

Soil Texture and Structure

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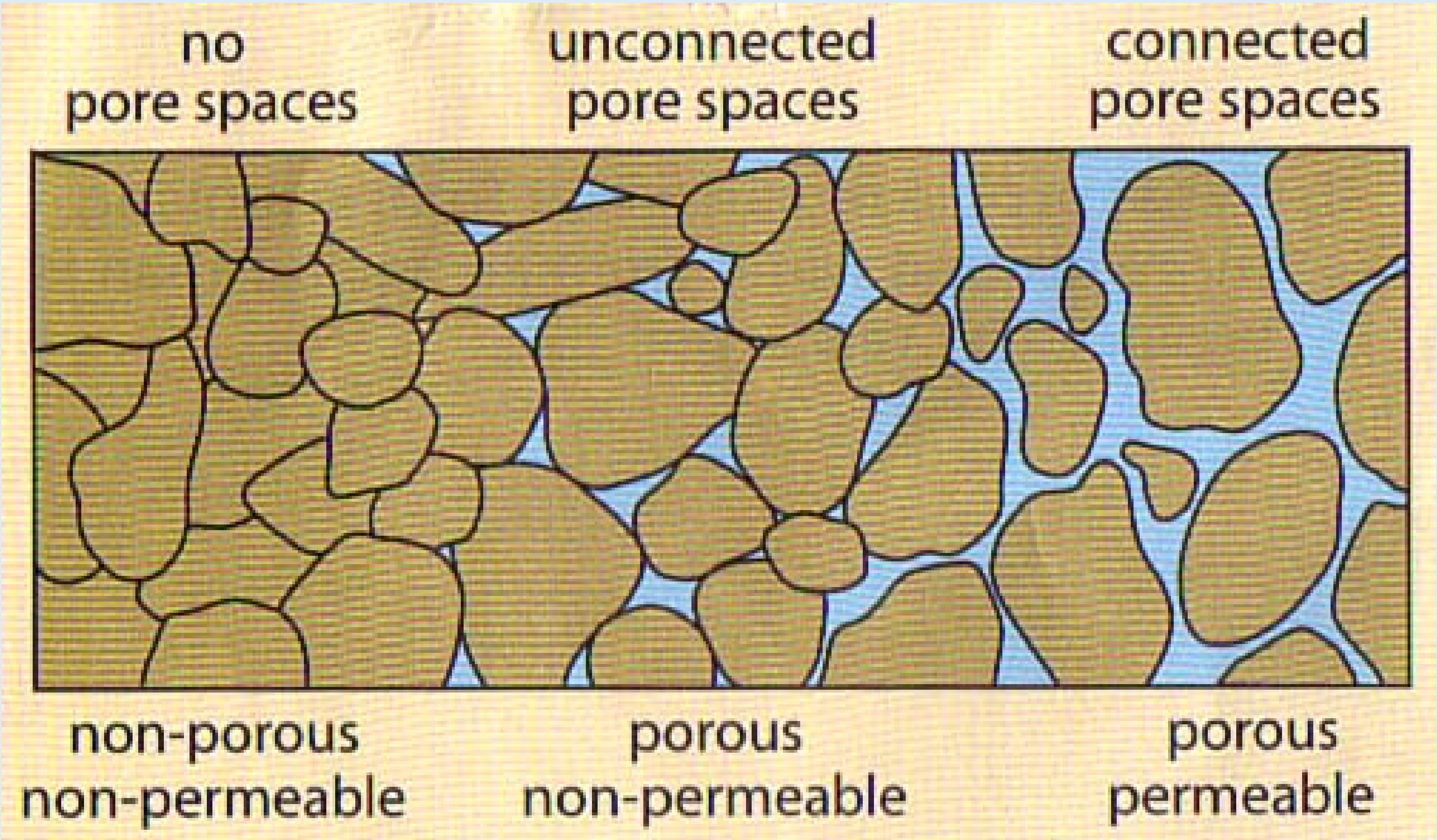
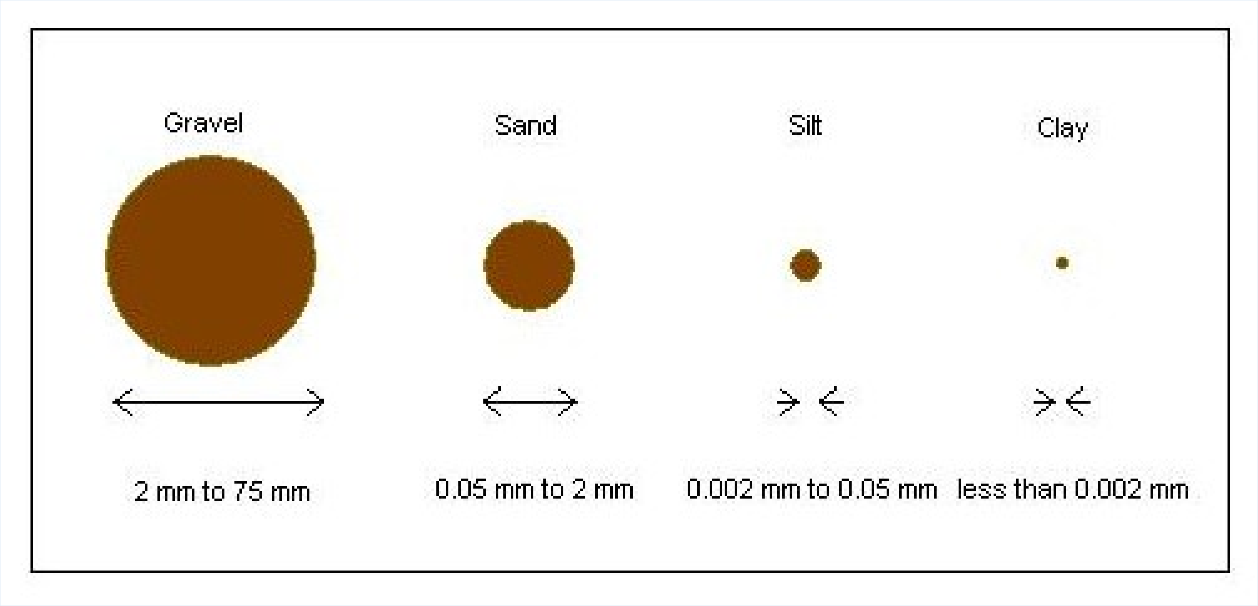
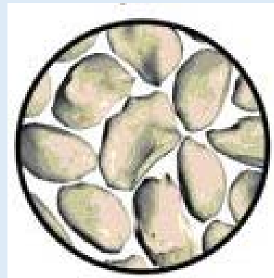
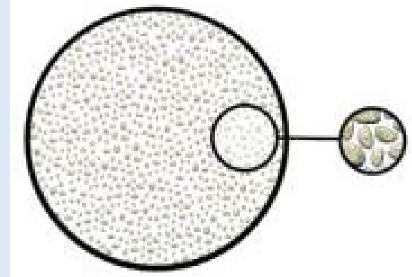
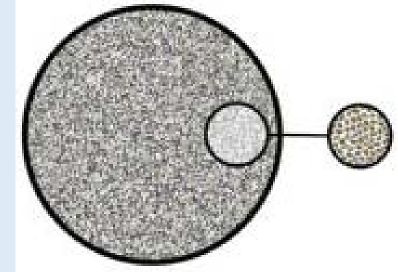

