Soil Architecture

- Texture
- Structure
- Bulk Density

Soil Morphology

Figure 1.17

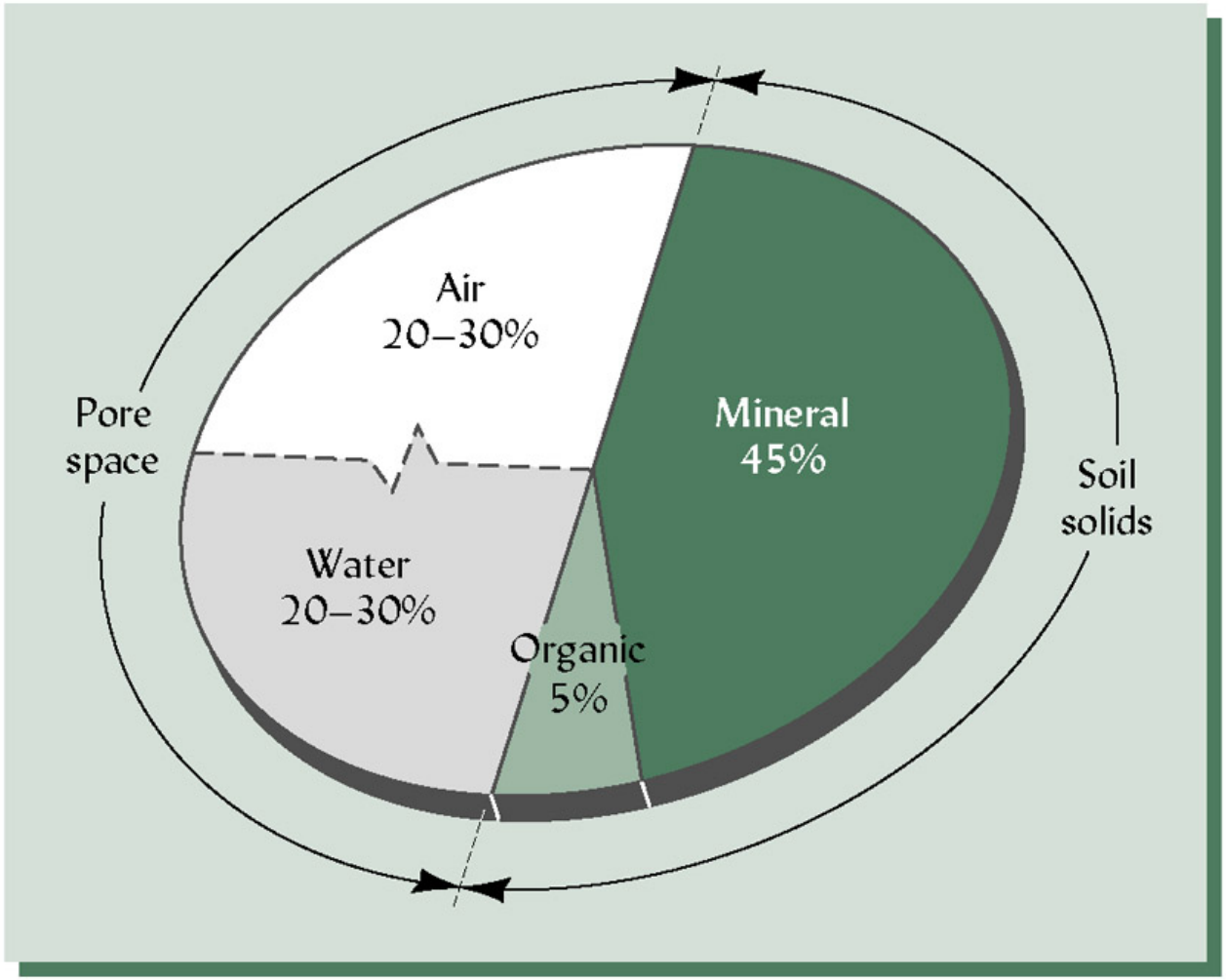

Air
20–30%
Pore
space
Mineral
45%
Soil
solids
Water
20–30%
Organic
5%

Figure 4.6

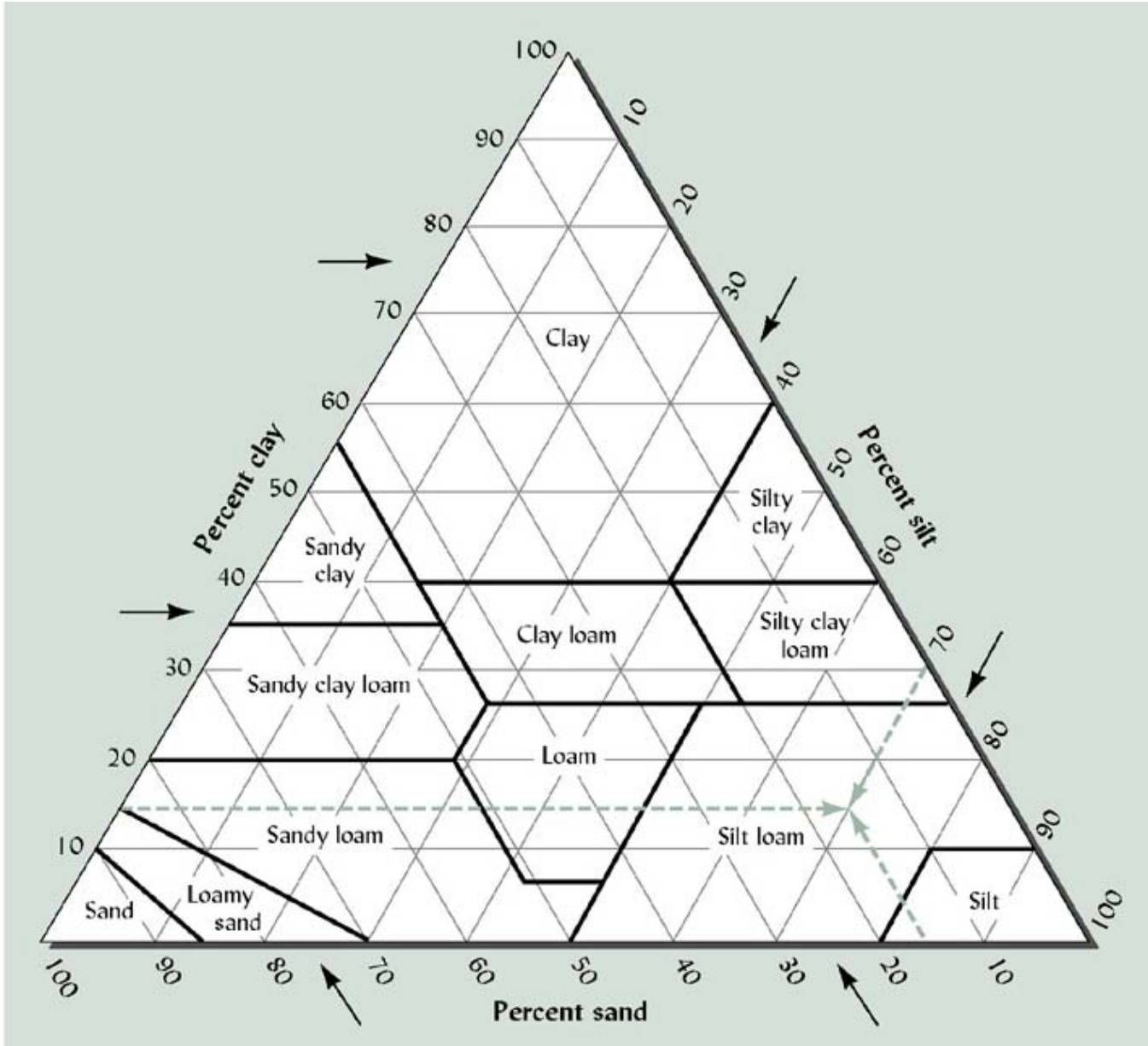

Clay
Silty clay
Sandy clay
Clay loam
Silty clay loam
Sandy clay loam
Loam
Sandy loam
Silt loam
Silt
Loamy sand
Sand
Percent clay
Percent silt
Percent sand
100
90
80
70
60
50
40
30
20
10

TABLE 4.2 General Terms Used to Describe Soil Texture in Relation to the Basic Soil Textural Class Names

U.S. Department of Agriculture Classification System

General terms		
Common names	*Texture*	*Basic soil textural class names*
Sandy soils	Coarse	Sands Loamy sands
Loamy soils	Moderately coarse	Sandy loam Fine sandy loam[a]
	Medium	Very fine sandy loam[a] Loam Silt loam Silt
	Moderately fine	Sandy clay loam Silty clay loam Clay loam
Clayey soils	Fine	Sandy clay Silty clay Clay

[a] Although not included as class names in Figure 4.6, these soils are usually treated separately because of their fine sand content.

