Size of Pores

I. AERATION PORES

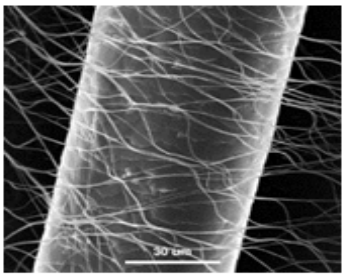
aeration pores
>60㎜ diameter
"macro-pores"

II.CAPILLARY PORES

1. available water pores
0.2 -- 60㎜ diameter
"meso-pores"

2. unavailable water pores
<0.2㎜ diameter
"micro-pores"

The average human hair is 0.1 millimeter wide



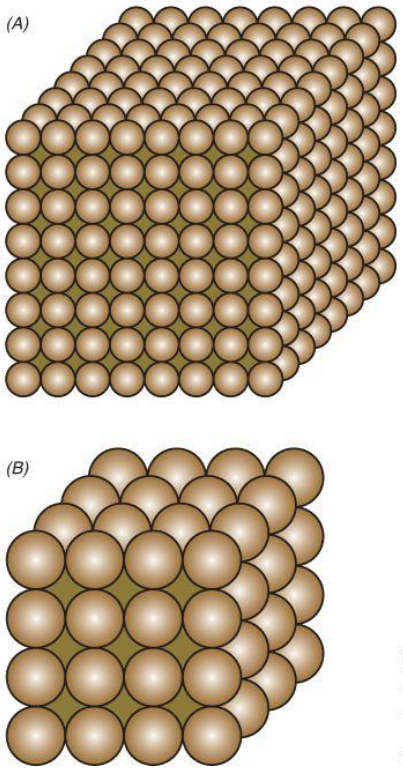
agresearch

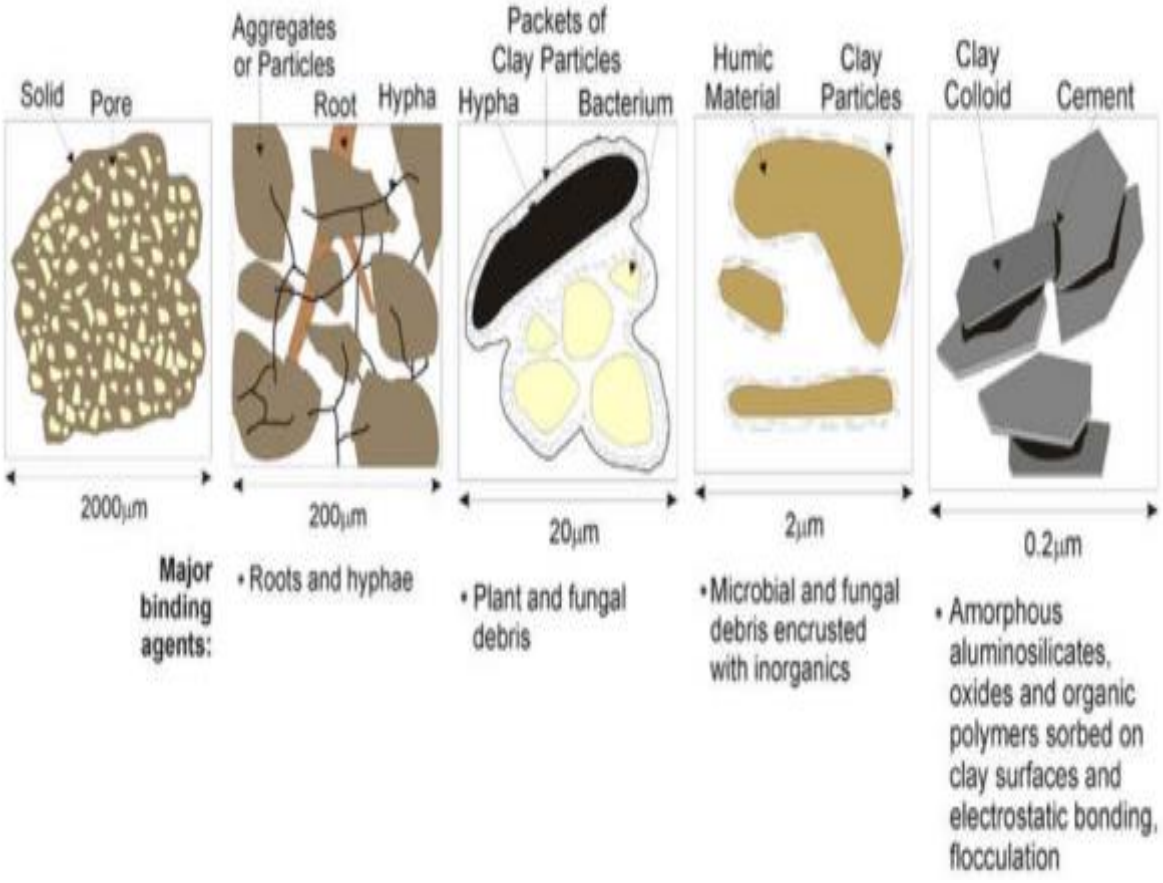
Soil pores

- Large pores (macro or transmission)
  - ⇨ Greater than 50 μm dia.
  - ⇨ Drain under gravity
- Storage pores
  - ⇨ 0.5 to 50 μm dia.
  - ⇨ Hold plant available water
- Residual pores (micro pores)
  - ⇨ Less than 0.5 μm dia.
  - ⇨ Hold unavailable water

Soil Pores

- Soil pore number and size depends on particle size
  - Macropores (aeration pores): large
  - Micropores: small
- (A) small particles create many small pores.
- (B) Pores are larger but fewer in number between large particles. Micropores usually hold water, macropores air.
- Sometimes the larger micropores are distinguished as *mesopores,* medium-sized pores that hold readily plant-available water





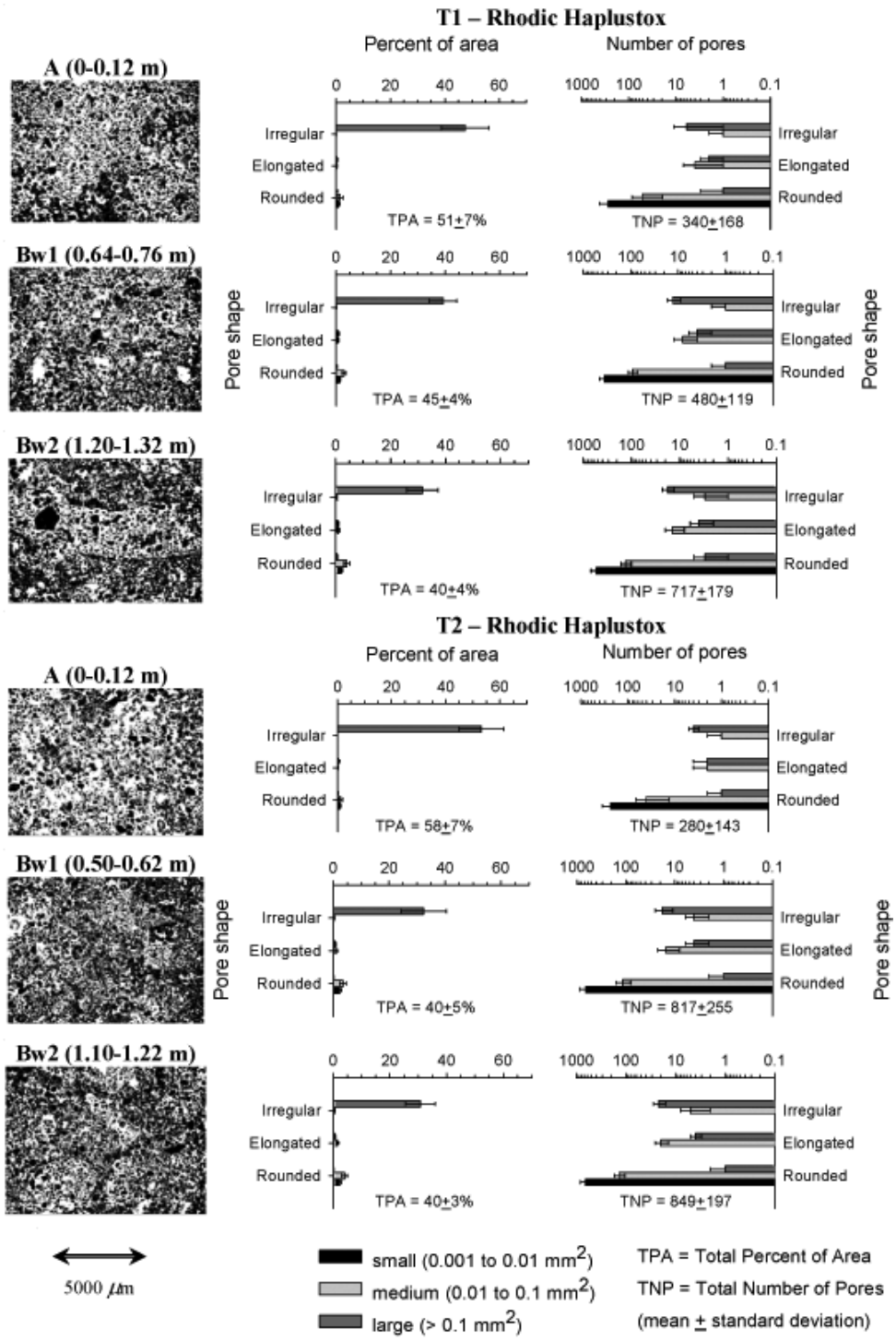
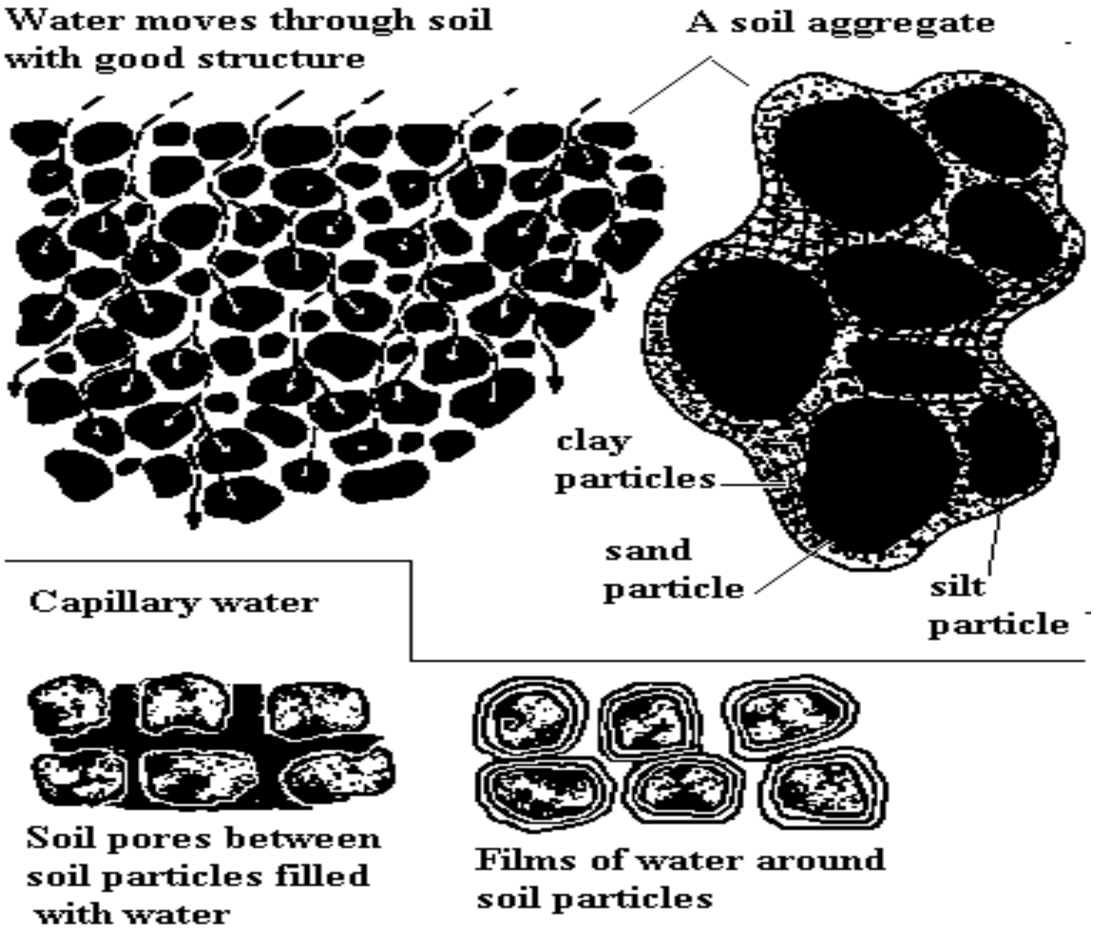