no
pore spaces
unconnected
pore spaces
connected
pore spaces
non-porous
non-permeable
porous
non-permeable
porous
permeable

Soil Mineral Particles

- Mineral Separates
  - Coarse Fraction (Rock Fragments): >2.0 mm diameter
  - Fine Earth Fraction: <2.0 mm diameter
    - Sand: 2.0 – 0.05 mm diameter
    - Silt: 0.5 – 0.002 mm diameter
    - Clay: <0.002 mm diameter



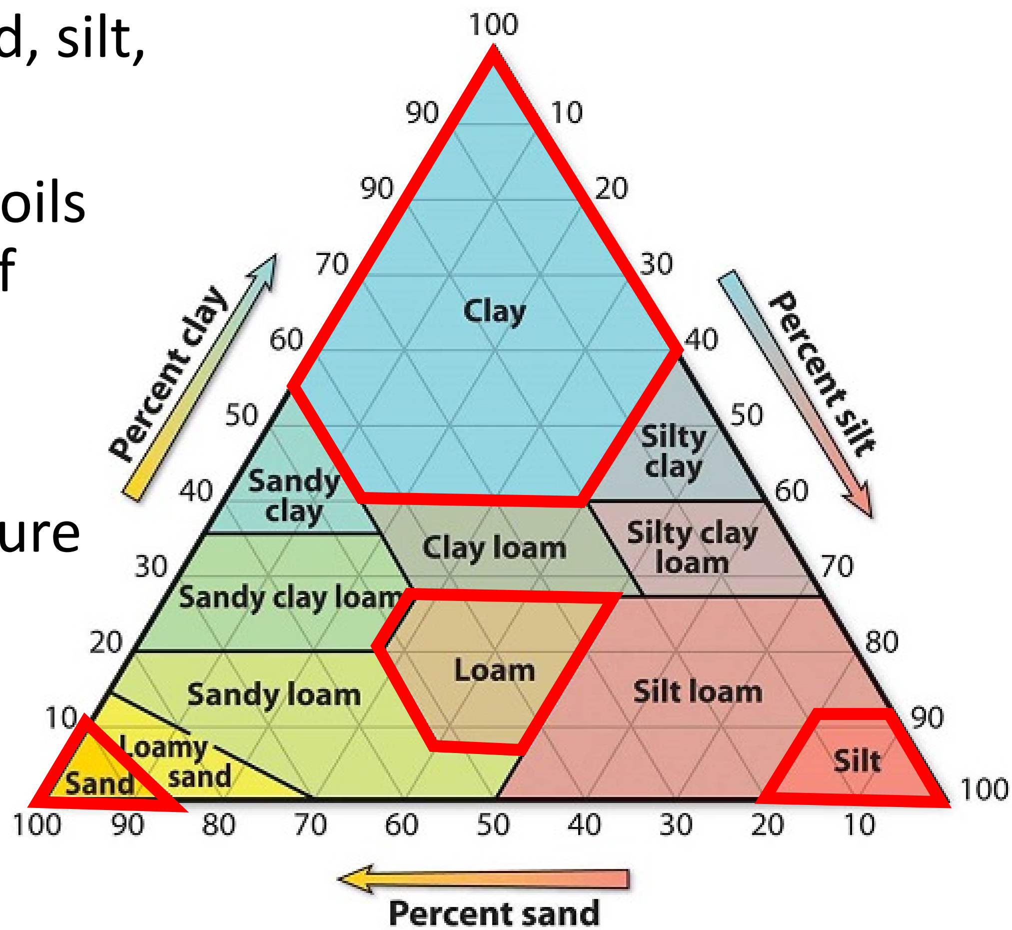
  

Property	Sand	Silt	Clay
Size range (mm)	2.0 – 0.05	0.05 – 0.002	<0.002
Means of observation	Naked eye	Light microscope	Electron microscope
Attraction of particles for each other (cohesion)	Low	Medium	High
Attraction of particles for water (adhesion)	Low	Medium	High
Water-holding capacity	Low	Medium-High	High
Aeration	Good	Medium	Poor
Resistance to pH change	Low	Medium	High
Nutrient holding capacity	Very Low	Low	Medium-High
Potential to be compacted	Low	Medium	High
Susceptibility to wind erosion	Moderate	High	Low
Susceptibility to water erosion	Low	High	Depends on degree of aggregation

