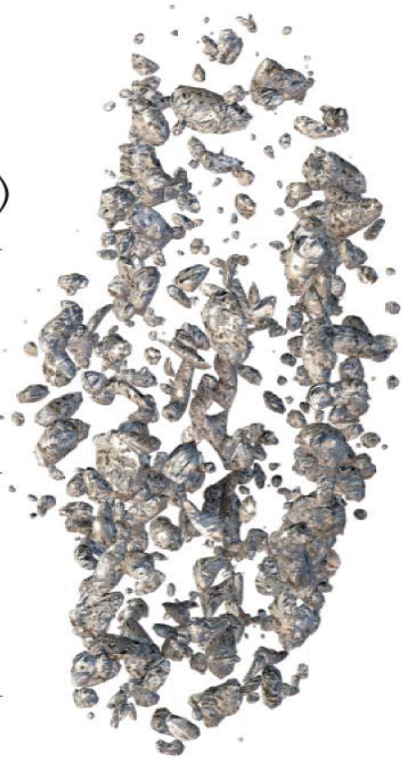
Physical weathering
(wind, rain, thermal expansion
and contraction, water freezing)



Chemical weathering
(water and gases)



Biological weathering
(tree roots and lichens)



Smaller particles
of parent material

Key processes in soil formation

Key processes in forming soil: weathering and the accumulation of parent materials and transformation of organic matter.

They are influenced by the following factors:

Climate (C) : soils form faster in warm, wet climates

Organisms (O) : plants and decomposers add organic matter

Topography (R): hills and valleys affect exposure to sun, wind, and water.

Parent material (P): influences properties of resulting soil

Time (T): soil can take decades to millennia to form.