Figure 2 - Microstructure and soil pore distribution in the Rhodic Haplustoxs.

6.8.0


Water moves through soil with good structure
A soil aggregate
clay particles
sand particle
silt particle
Capillary water
Soil pores between soil particles filled with water
Films of water around soil particles

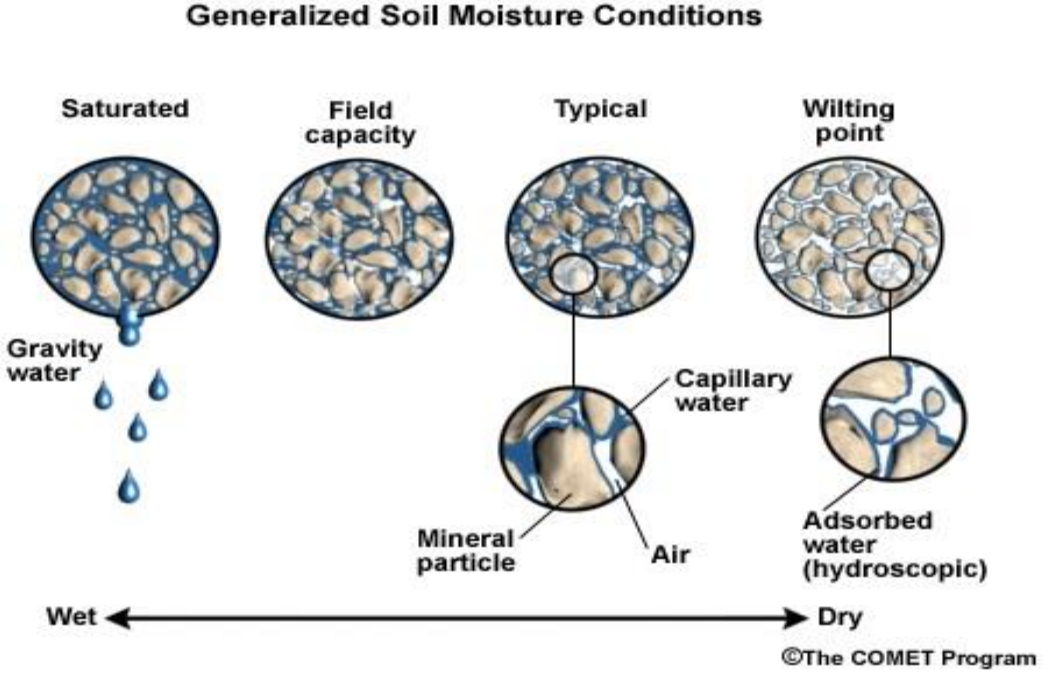
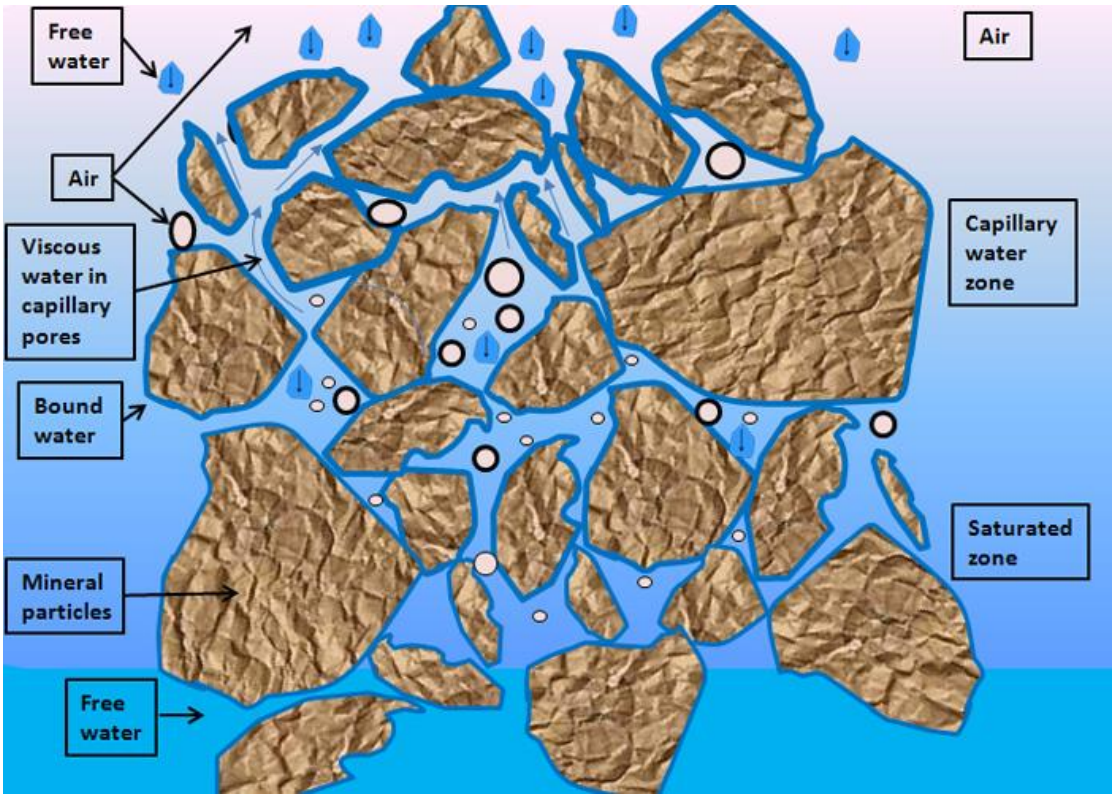
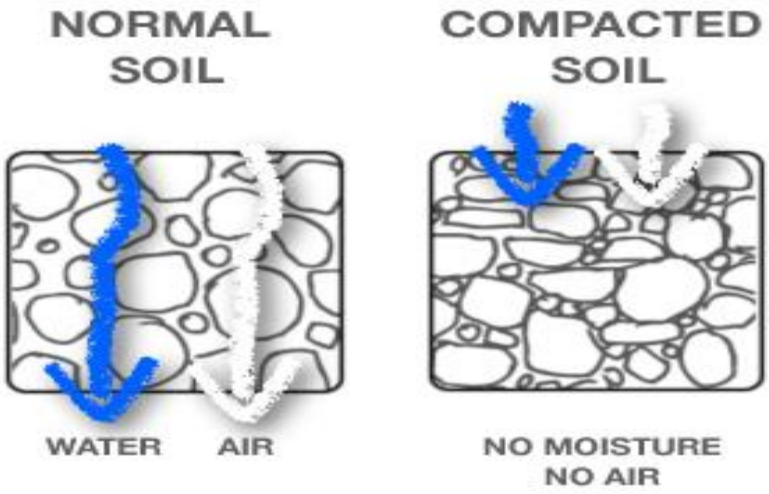