Adapted from Brady and Weil, 2007

Soil Texture

- Soil Texture - Describes the relative proportions of sand, silt, and clay
- Soil texture classes group soils with similar distributions of particle sizes
- Sand, silt, and clay are texture classes AND particle sizes
- Loam refers to a soil that has equal influence of sand, silt, and clay



Soil Texture

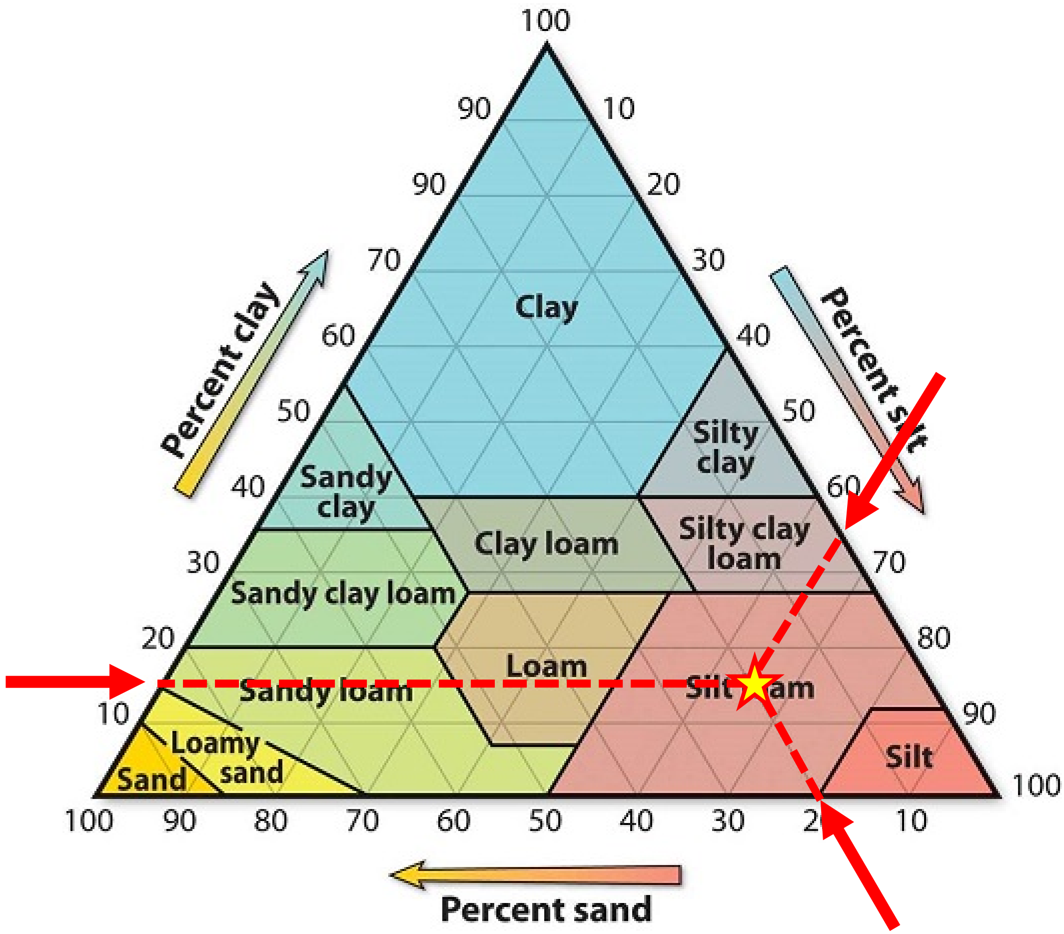
Example:

