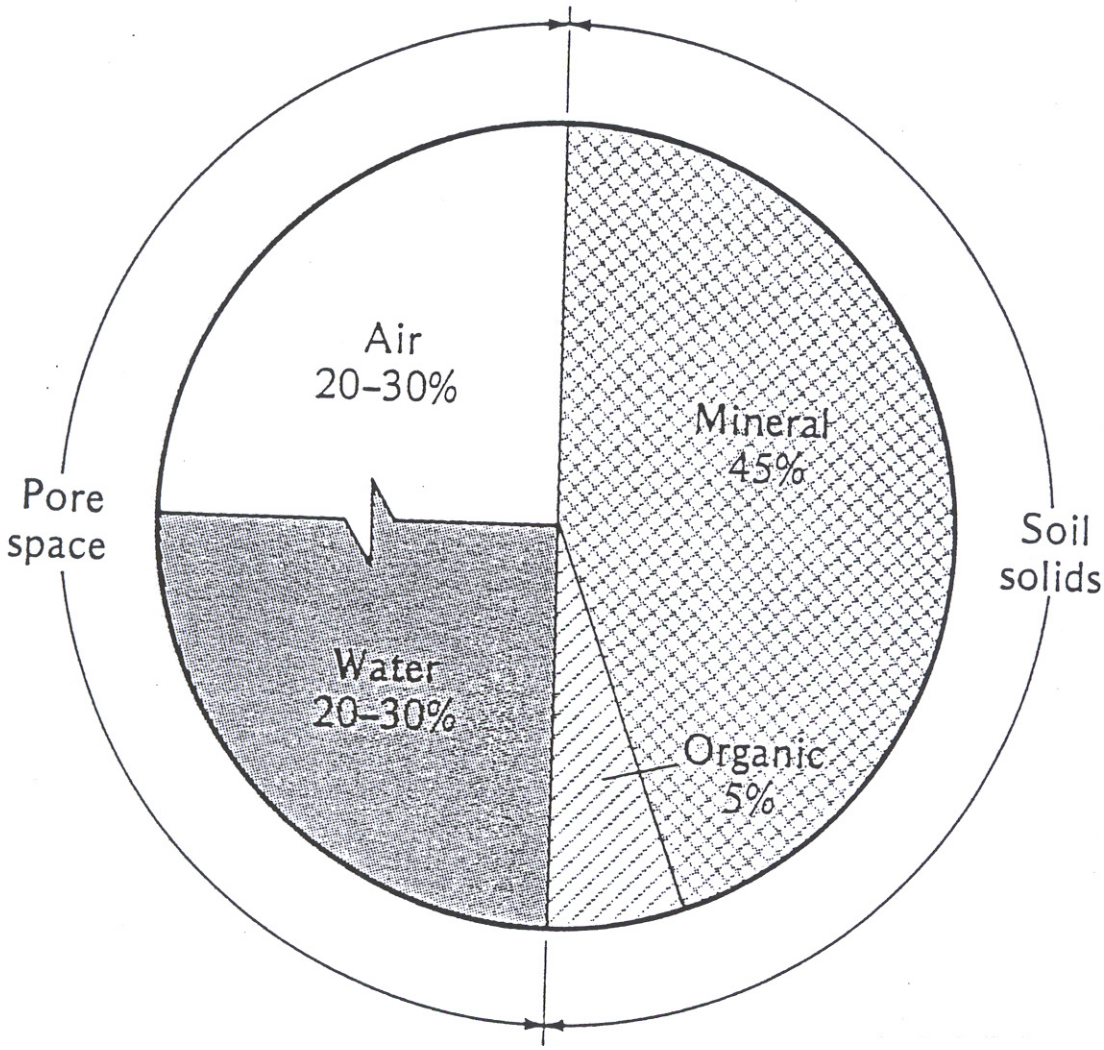

Air
20–30%
Mineral
45%
Pore
space
Soil
solids
Water
20–30%
Organic
5%

Soil Architecture

- Texture
- Structure
- Bulk Density
- Organic Matter

Soil Chemistry

- Acidity and Alkalinity (pH and pOH)

PARTICLE SIZE

Stones, pebbles Sand Silt Clay

<----------->

2mm 0.05mm 0.002mm

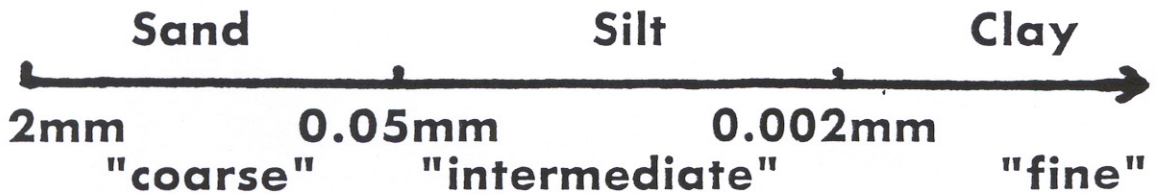
Coarse fraction "Fine-earth fraction"