Generalized Soil Moisture Conditions
Saturated
Field capacity
Typical
Wilting point
Gravity water
Capillary water
Mineral particle
Air
Adsorbed water (hydroscopic)
Wet
Dry
©The COMET Program

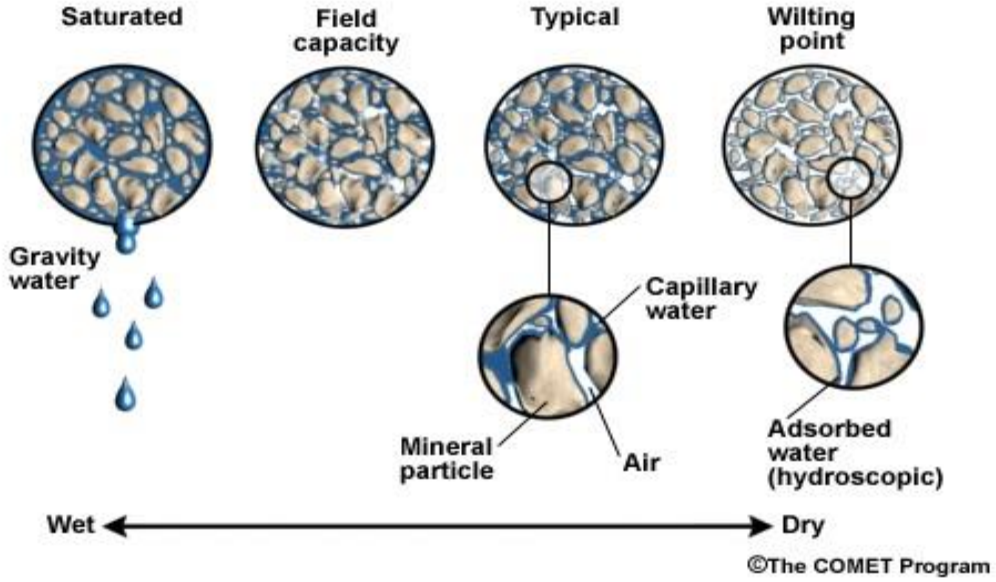
Table 3. Mean pore diameter (d*) for the dθ/dh maximum curve and difference in the area under the curve when compared with control (Δarea). C: non-irrigated control plot, STW: wastewater-irrigated plot and W: water-irrigated plot

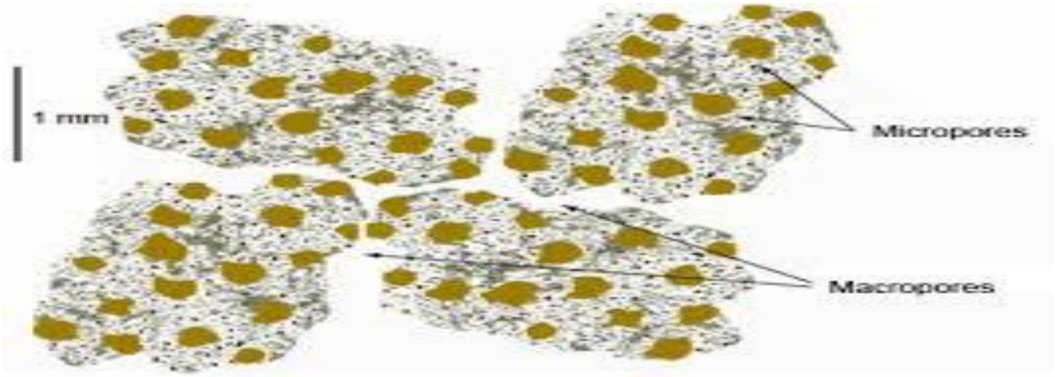
Depth	d*			Δarea	
	C	STW	W	STW	W
m	μm			%	
0.125	23	12	36	-33	-33
0.375	46	26	8	1	-8
0.625	46	73	36	11	-22
0.875	41	115	33	-6	-27
1.125	23	58	65	-4	5
1.375	16	16	102	-15	-1
1.625	41	51	73	-7	-4
1.875	46	26	65	-20	0
Mean value ± σ	35±12	47±35	52±30	-9	-11