Clay = 15%

Sand = 20%

Silt = 65%

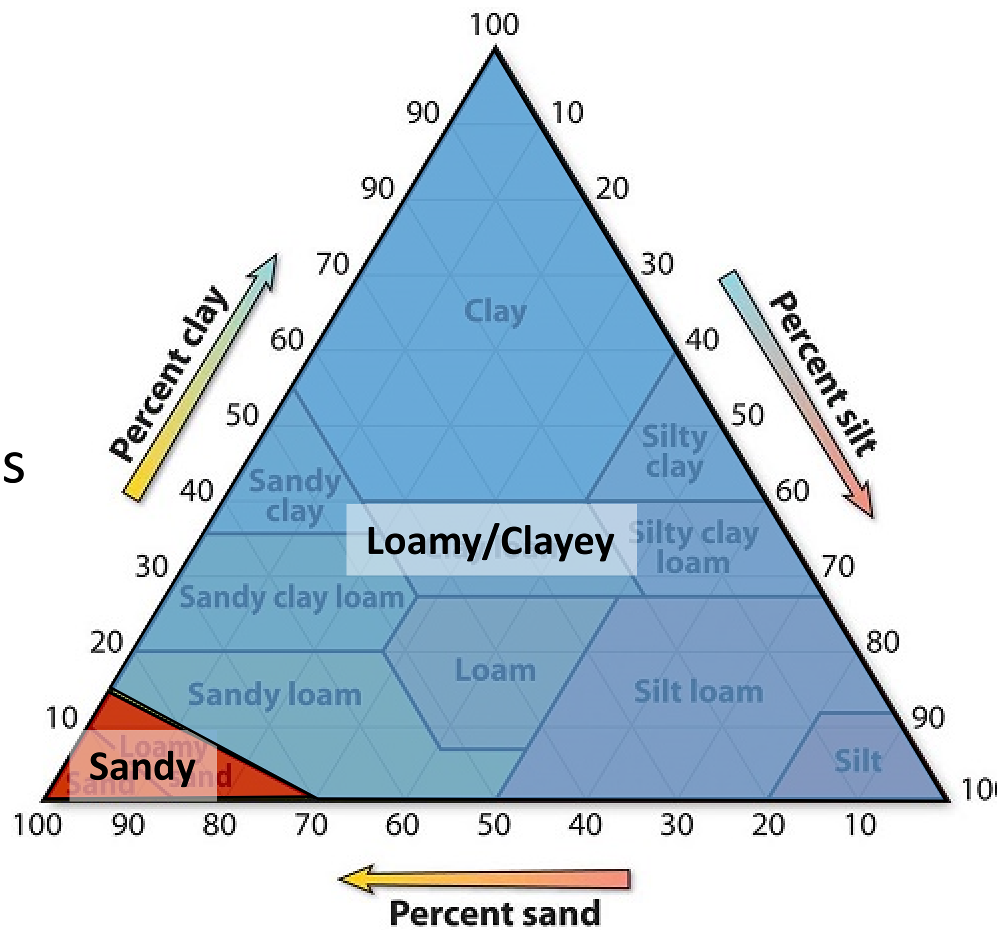
Silt Loam



Soil Texture

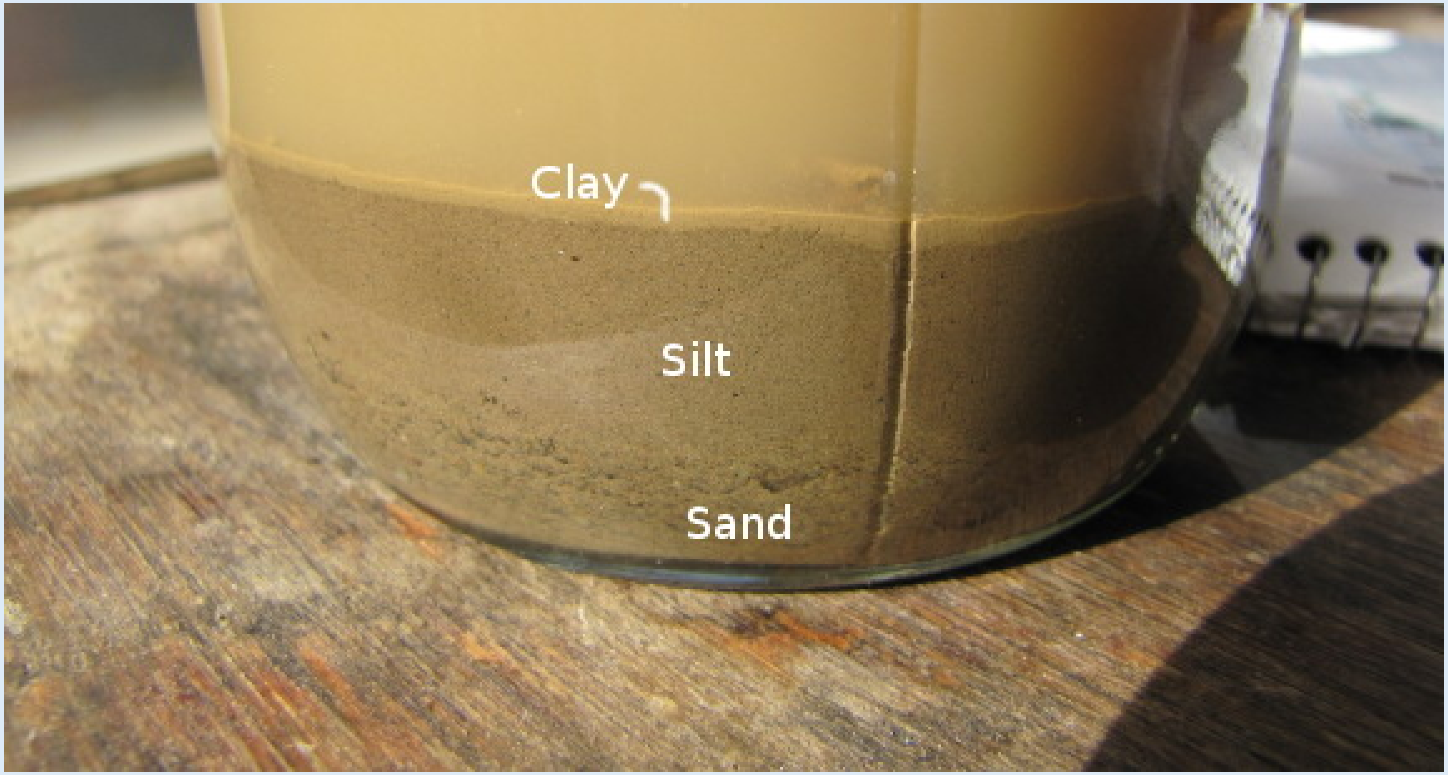
For hydric soil delineation, soil texture classes are often grouped into two categories

- Sandy (sands and loamy sands)
- Loamy/Clayey (sandy loams and finer textures)



Measuring Soil Texture

- In the lab – based on how quickly particles drop out of suspension
- In the field – Texture by Feel