$$S = F (C, O, R, P, T..)$$

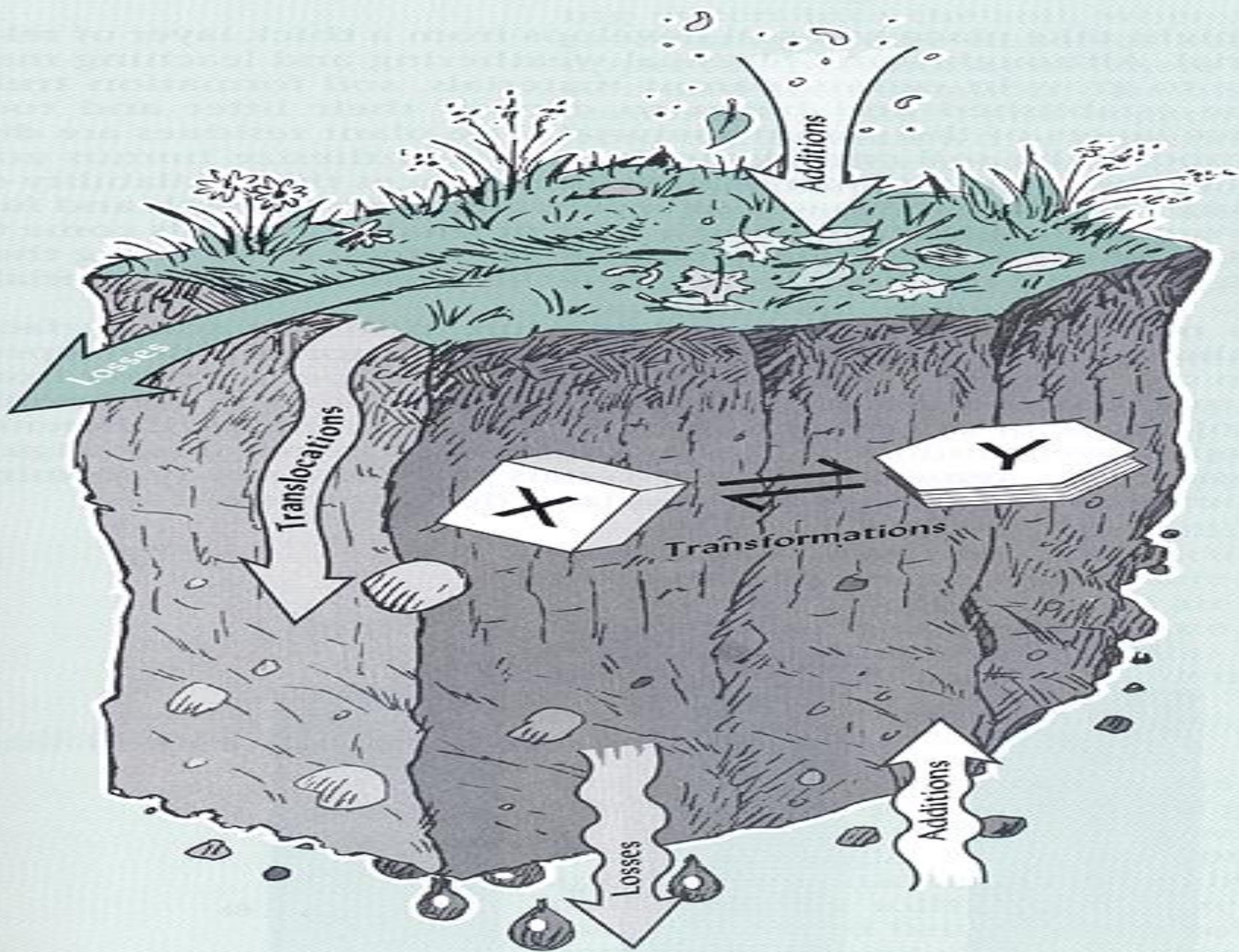
Soil forming processes

1- Addition.

2- Losses.

3- Transformation.

4- Translocation.



Orders of Soil Taxonomy

- 1- Alfisols** high base saturation – areas with low rain fall, but wetter than deserts.
- 2- Andisols** volcanic ash affected
- 3-Aridosols** deserts
- 4- Entisols** “young” soils (floodplain ,mountains , desert, etc.)
- 5- Geisols** permafrost – affected soils
- 6- Histosols** Organic soils ,common in wet and cold areas (marshes ,muskeg, etc.)
- 7-Inceptisols** Fairly “young” soils – soil development more advanced than Entisols
- 8-Molisols** thick ,dark surface - humid and sub-humid grasslands(corn belt)
- 9- Oxisols** very low fertility ,very “old” soils -humid tropics
- 10-Spodosols** humid temperature woodlands, acidic
- 11-Ultisols** low base saturation – humid warm – temperature, sub- tropics and tropics
low fertility , acidic.
- 12-Vertisols**

Soil physics

- Soil physics is a branch of soil science which deals with the mechanical behavior (i.e. physical properties) of soils as well as mechanical processes that take place in and through the soil.
- One of the fundamental subject of soil science is soil physics which deals with the study of **mechanics**, **heat** ,optics as they related to soil.
- Soil physics is a branch of soil science dealing with the **state** and **movement of matter** and **transformation of energy** in the soil.

Soils are characterized in many ways

- Soils are classified by **Color**, Texture, **Structure**, and **pH**
- Soil color = indicates its composition and fertility
 - **Black** or dark brown = rich in organic matter
 - **Pale gray** or white = indicates leaching.
- Soil texture = determined by the size of particles
 - from smallest to largest: **clay, silt, sand**
 - **Loam** = soil with an even mixture of the three affects how easily air and water travel through the soil
 - Influences how easy soil is to cultivate

Soil Characterization

Soil can be characterized by color and several other traits

1. **Texture** (percentage of sand, silt, and clay).

2- Structure

3- Porosity

4- Cation exchange capacity

5- pH

6- Parent material.

7- Infiltration rate.

8- Nutrient concentrations.

Soil Texture

- Soil texture is the relative proportions of the various soil separates namely **sand**, **silt**, and **clay** in a given soil. Natural soils are the mixture of soil separates of infinite combinations.
- Therefore, it is necessary to have some limits of variations among the soil separates to group them into textural classes upon significant differences in physical properties of each textural class.
- So the proportion of each size group in a given soil can not be altered easily. That is why soil texture is considered as a basic property of a soil.