Coarse Fraction -
- **usually ignored in textural classification of soil**
- **little effect on soil's chemical properties**
- **hinders water retention, cultivation**

Fine-Earth Fraction - **divided into 3 main size separates:**

SAND (2.0 - .05 mm)
SILT (0.05 - 0.002 mm)
CLAY (< 0.002 mm)

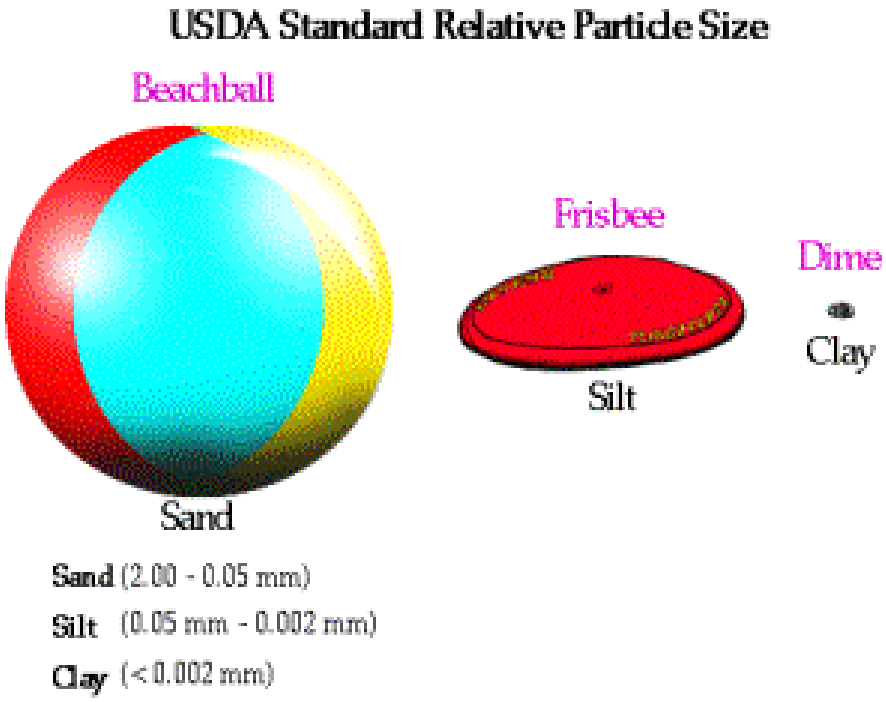
Particle Size -



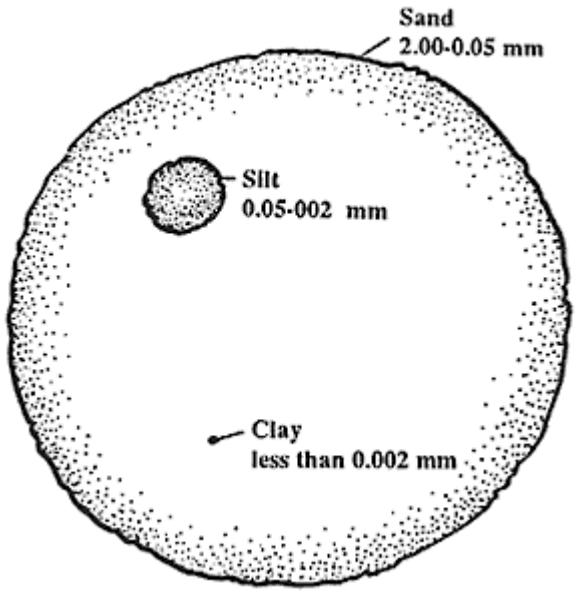
SOIL TEXTURE -
- refers to particle size (gravelly, sandy, loamy, etc.)
- cannot be changed