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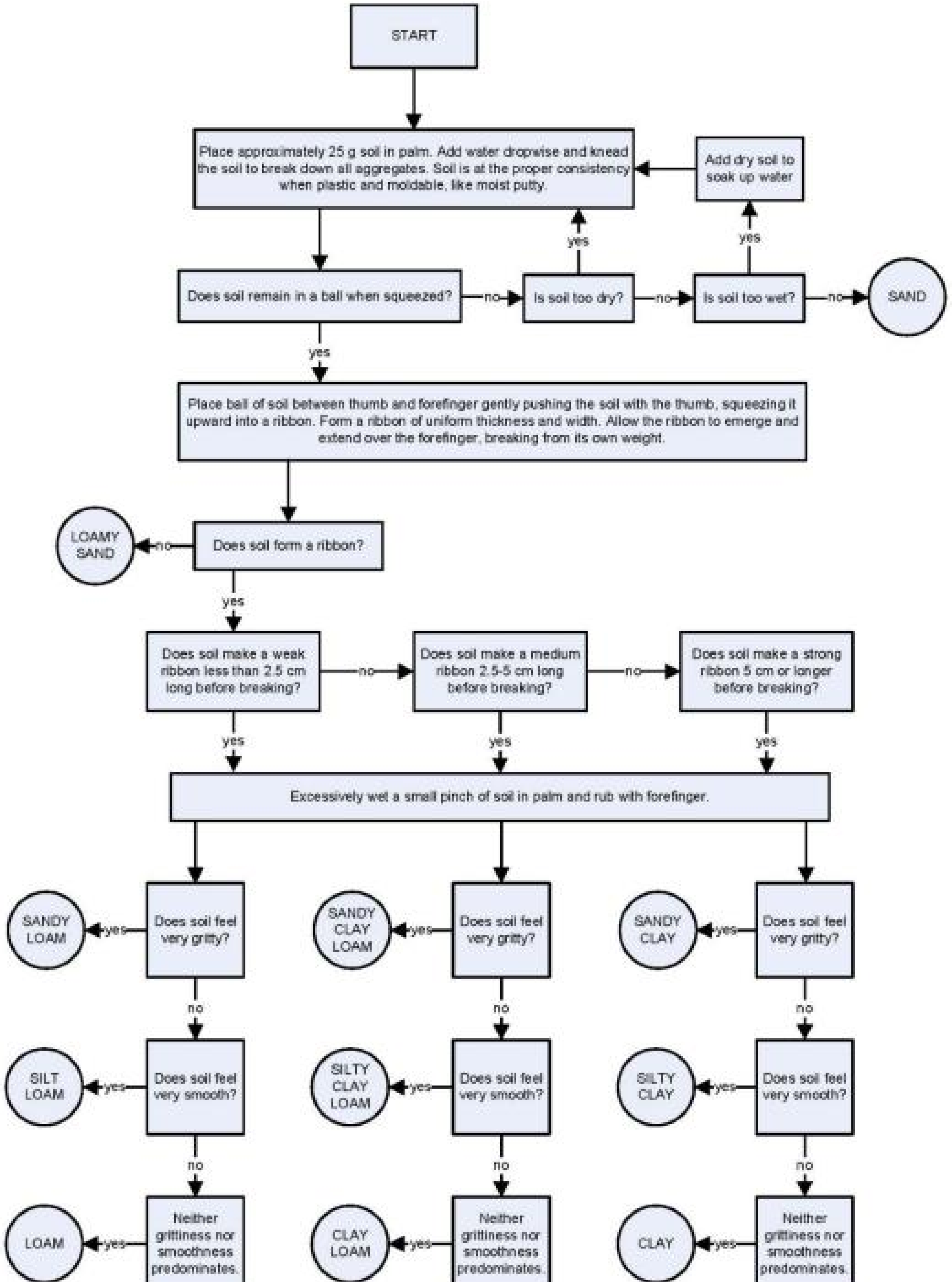

START
Place approximately 25 g soil in palm. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty.
Add dry soil to soak up water
yes
yes
Does soil remain in a ball when squeezed?
no
Is soil too dry?
no
Is soil too wet?
no
SAND
yes
Place ball of soil between thumb and forefinger gently pushing the soil with the thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.
LOAMY SAND
no
Does soil form a ribbon?
yes
Does soil make a weak ribbon less than 2.5 cm long before breaking?
no
Does soil make a medium ribbon 2.5-5 cm long before breaking?
no
Does soil make a strong ribbon 5 cm or longer before breaking?
yes
yes
yes
Excessively wet a small pinch of soil in palm and rub with forefinger.
SANDY LOAM
yes
Does soil feel very gritty?
SANDY CLAY LOAM
yes
Does soil feel very gritty?
SANDY CLAY
yes
Does soil feel very gritty?
no
no
no
SILT LOAM
yes
Does soil feel very smooth?
SILTY CLAY LOAM
yes
Does soil feel very smooth?
SILTY CLAY
yes
Does soil feel very smooth?
no
no
no
LOAM
yes
Neither grittiness nor smoothness predominates.
CLAY LOAM
yes
Neither grittiness nor smoothness predominates.
CLAY
yes
Neither grittiness nor smoothness predominates.

Soil Texture – Coarse Fragment Modifiers

- Coarse fragments are described by size and shape

Shape and Size	Class
Spherical or Cube-like	
> 2 – 76 mm diameter	Gravel
> 76 – 250 mm diameter	Cobbles
> 250 – 600 mm diameter	Stones
> 600 mm diameter	Boulders
Flat	
> 2 – 150 mm long	Channers
> 150 – 380 mm long	Flagstones
> 380 – 600 mm long	Stones
> 600 mm long	Boulders

Photo Courtesy NRCS

Soil Texture – Coarse Fragment Modifiers

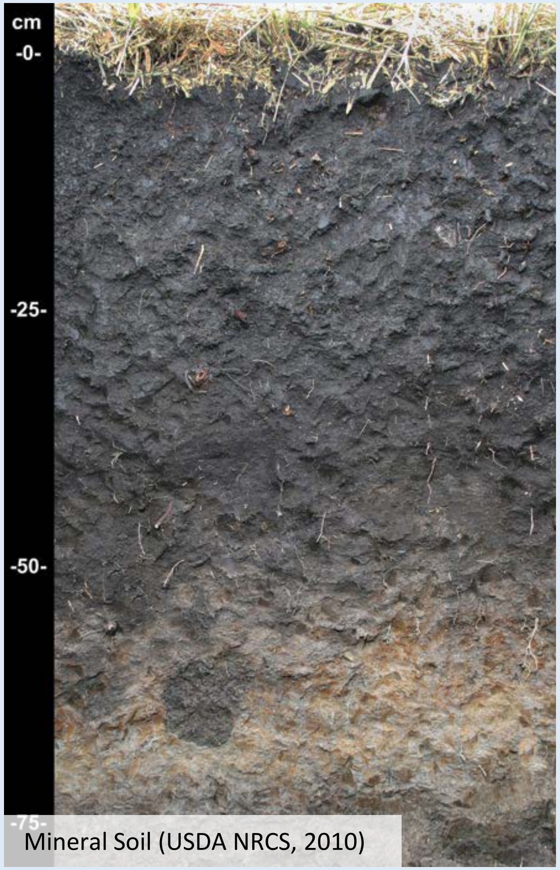
- Rock Fragment Modifiers are added to the texture class when the volume of rock fragments is greater than 15%