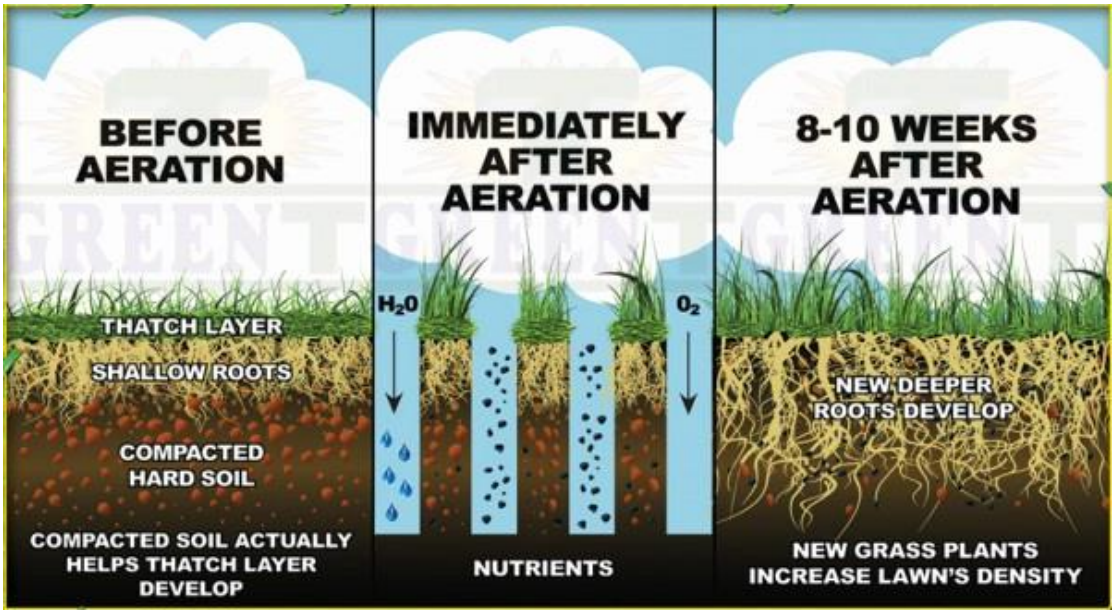


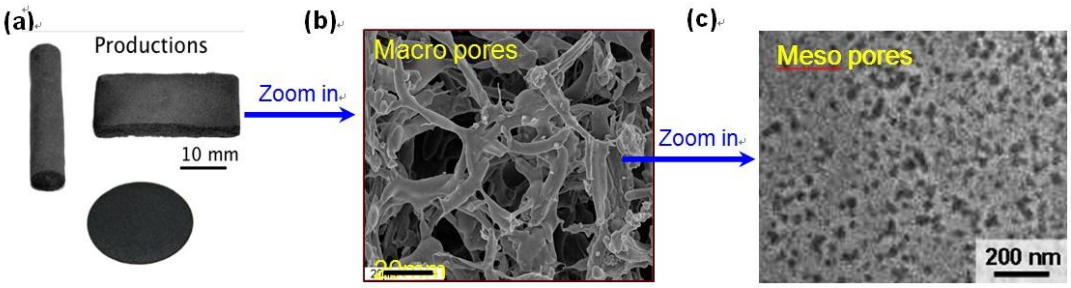


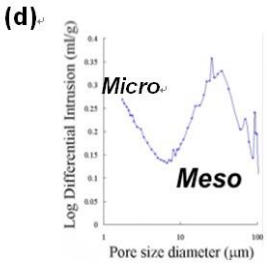
Generalized Soil Moisture Conditions

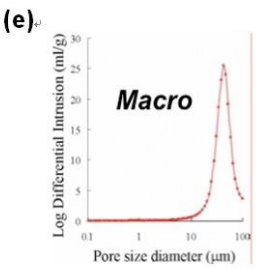




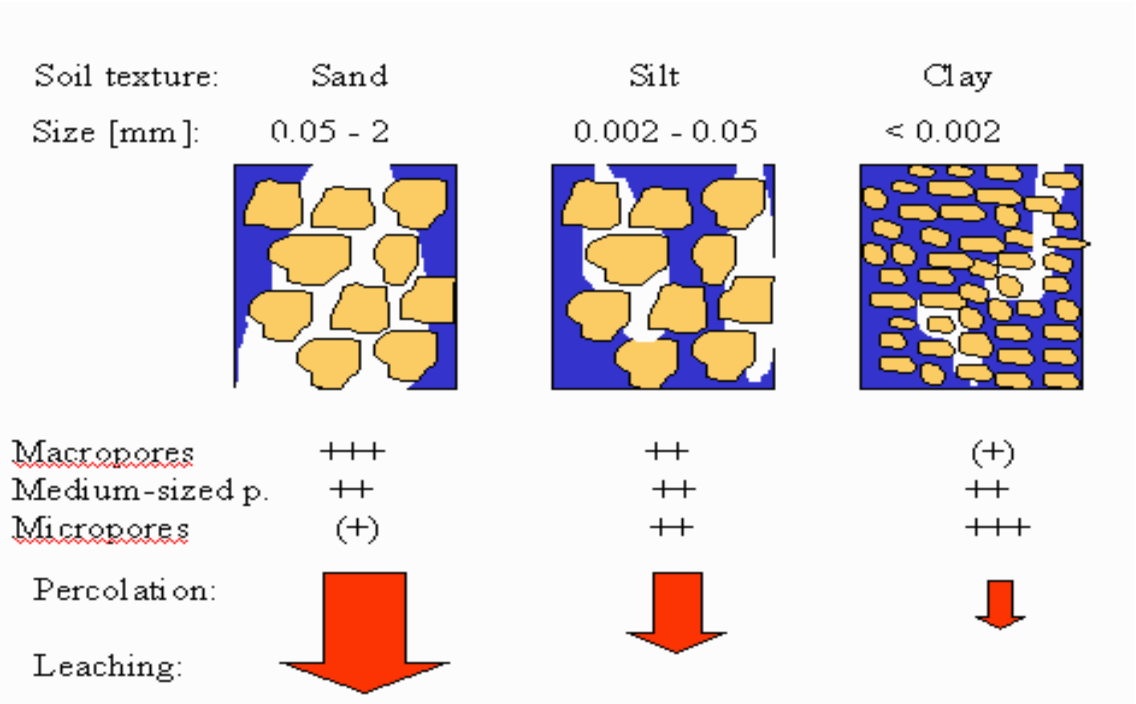






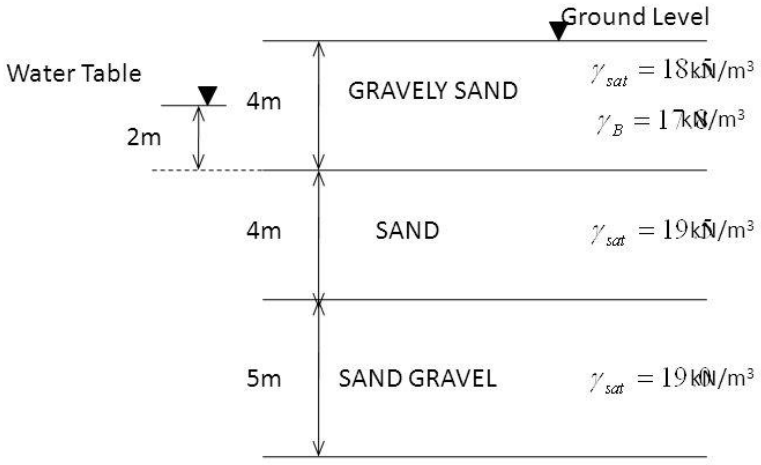


- Average pore diameters: >1 nm, 20 nm, and 30 μm
- Porosity: 98.5 - 99.1 %
- BET surface area: 700 m^2/g
- Structure: amorphous carbon
- Electric conductivity: 1.3 x 10^{-2} - 2.9 x $10^{-3}\Omega \cdot m$

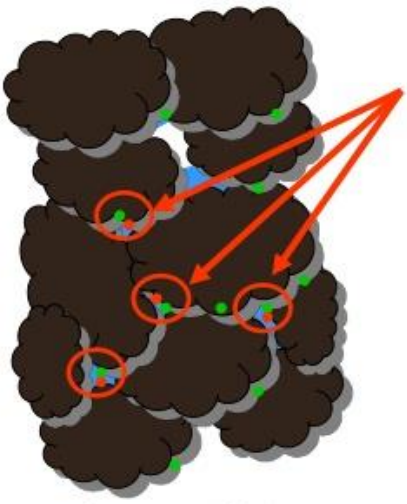


EXAMPLE 1

Plot the variation of total and effective vertical stresses, and pore water pressure with depth for the soil profile shown below

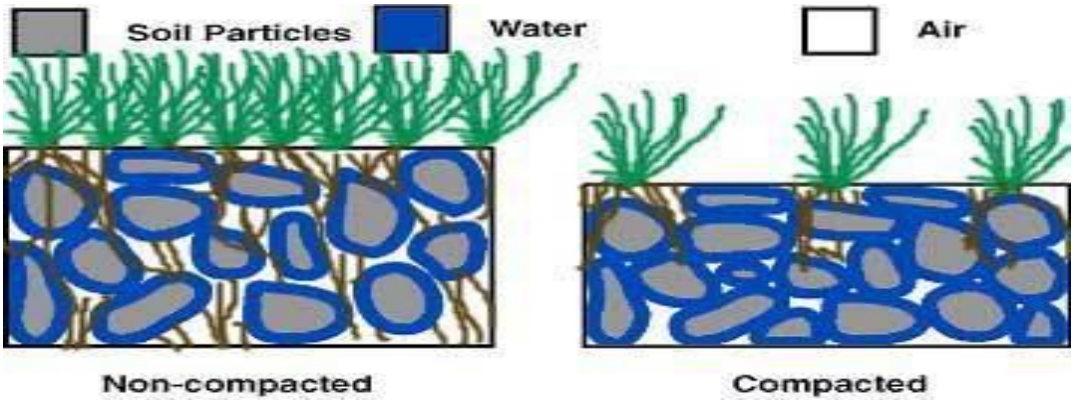


Microbial Degradation of Herbicides in Moist Soil



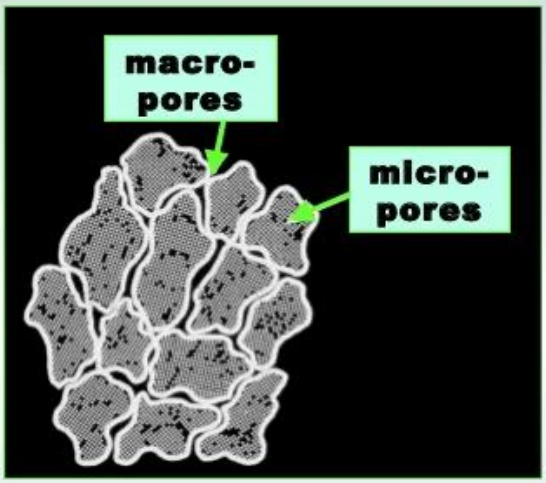
Saturated Soil

- Microbes must either ingest or be closely associated with herbicide molecules for herbicide degradation to occur
- Microbes are relatively large and require ample water and space to live
- Micropores filled with water best support microbial growth
- Herbicide molecules move from the water film on the soil colloid into the micropores as microbes degrade molecules in the micropores

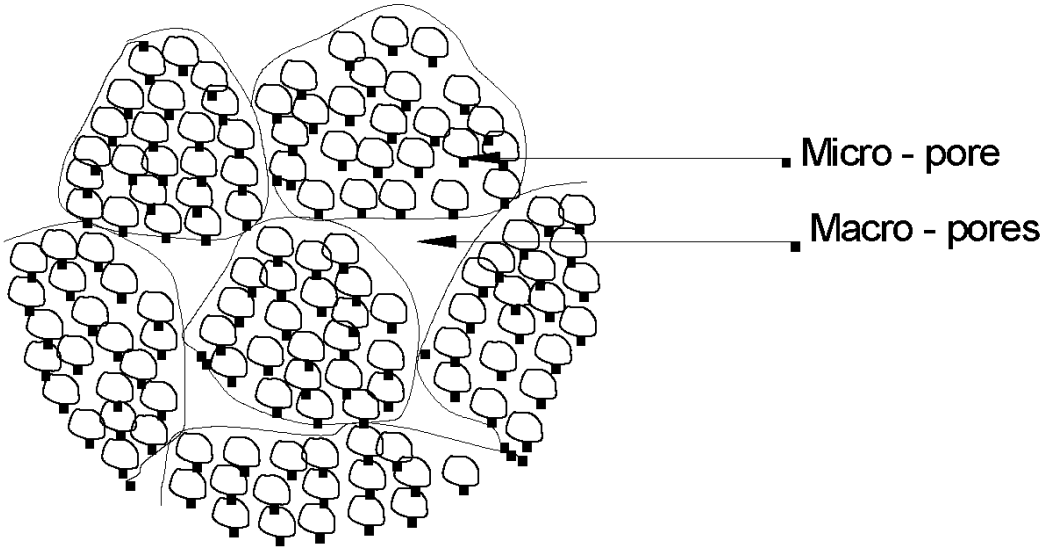


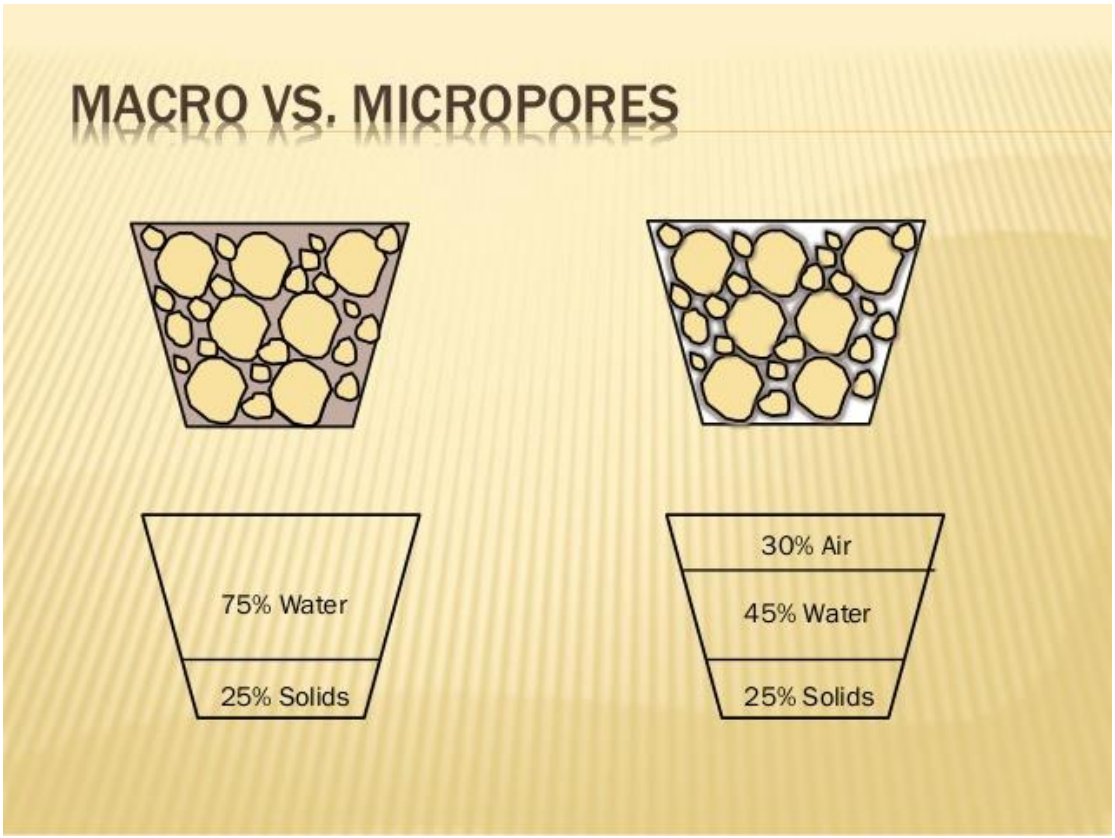
Soil porosity: Macropores and micropores