Soil Texture

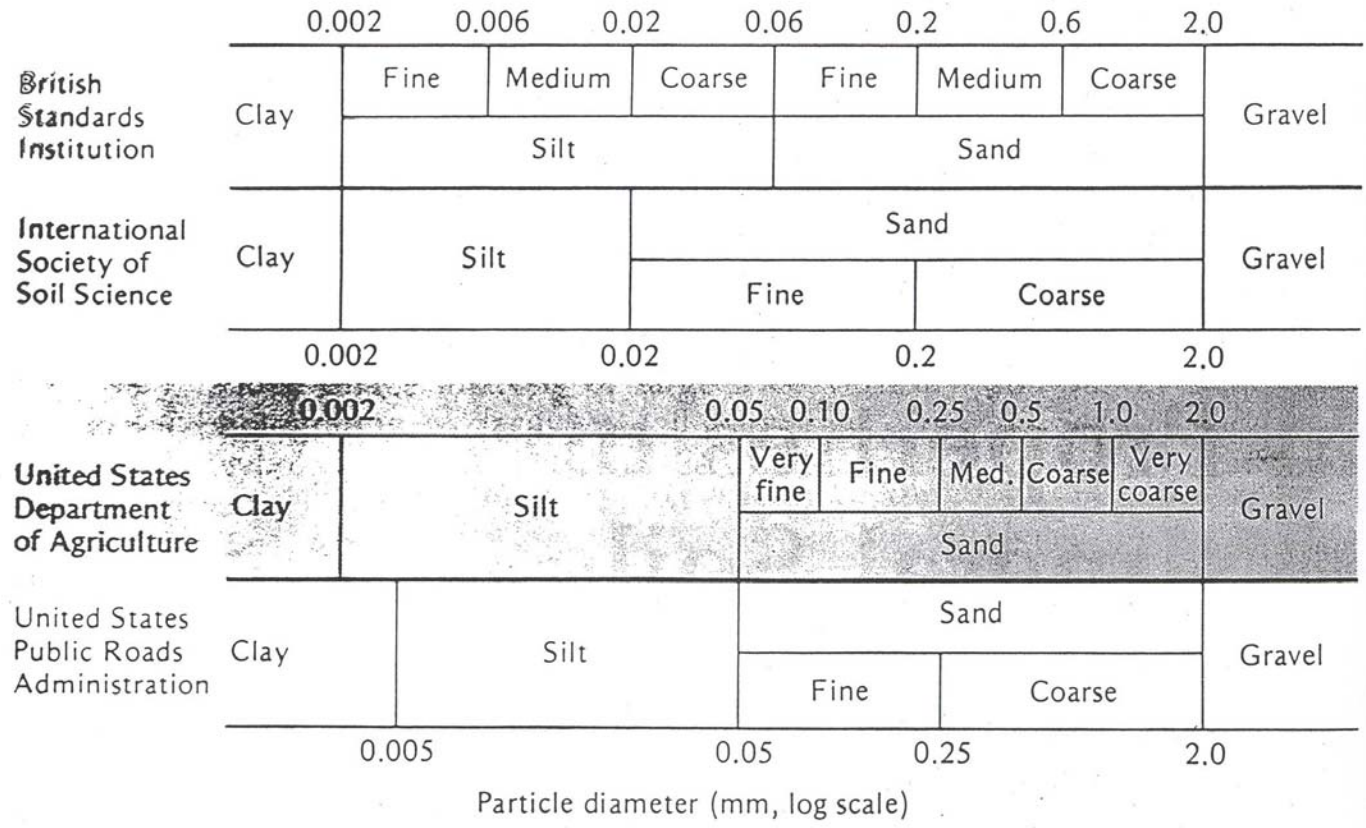
– Course Fragments, Sand, Silt and Clay

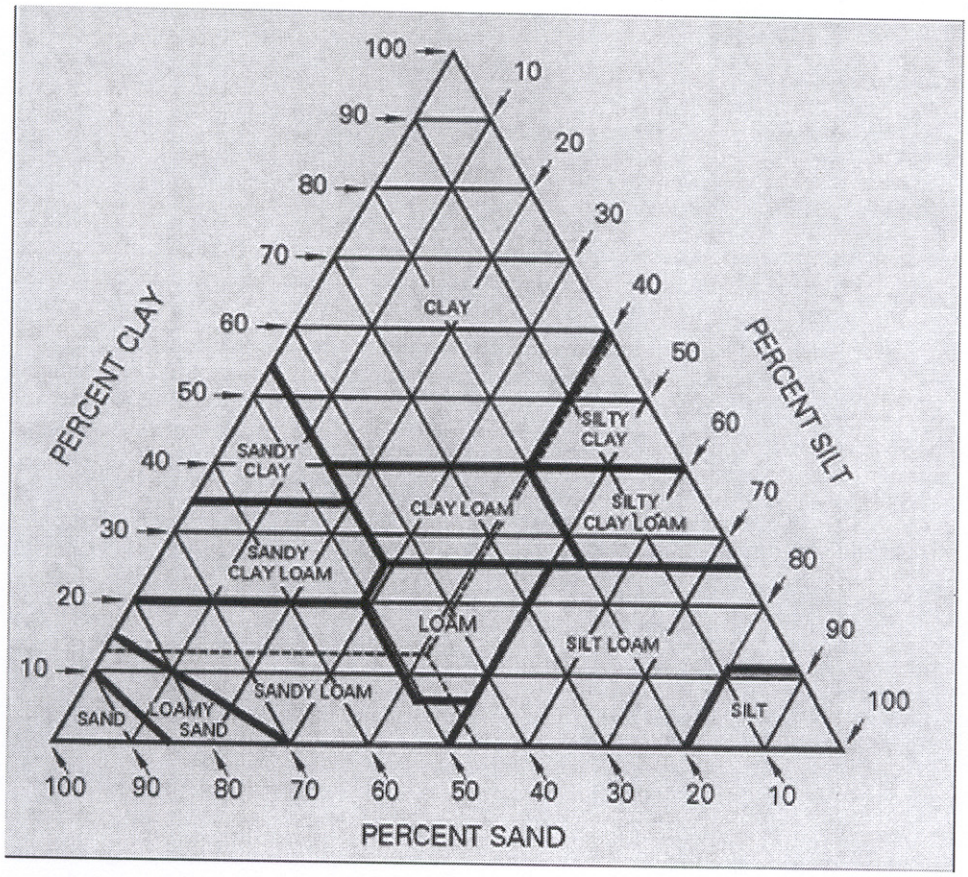


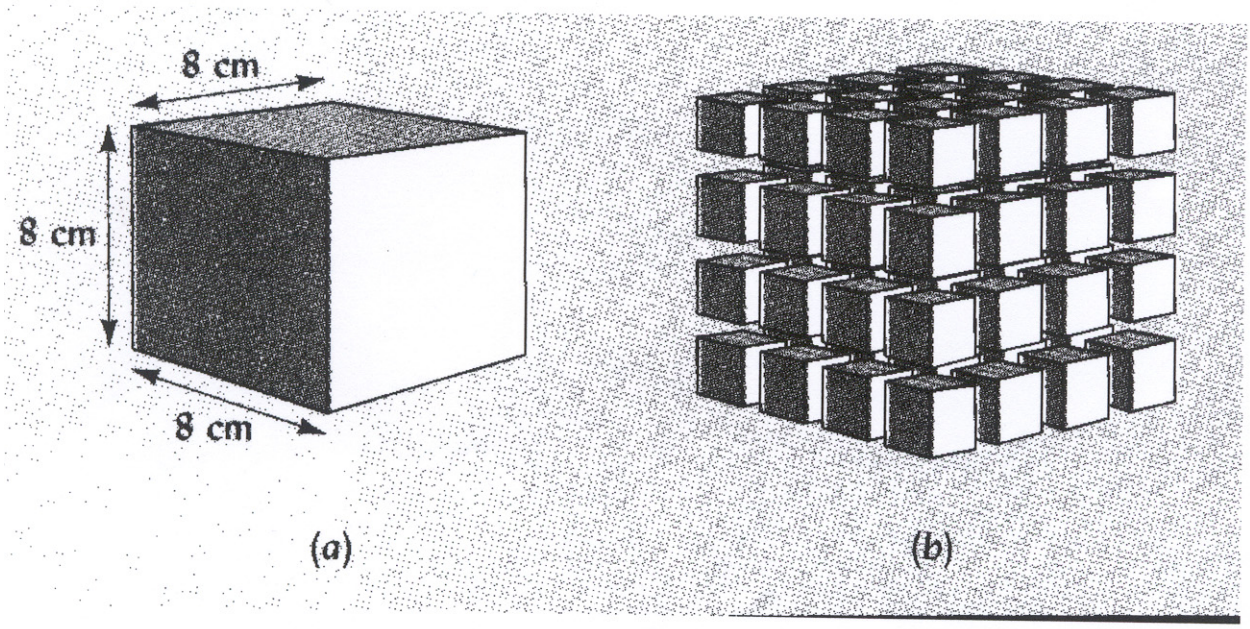
www.cas.umt.edu/ science226/226.soils.htm



http://www.cst.cmich.edu/users/Franc1M/esc334/lectures/physical.htm


0.002
0.006
0.02
0.06
0.2
0.6
2.0
British Standards Institution
Clay
Fine
Medium
Coarse
Fine
Medium
Coarse
Gravel
Silt
Sand
International Society of Soil Science
Clay
Silt
Sand
Fine
Coarse
Gravel
0.002
0.02
0.2
2.0
0.002
0.05
0.10
0.25
0.5
1.0
2.0
United States Department of Agriculture
Clay
Silt
Very fine
Fine
Med.
Coarse
Very coarse
Gravel
Sand
United States Public Roads Administration
Clay
Silt
Sand
Fine
Coarse
Gravel
0.005
0.05
0.25
2.0
Particle diameter (mm, log scale)