Rock Fragments by Volume	Modifier	Example Usage
< 15%	No texture class modifier	loam
15% to < 35%	Use fragment-size adjective	gravelly loam
35% to < 60%	Use "very" with fragment-size adjective	very gravelly loam
60% to < 90%	Use "extremely" with fragment-size adjective	extremely gravelly loam
≥ 90%	No modifier. Use the fragment-size class in lieu of texture	gravel

Mineral vs. Organic Soil Material

- Mineral soils form from rocks or materials transported by wind, water, landslides, or ice
- Organic soils form from plant debris

Organic Soil (USDA NRCS, 2010)



Mineral Soil (USDA NRCS, 2010)

Distinguishing Organic and Mineral Soil Materials

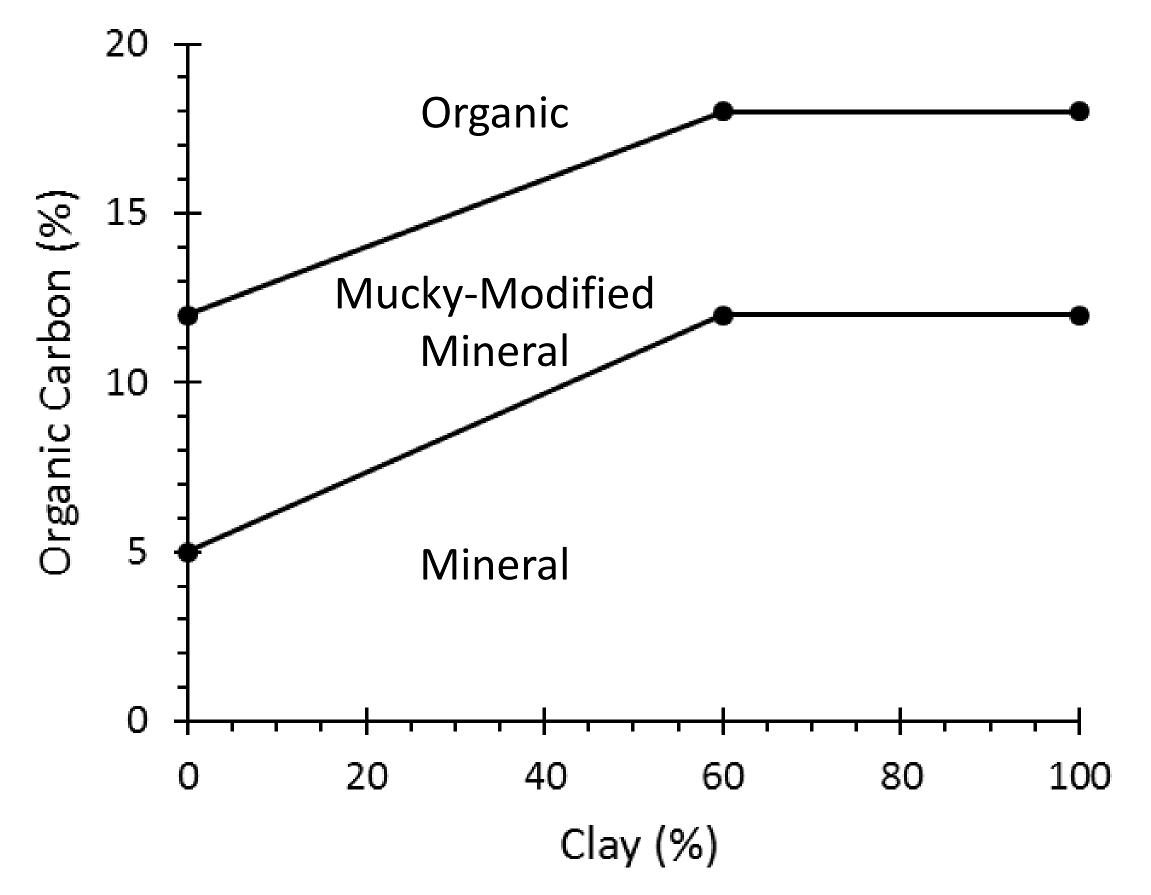
Organic Soils:

- Feels greasy or slippery when rubbed between fingers
- Often stain fingers when rubbed
- Porous and squishy – can be compressed
- Light in weight (low density)
- Range from pudding-like muck to fibrous peats
- Almost no internal strength

Mineral Soils:

- Feel gritty or sticky, but not greasy
- Resists compression
- Heavier than organic soils when water is removed
- Maintains internal structure (forms distinct peds)