Soil texture classification

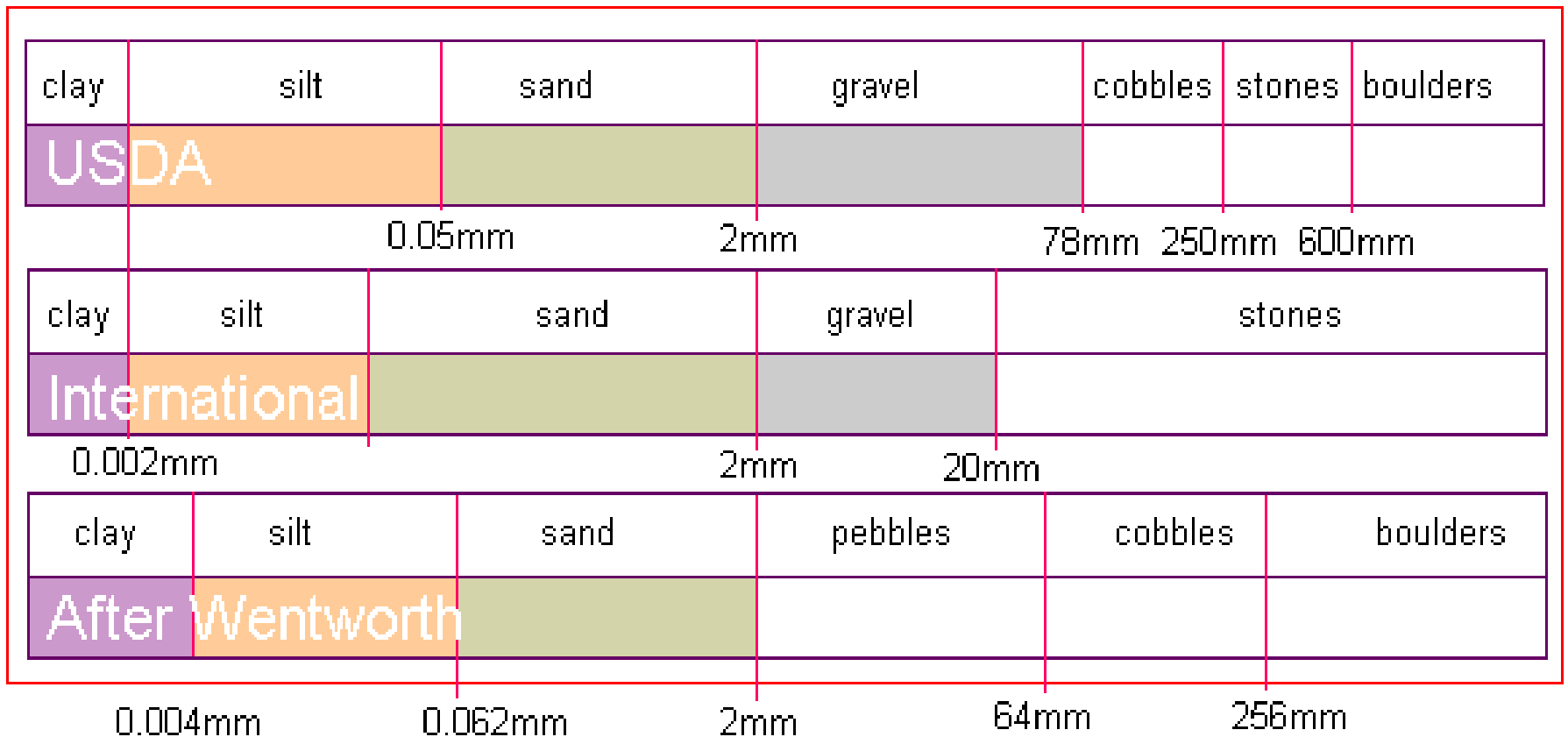
Silty soils with medium-size pores,

or