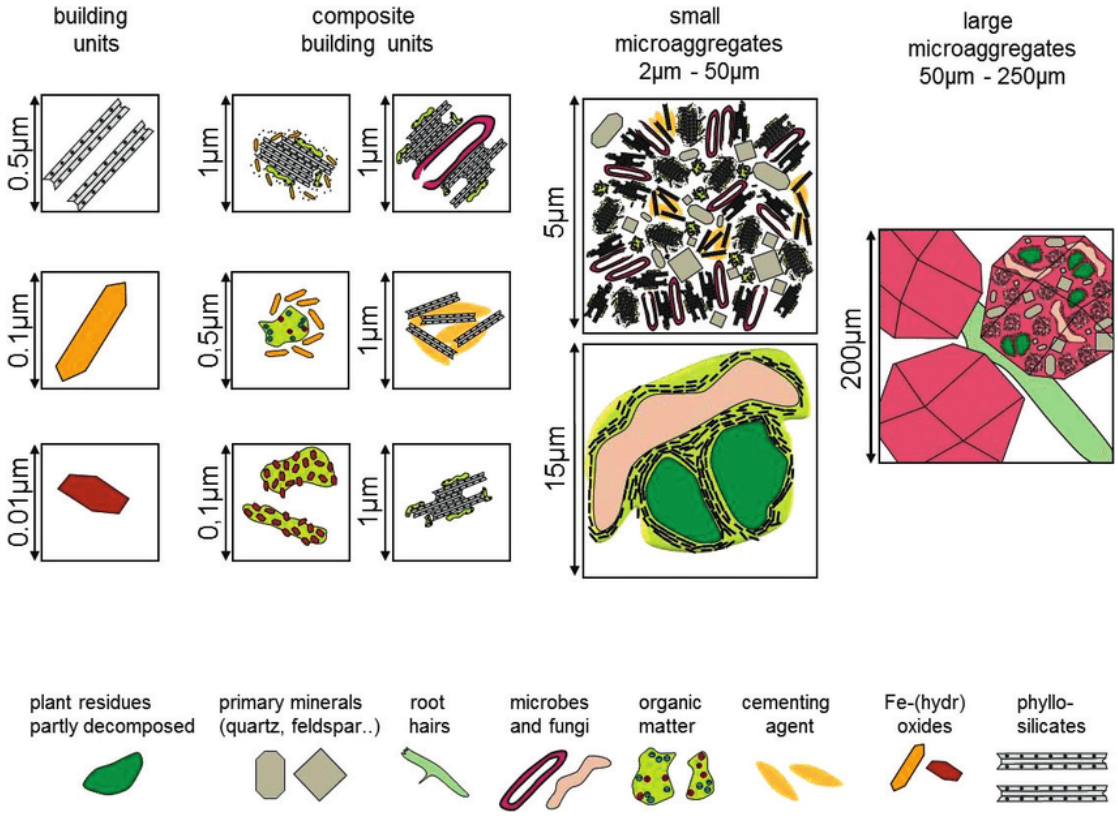
- The size of the individual pore spaces, rather than their combined volume, will have the most effect on air and water movement in soil.
- Pores smaller than about 0.05 mm (or finer than sand) in diameter are typically called *micropores*.
- Pores larger than 0.05 mm are called *macropores*.



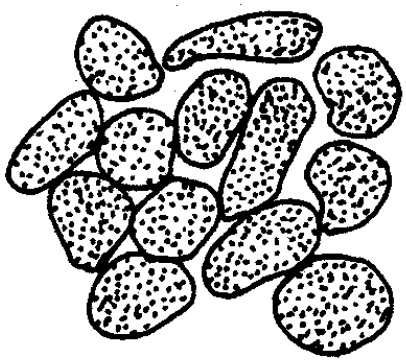
SOIL PORES



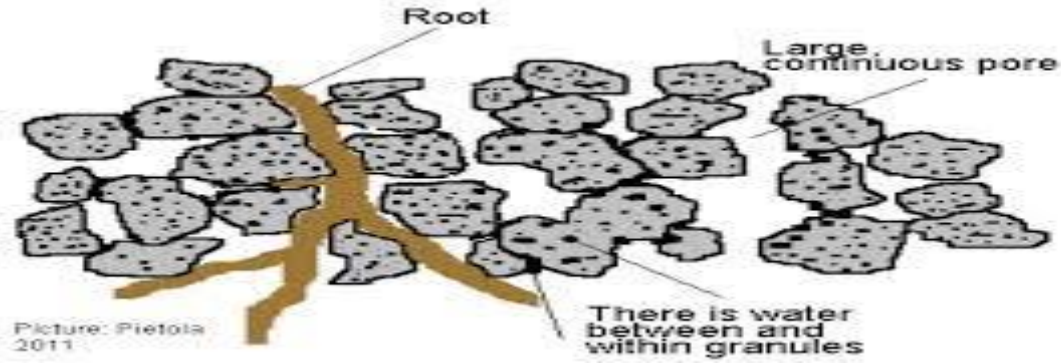

MACRO VS. MICROPORES
75% Water
25% Solids
30% Air
45% Water
25% Solids

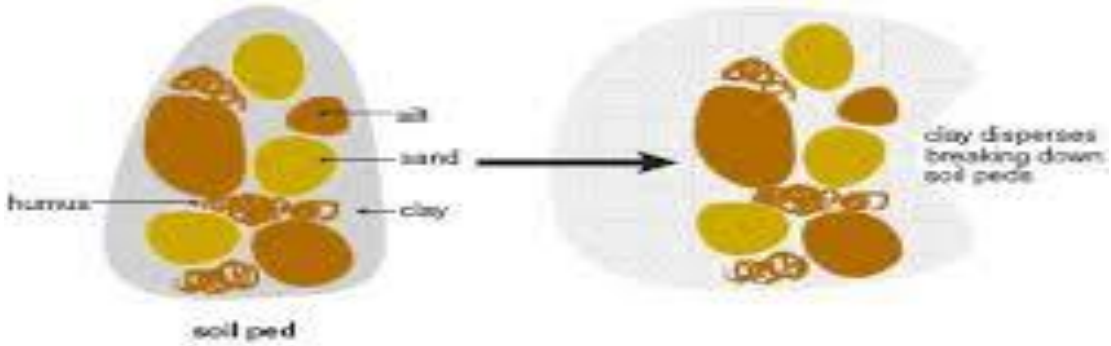

building units
composite building units
small microaggregates 2µm - 50µm
large microaggregates 50µm - 250µm
0.5µm
0.1µm
0.01µm
1µm
1µm
0,5µm
1µm
0,1µm
1µm
5µm
15µm
200µm
plant residues partly decomposed
primary minerals (quartz, feldspar..)
root hairs
microbes and fungi
organic matter
cementing agent
Fe-(hydr) oxides
phyllo-silicates