Distinguishing Organic and Mineral Soil Materials



$$\text{Organic Matter} = \frac{\text{Organic Carbon}}{0.58}$$

Organic Soil Material

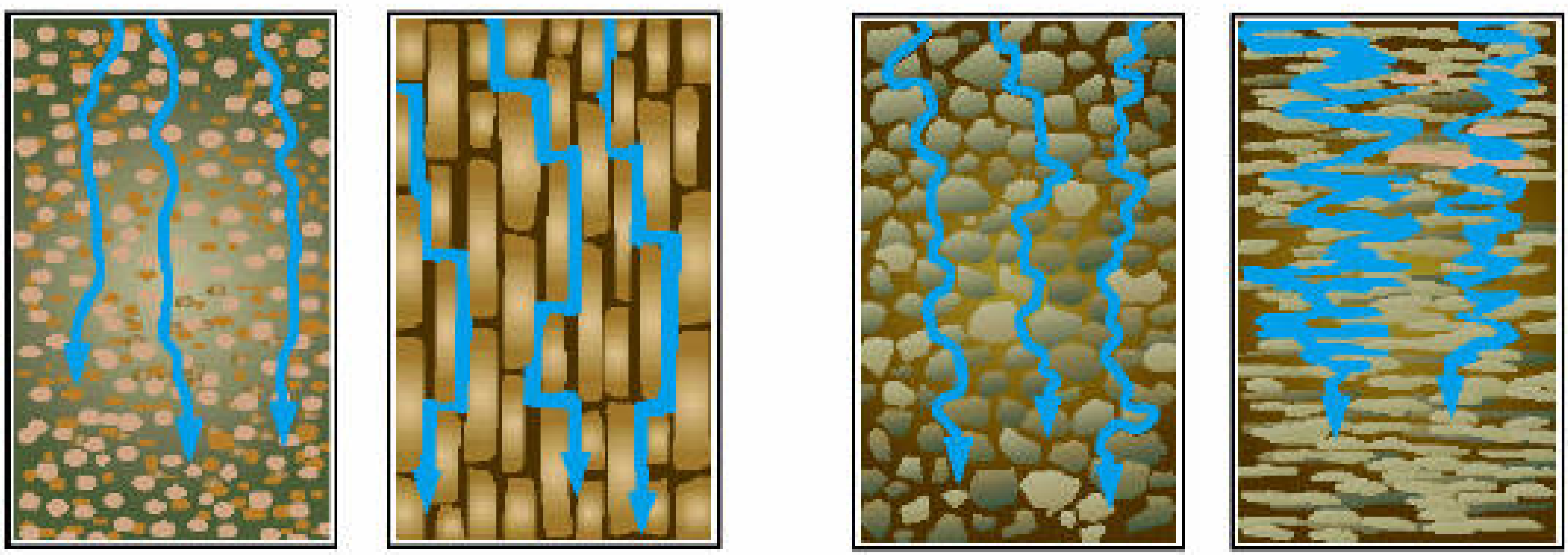
Distinguished by degree of decomposition

Organic Soil	Description	Fiber content after rubbing	Soil Texture
Fibric	Slightly decomposed	≥ 40%	Peat
Hemic	Moderately decomposed	17 to < 40%	Mucky Peat
Sapric	Highly decomposed	< 17%	Muck

Photo Courtesy John Kelley, NRCS

Soil Structure

- Describes the aggregation and arrangement of primary soil particles (e.g. mineral grains) into secondary units or peds
- Characterized by size, shape, and degree of distinctness (grade)
- Form as a result of pedogenic processes



Granular Soil Structure

- Associated with organic-rich, near-surface mineral horizons
- Roughly spherical, crumb shaped peds, typically 1 – 5 mm in diameter
- High porosity and permeability

Photo Courtesy John Kelley, NRCS

soilquality.org

Platy Soil Structure

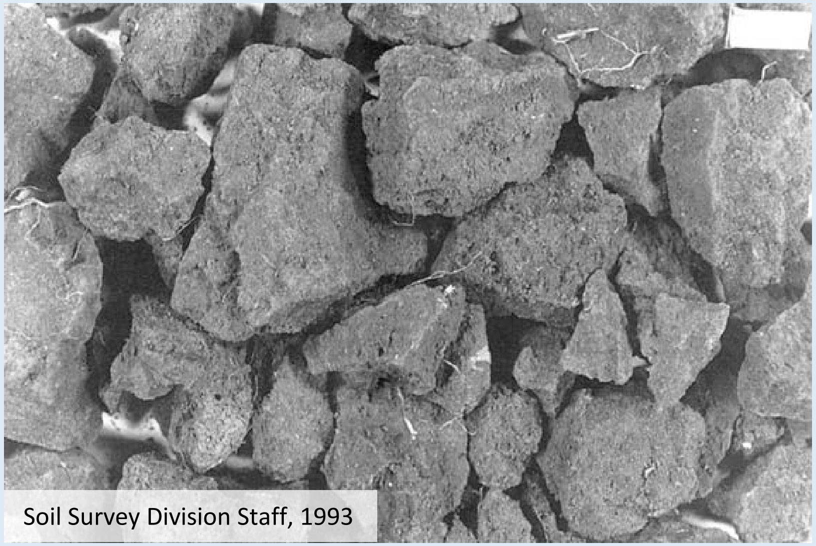
- Thin, plate-like peds, aligned parallel to the soil surface
- If well developed can impede infiltration


http://www.soilsofcanada.ca/


Soil Survey Division Staff, 1993

Blocky Soil Structure

- Angular or Sub-Angular
- Common to subsoil horizons
- Held together by coatings of translocation materials, such as clays
- Structure often maintained by root channels between peds