loamy soils with mixtures of pore sizes,

are

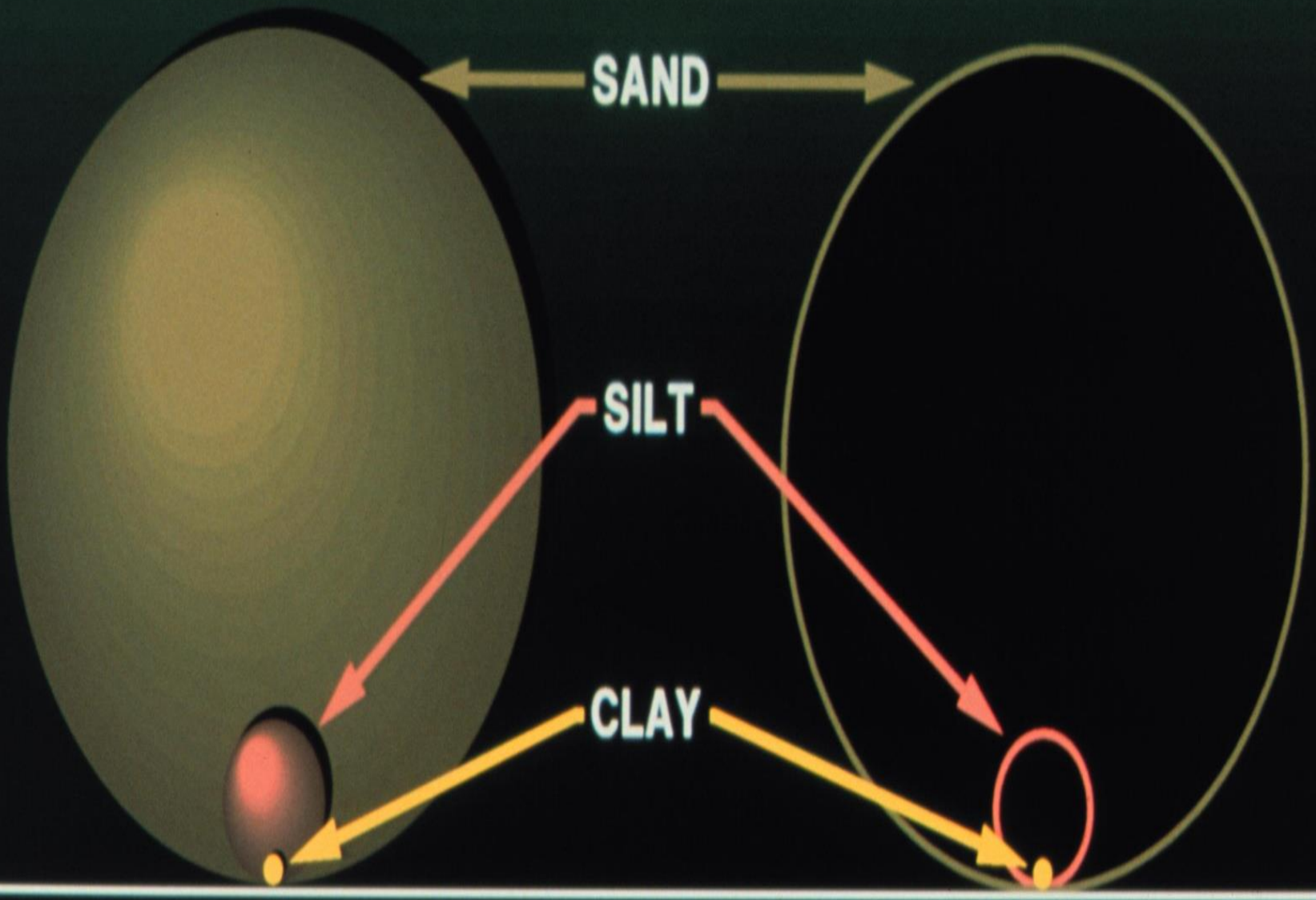
best for plant growth and agriculture.