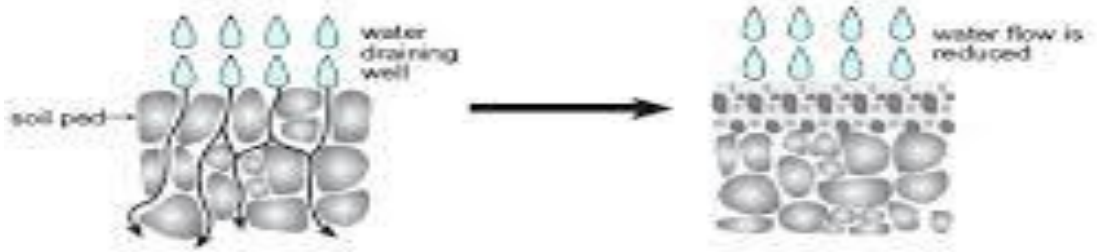
Clay

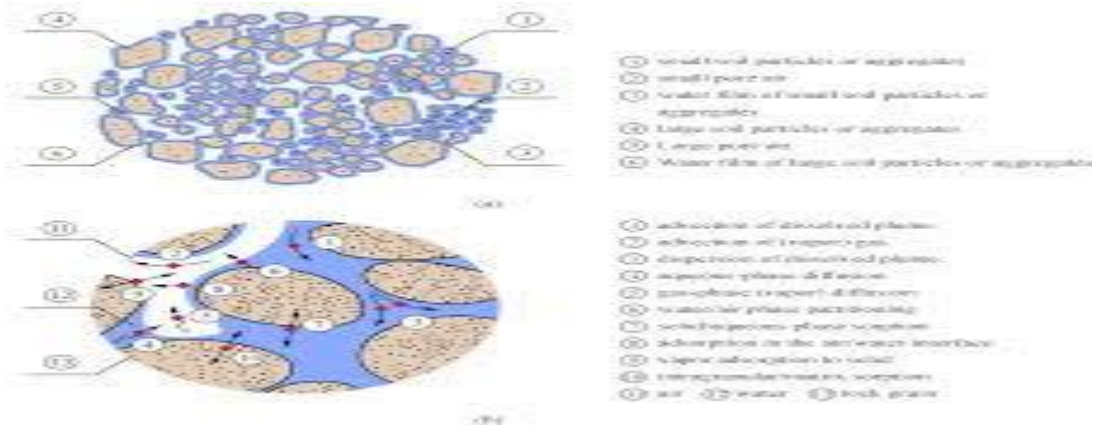


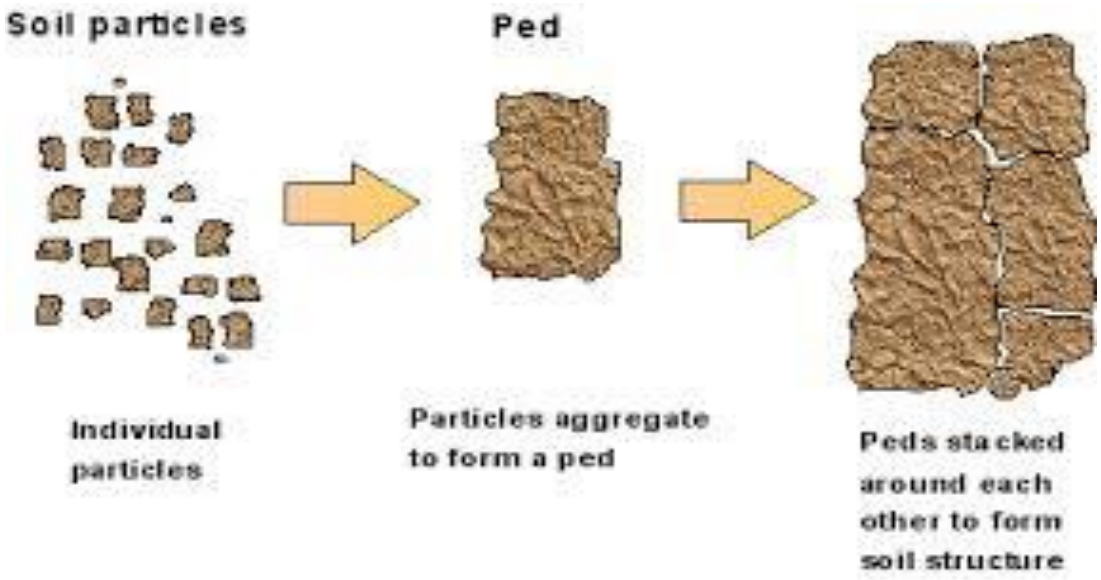
Sand

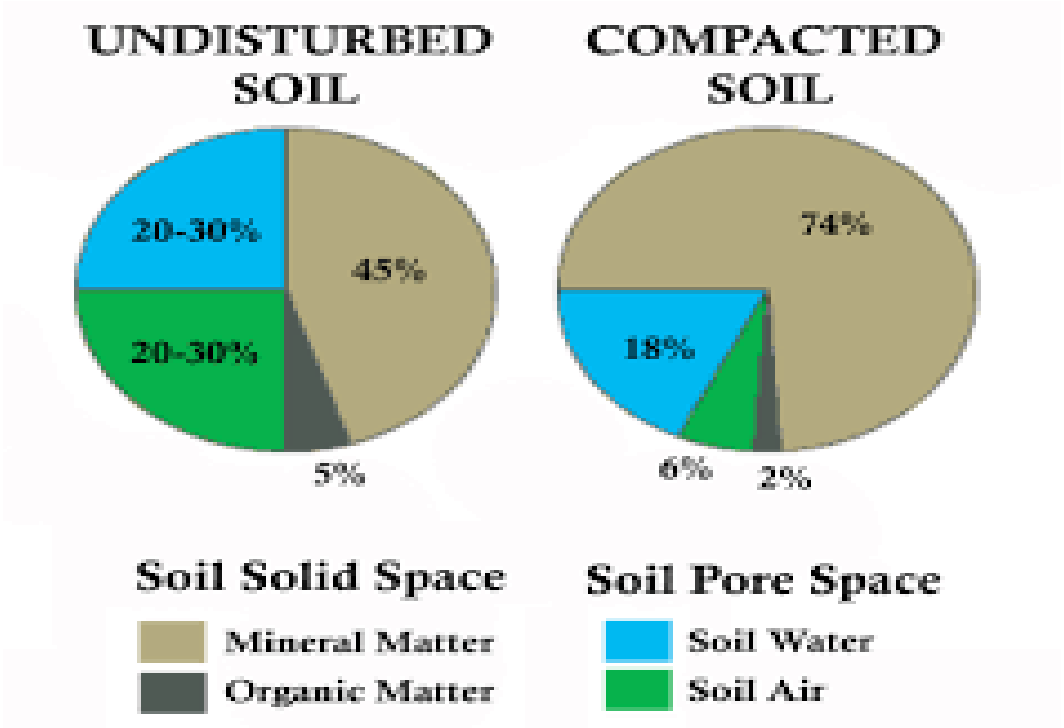

Root
Large, continuous pore
There is water between and within granules
Picture: Pietola 2011


silt
sand
humus
clay
clay disperses breaking down soil peds
soil ped


water draining well
soil ped
water flow is reduced




Soil particles
Ped
Individual particles
Particles aggregate to form a ped
Peds stacked around each other to form soil structure


UNDISTURBED SOIL
COMPACTED SOIL
20-30%
45%
20-30%
5%
74%
18%
6%
2%
Soil Solid Space
Mineral Matter
Organic Matter
Soil Pore Space
Soil Water
Soil Air

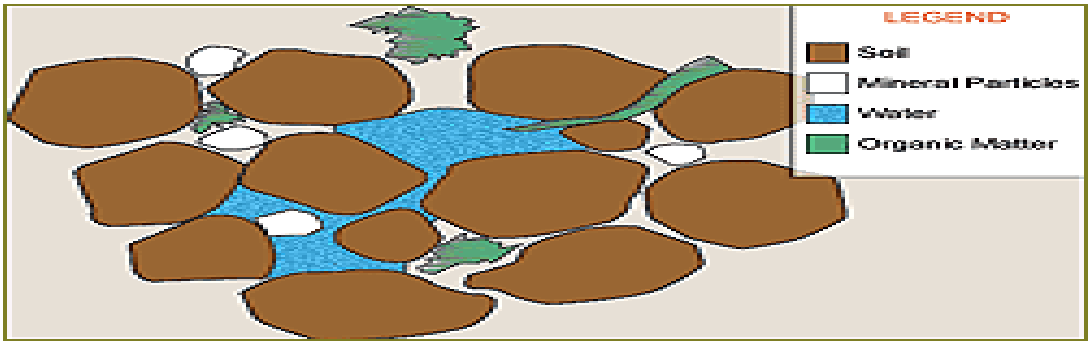
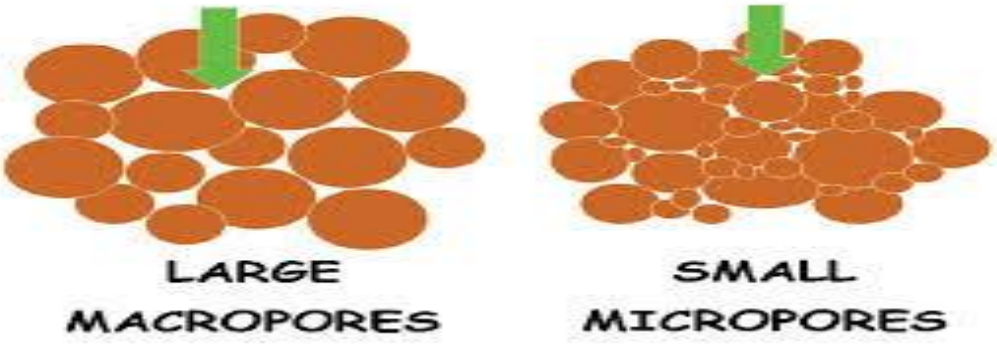
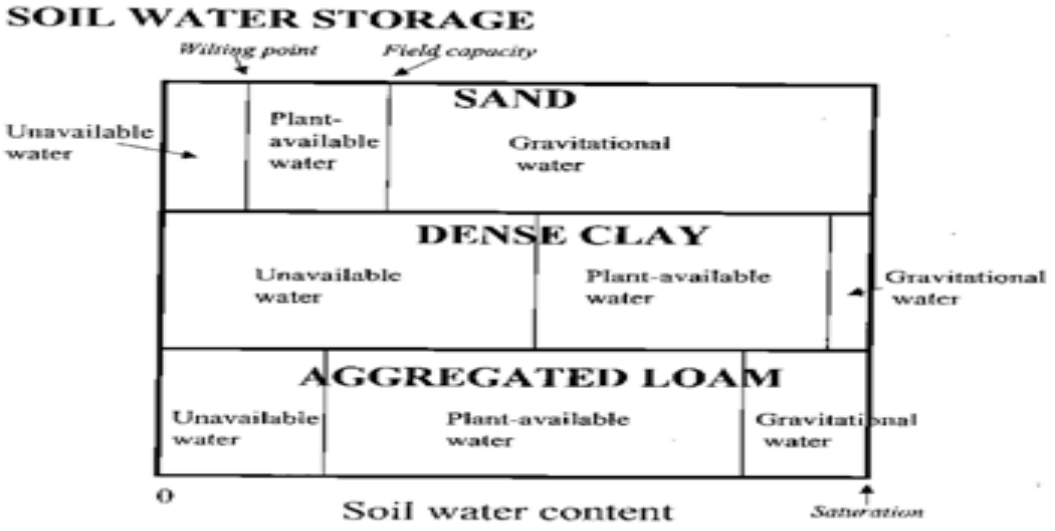