PERCENT CLAY
PERCENT SILT
PERCENT SAND
100
90
80
70
60
50
40
30
20
10
CLAY
SILTY CLAY
SANDY CLAY
CLAY LOAM
SILTY CLAY LOAM
SANDY CLAY LOAM
LOAM
SILT LOAM
SANDY LOAM
SILT
SAND
LOAMY SAND


8 cm
8 cm
8 cm
(a)
(b)

KEY TO SOIL TEXTURE BY FEEL

[Adapted from flow chart by Steve Thien, 1979, source unknown.]

Begin at the place marked "Start" and follow the flow chart by answering the questions, until you identify the soil sample.

START

Place approximately 2 teaspoons of soil in your palm. Add water by drops and knead the soil until it is moldable and feels like moist putty.

Add dry soil to soak up water.

Add drops to make wetter.

Does soil remain in a ball when squeezed? YES NO

YES Is soil too dry? NO

YES Is soil too wet? NO

SAND

Place ball of soil between thumb and forefinger. Gently push the soil with thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over forefinger, until it breaks from its own weight. **Does soil form a ribbon?** NO YES

LOAMY SAND

Wet a small pinch of soil in palm until it is very wet. Rub soil around with your finger.

Does soil make a weak ribbon <1" long before it breaks? YES

Does soil make a medium ribbon 1-2" long before it breaks? YES

Does soil make a strong ribbon >2" or longer before it breaks? YES

Does soil feel very gritty? YES NO

SANDY LOAM

Is soil really neither gritty nor smooth? YES NO

LOAM

Does soil feel very smooth? YES

SILTY LOAM

Does soil feel very gritty? YES NO

SANDY CLAY LOAM

Is soil really neither gritty nor smooth? YES NO

CLAY LOAM