Prismatic Soil Structure

- Vertically oriented, elongated blocks or prisms

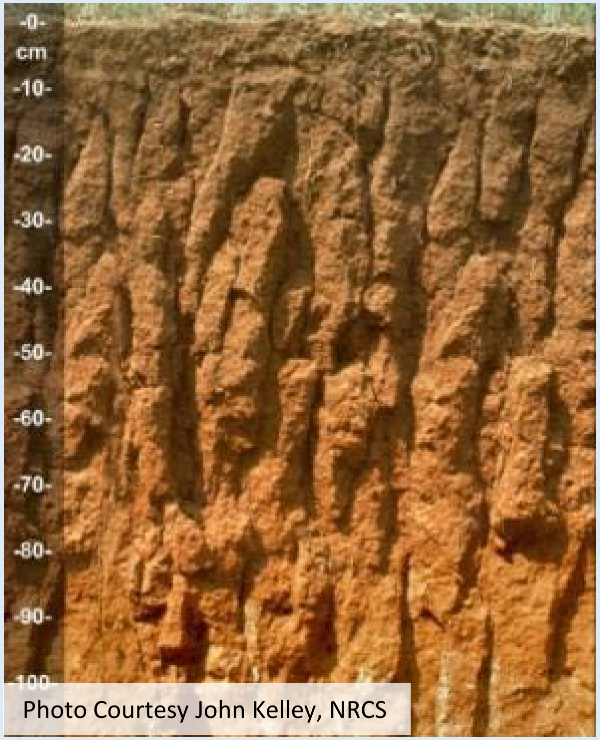


Photo Courtesy John Kelley, NRCS

Columnar Soil Structure

- Similar to prismatic structure, but prism tops are rounded
- Found in soils with high amounts of exchangeable sodium

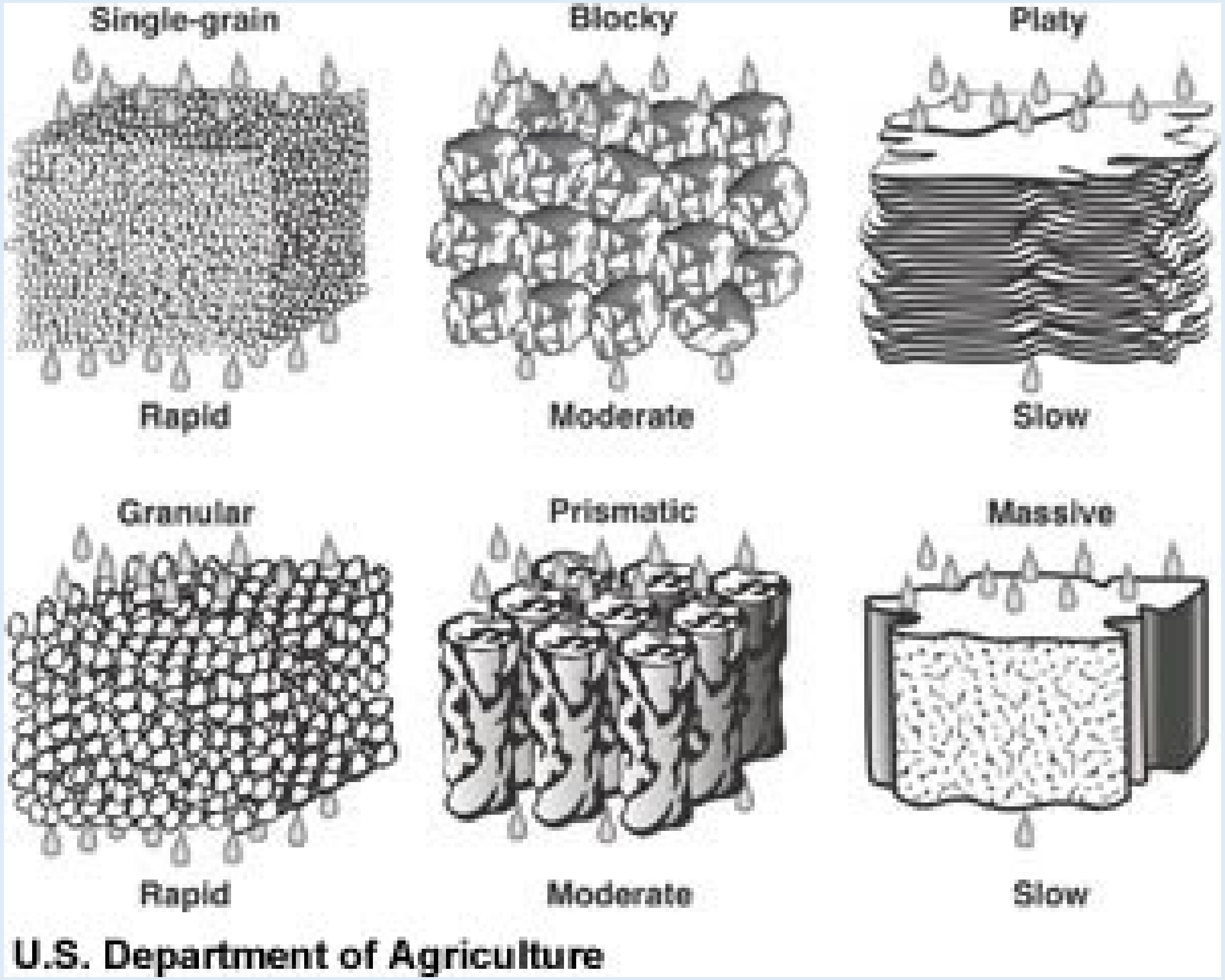
Photo Courtesy of Agriculture Canada, Canadian Soils Information System (CANSIS)

Structureless

Massive

Single Grain

Soil Structure and Hydraulic Conductivity



Soil Texture and Structure

- Used to describe physical characteristics of the soil, in soil profile descriptions and to differentiate horizons
  - Texture - size of primary particles
    - Mineral soil – relative proportion of sand, silt, and clay
    - Organic soil – based on the degree of decomposition
  - Structure – describes the aggregation of mineral grains into secondary units or peds
- May reflect natural pedogenic processes (e.g. weathering, illuviation) or disturbances (e.g. compaction)
- Influence porosity and pore connectivity
  - Aeration
  - Water storage
  - Water movement into and through the soil (infiltration, permeability, and hydraulic conductivity)
  - Root penetration and ability of plants to access water, air, and nutrients

Questions?