TABLE 2.8 : Effect of Continuous Cropping on Total Pore Spaces

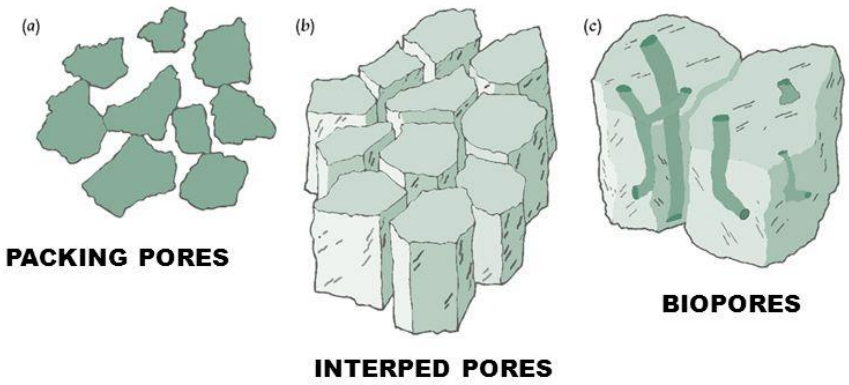
Soil treament	Organic matter (%)	Pore space		
		Total pore space (%)	Macro pore space (%)	Micro pore space (%)
Virgin spoil	5.6	58.3	32.7	25.6
Cultivated soil	2.9	50.2	16.0	34.2

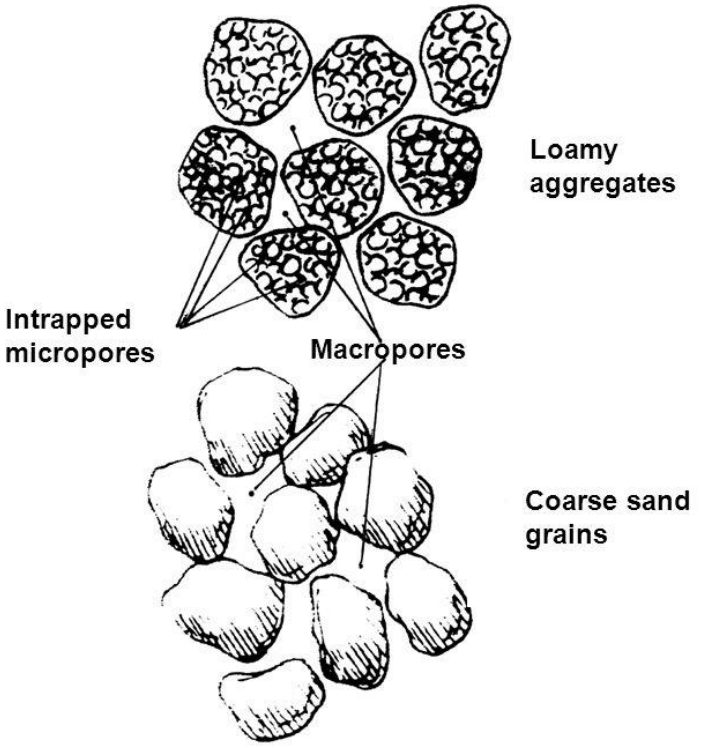


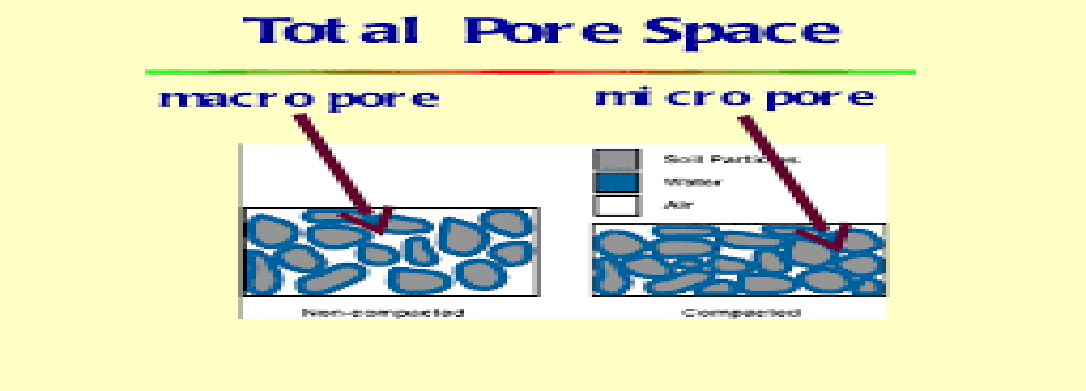


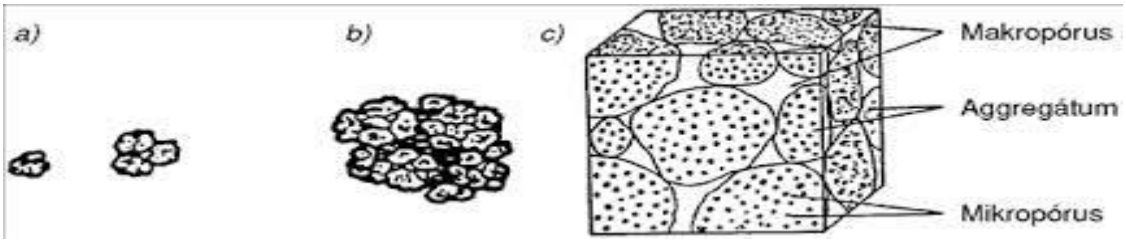
Pore Type and Shape

Packing pores (between primary soil particles)
Interped pores (shape depends on ped/granules)
Biopores (often long, narrow and branched; some are spherical)



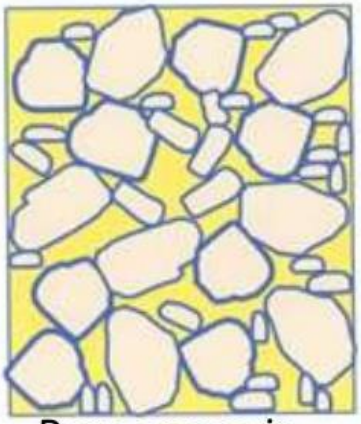




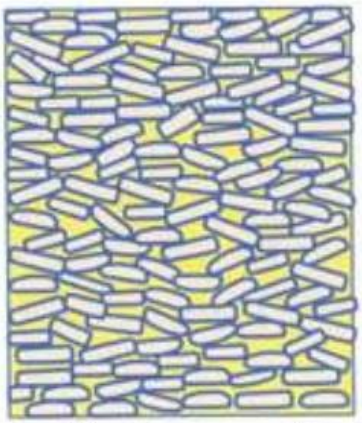


Which kind of soil would water drain through more quickly?

Which kind of soil would retain or hold more water?

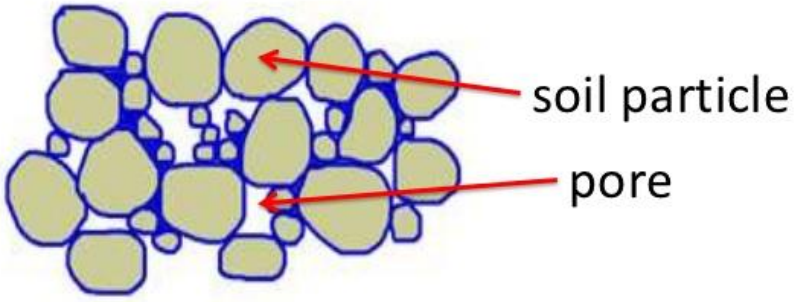


Pore space in sandy soils



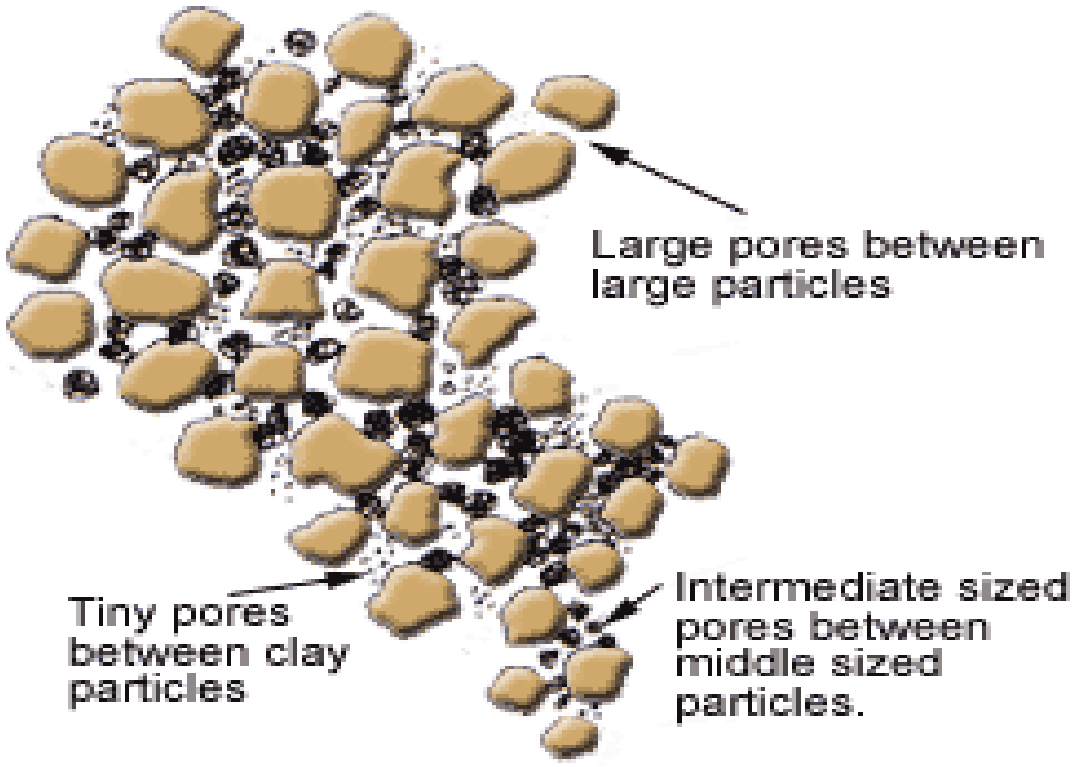
Pore space in clay soils

The size particles that make up each type of soil determines the size of the pores between the particles.