Does soil feel very smooth? YES

SILTY CLAY LOAM

Does soil feel very gritty? YES NO

SANDY CLAY

Is soil really neither gritty nor smooth? YES NO

CLAY

Does soil feel very smooth? YES

SILTY LOAM

HI

% SAND

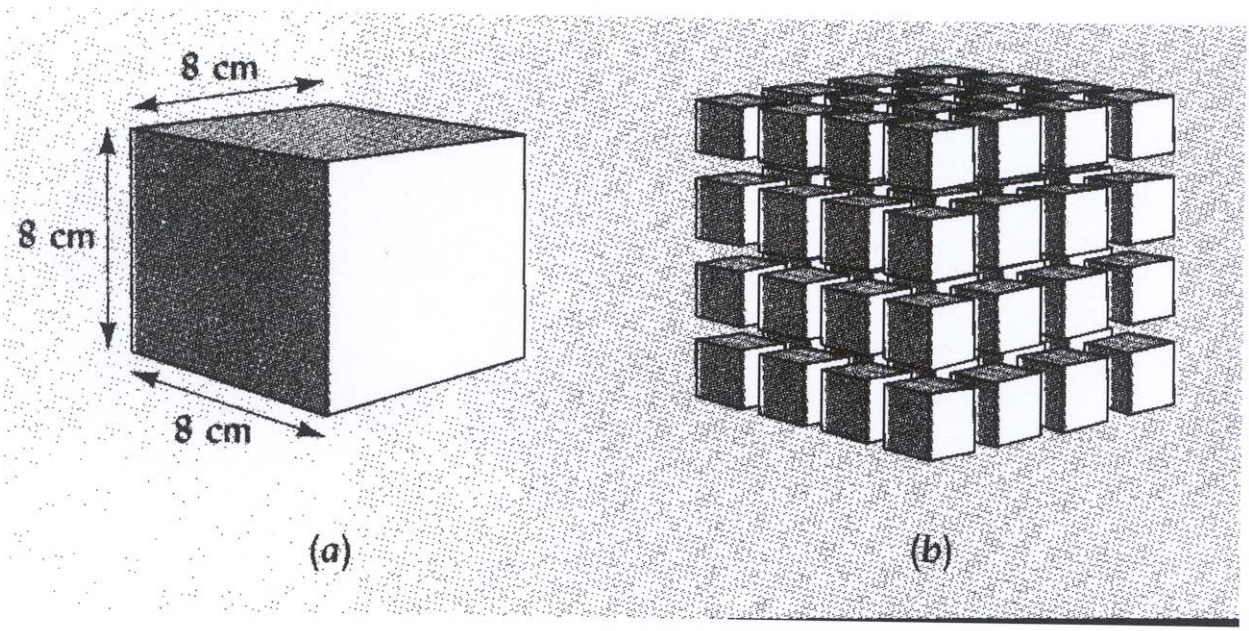
LO

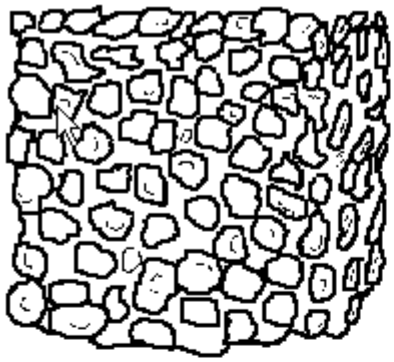
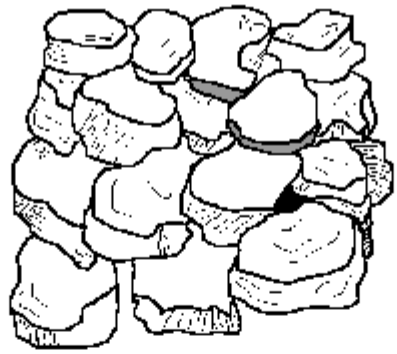
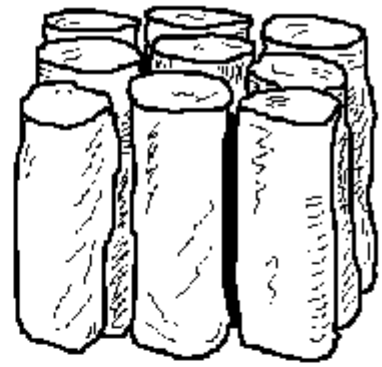
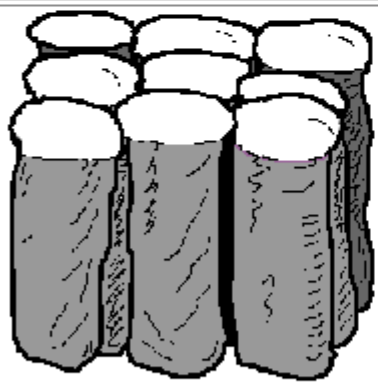
% CLAY

HI

Soil Structure

- Spheroidal or Granular
- Plate-like
- Prism-like
  - columnar
  - prismatic
- Block-like
  - angular blocky
  - subangular blocky
- Massive



		
Granular: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.	**Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.	**Prismatic**: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.
		
Columnar: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates.	**Platy**: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.	**Single Grained**: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.

Spheroidal

Characteristic of surface (A) horizons. Subject to wide and rapid changes.

Granular (porous)

Crumb (very porous)

(a)

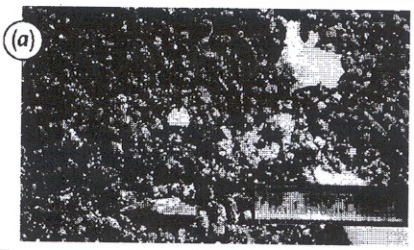
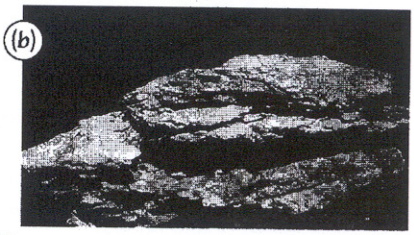


Plate-like

Common in E-horizons, may occur in any part of the profile. Often inherited from parent material of soil, or caused by compaction.

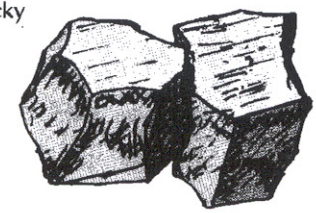
(b)



Block-like

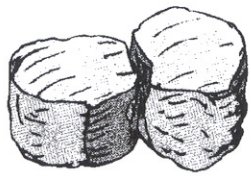
Common in B-horizons, particularly in humid regions. May occur in A-horizons.