Some commonly used soil particle size classification systems.

USDA: United States Department of Agriculture.

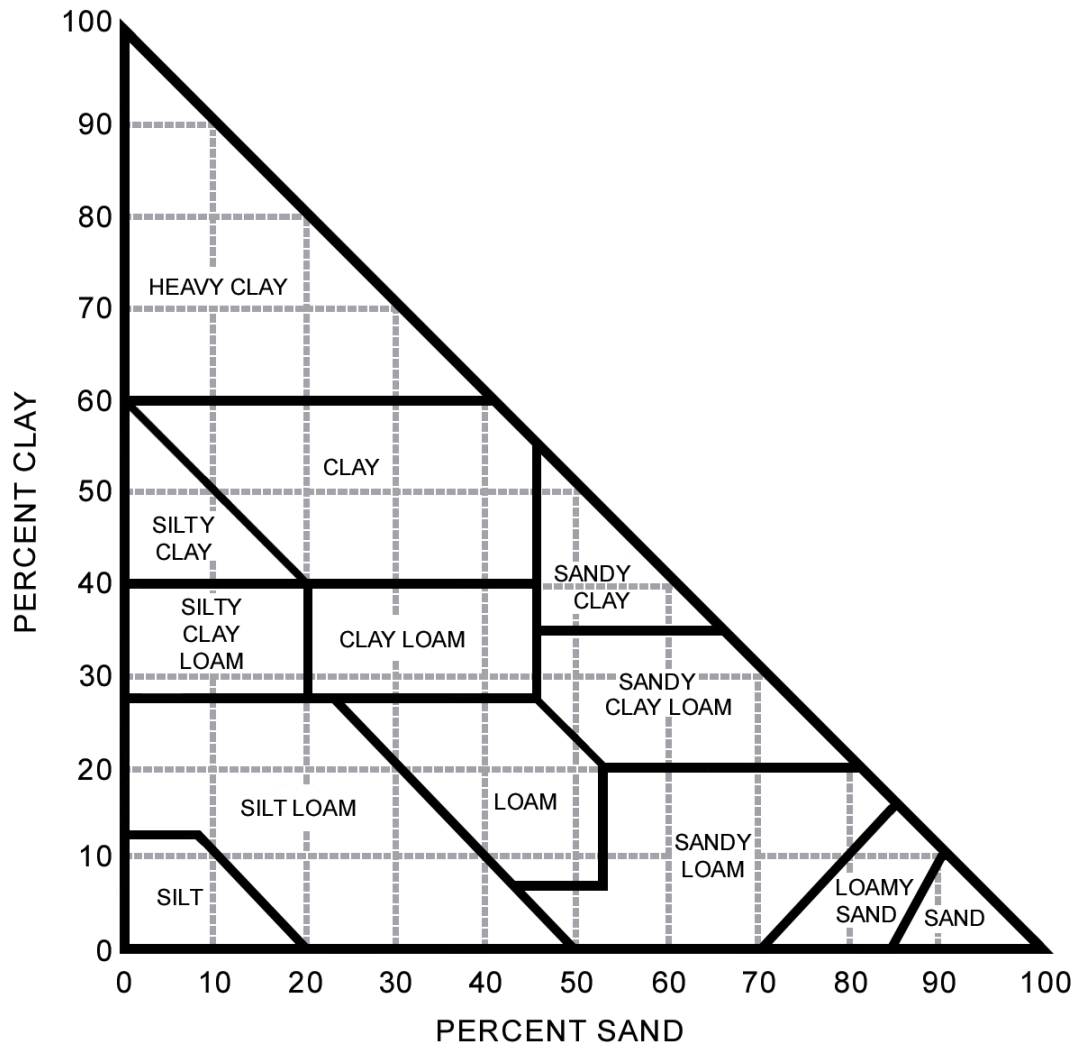
ISSS: International Society of Soil Science



SAND

SILT

CLAY



**Soil textural classes in the
Canadian System of Soil Classification**