The pores in the soil hold air and water.

The larger the particles making up the soil, the larger the pores between them.



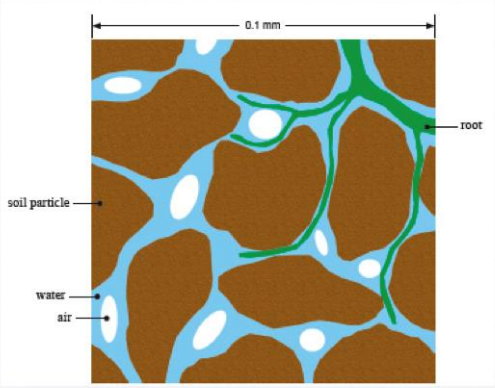
SOLIDS + PORE SPACE =

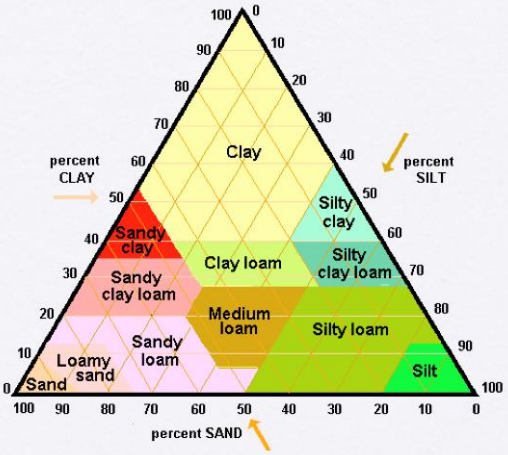
SOIL

Pore Space

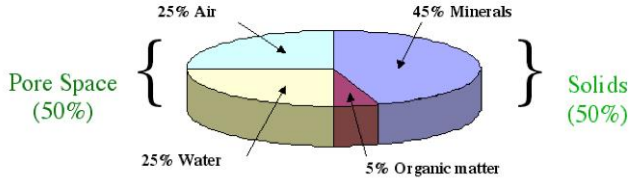
- Two kinds:
  - Macro pore space → air
  - Micro pore space → water

Soil Aggregation

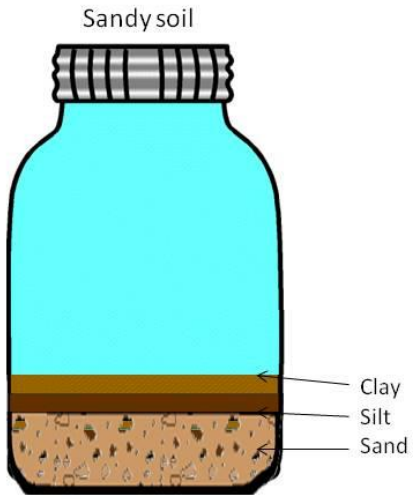




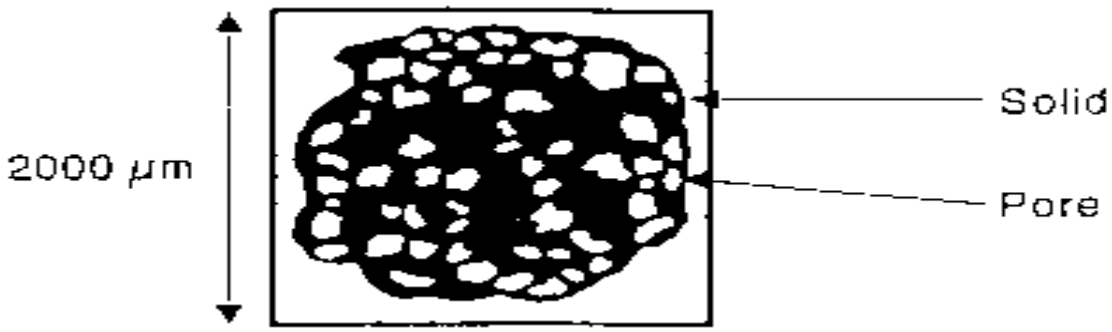
Increased Soil Pore Space!

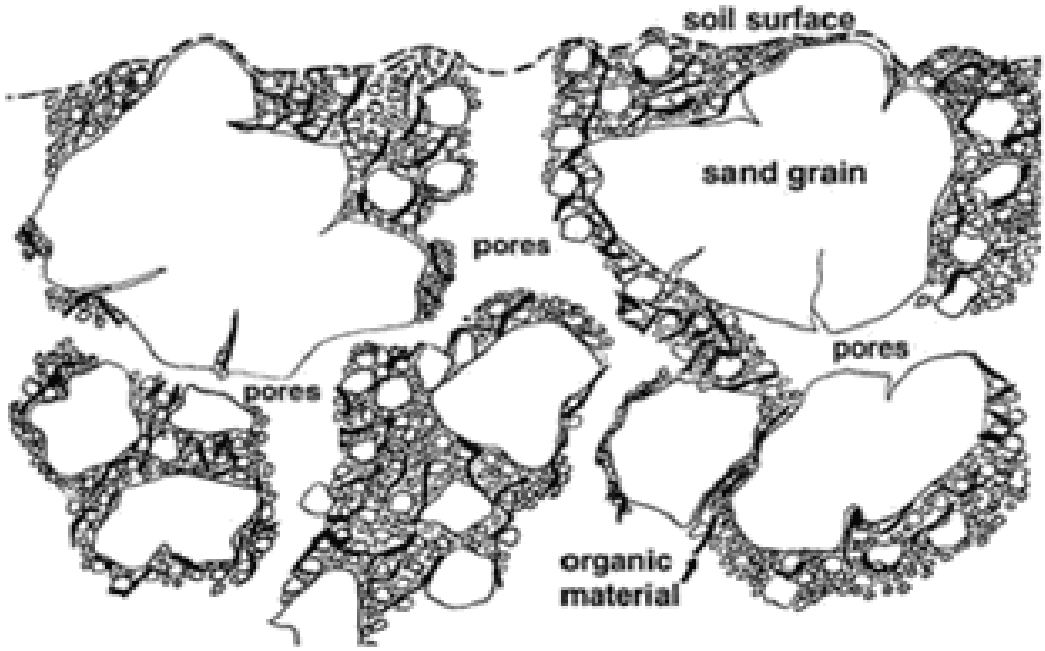


Soil Texture & Soil Structure



- **Soil Texture**
  - Sandy Soils
  - Silty soils
  - Clay soils
  - Loam
  - How to test your soil
- **Soil Structure**
  - What is soil structure?
  - Creating & maintaining an ideal soil structure.
  - How to test your soil

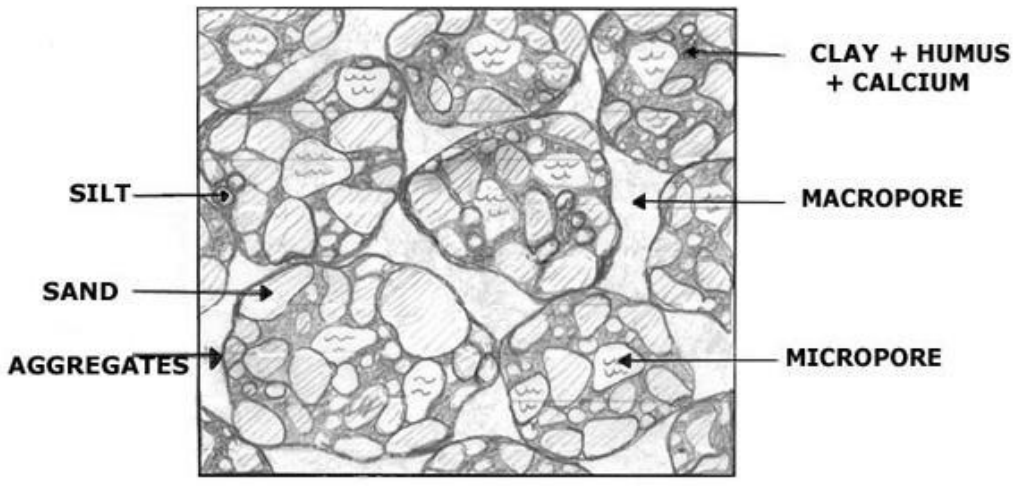

2000 μm
Solid
Pore


soil surface
sand grain
pores
pores
pores
organic material

Porosity

- *Soil porosity* is the percentage of a soil that is pore space or voids.
- The average soil has a porosity of about 50%, and the pores are filled with air or water depending on the moisture content.
- Sands have larger pores, but less <u>total</u> pore space than clays.
- If both bulk density and particle density are known, the total porosity can be calculated using these values.

$$\% \text{ Porosity} = \left(1 - \frac{\text{Bulk Density (BD)}}{\text{Particle Density (PD)}} \right) \times 100$$



Soil porosity: Macropores and micropores

❖***Macropores*** **allow the ready movement of air, roots, and percolating water.**

- **Movement of air and water through a coarse-textured sandy soil is often rapid despite its low total porosity because of the dominance of *macropores.***

❖***Micropores*** **in moist soils are typically filled with water, and this does not permit much air movement into or out of the soil.**

- **Movement of air and water through a fine textured clay soil may be slow (see picture at right) despite high total porosity because of the dominance of *micropores.***

Jim Baker, Virginia Tech

Soil Pores

- Soil pore number and size depends on particle size
  - Macropores (aeration pores): large
  - Micropores: small
- (A) small particles create many small pores.
- (B) Pores are larger but fewer in number between large particles. Micropores usually hold water, macropores air.
- Sometimes the larger micropores are distinguished as *mesopores,* medium-sized pores that hold readily plant-available water