Angular blocky

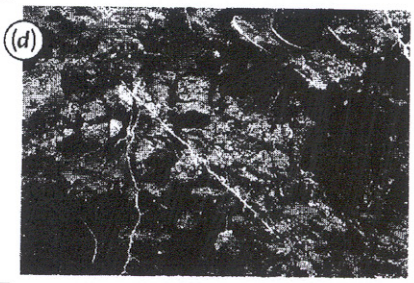


(c)

Subangular blocky



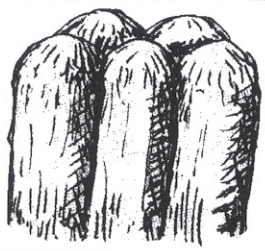
(d)



Prism-like

Usually found in B-horizons. Most common in soils of arid and semi-arid regions.

Columnar (rounded tops)



(e)

Prismatic (flat, angular tops)

(f)

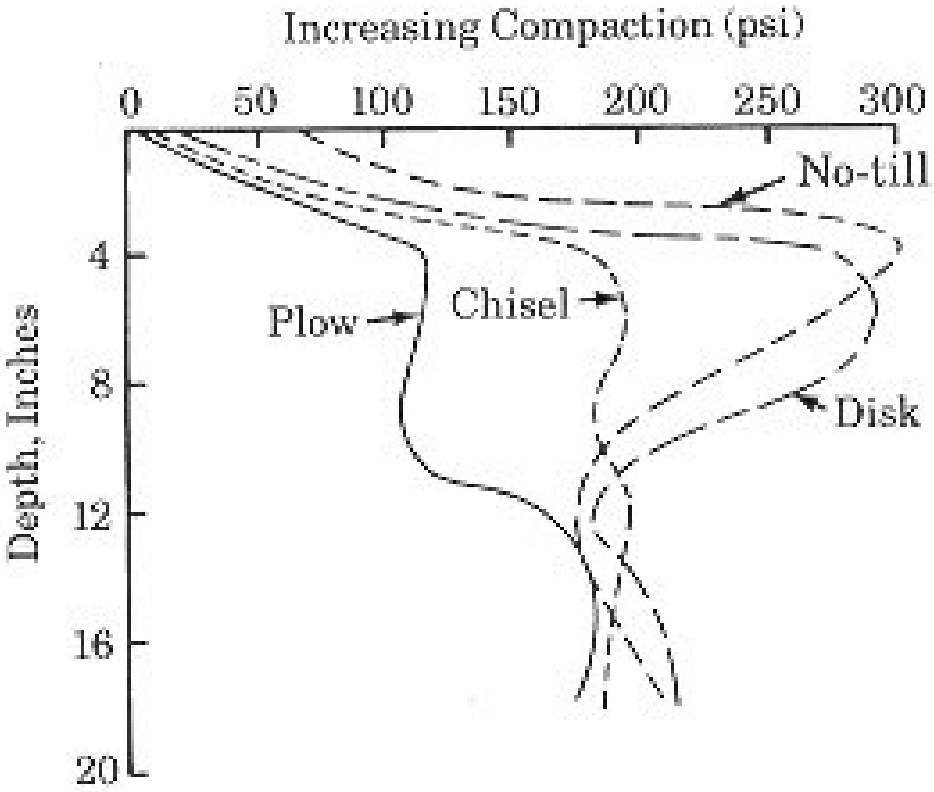
Particle Density:

$$D_P = \frac{W_S}{V_S} = \frac{\textit{particle mass (g)}}{\textit{particle volume } (cm^3)}$$

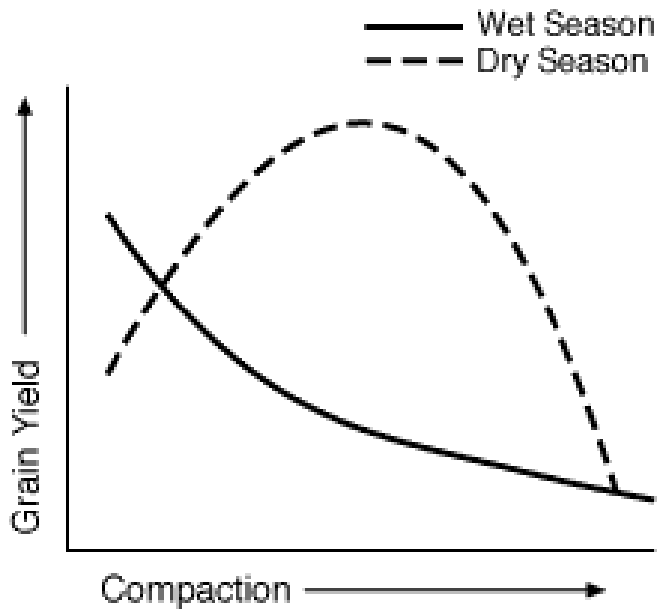
Bulk Density:

$$D_b = \frac{W_s}{V_T} = \frac{\textit{soil solids mass (g)}}{\textit{whole soil volume (cm)}}$$

bulk density < particle density



Soil compaction (measured by cone penetrometer) was higher for no-till than for other systems in an Illinois study. Data: Illinois, USA. Cited in PPI. Fertilizer mangement for today's tillage systems.



adapted from Soane et al., 1994

ORGANIC MATTER

Living
- plants, fungi
- single-celled organisms (bacteria & algae)
- small animals (protozoa, worms, insects, etc.)

Decomposed
- humus - colloidal product of bacterial and fungal decay of plant/animal tissue
- composed of large complex molecules, rather resistant to decay
- causes dark color in topsoil

ORGANISMS

Most obvious first step in soil development is organic matter added to soil surface.

HUMUS ----------> organic acids
decompositon

ORGANIC ACIDS

chelating agents

H +

SOIL MINERALS ----------> WEATHERED PRODUCTS

Soil Organic Matter (SOM)

Most soils have less than 5% (by weight) organic material

The main building block of organic matter is carbon (C)

Organic matter is a rich source of phosphorus (P), nitrogen (N) and sulfur (S)

- nutrients critical for plant growth

Soil Organic Colliods

Long C chained molecules

Humus - SOM that decomposes slowly

- colors soils browns and blacks
- high surface area and highly + charged

Lignins

Glucose/Celluloses

Organic matter

improves structure

improves drainage

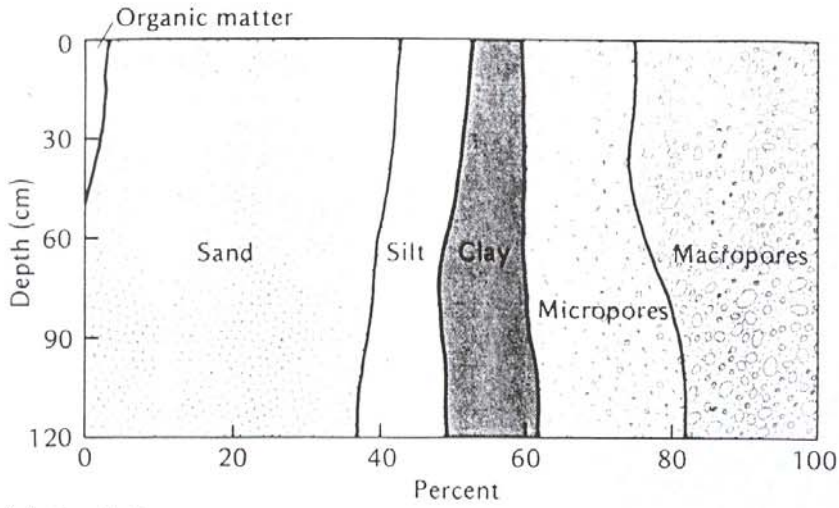
improves nutrient availability

decreases bulk density

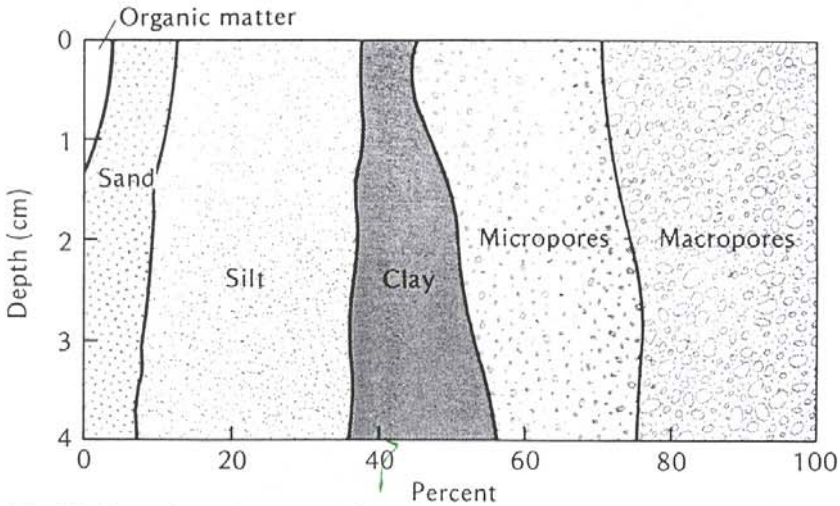
Suspect if more OM present

Poor drainage

Toxicity issues



(a) Sandy loam



(b) Silt loam (good structure)