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 - 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

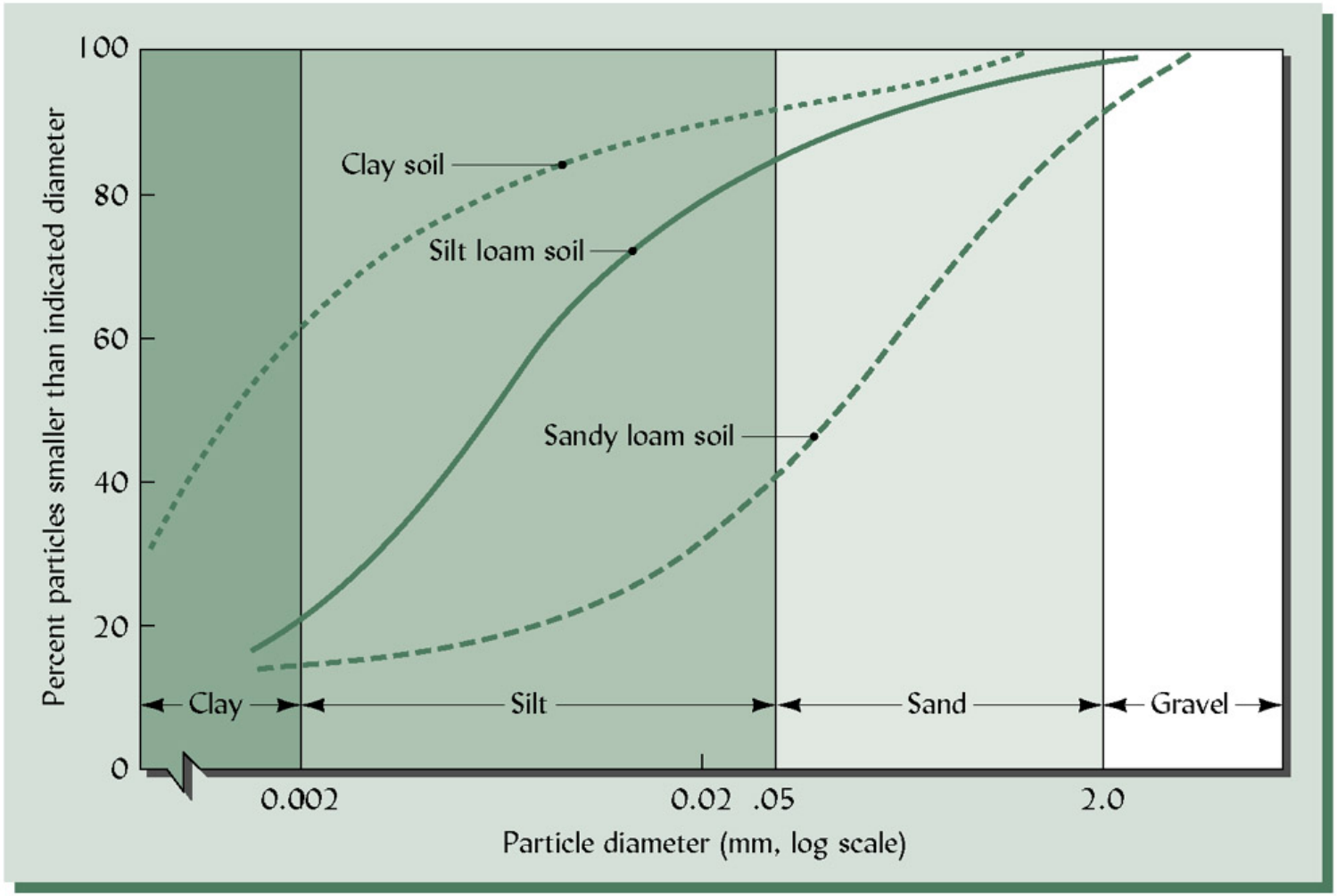
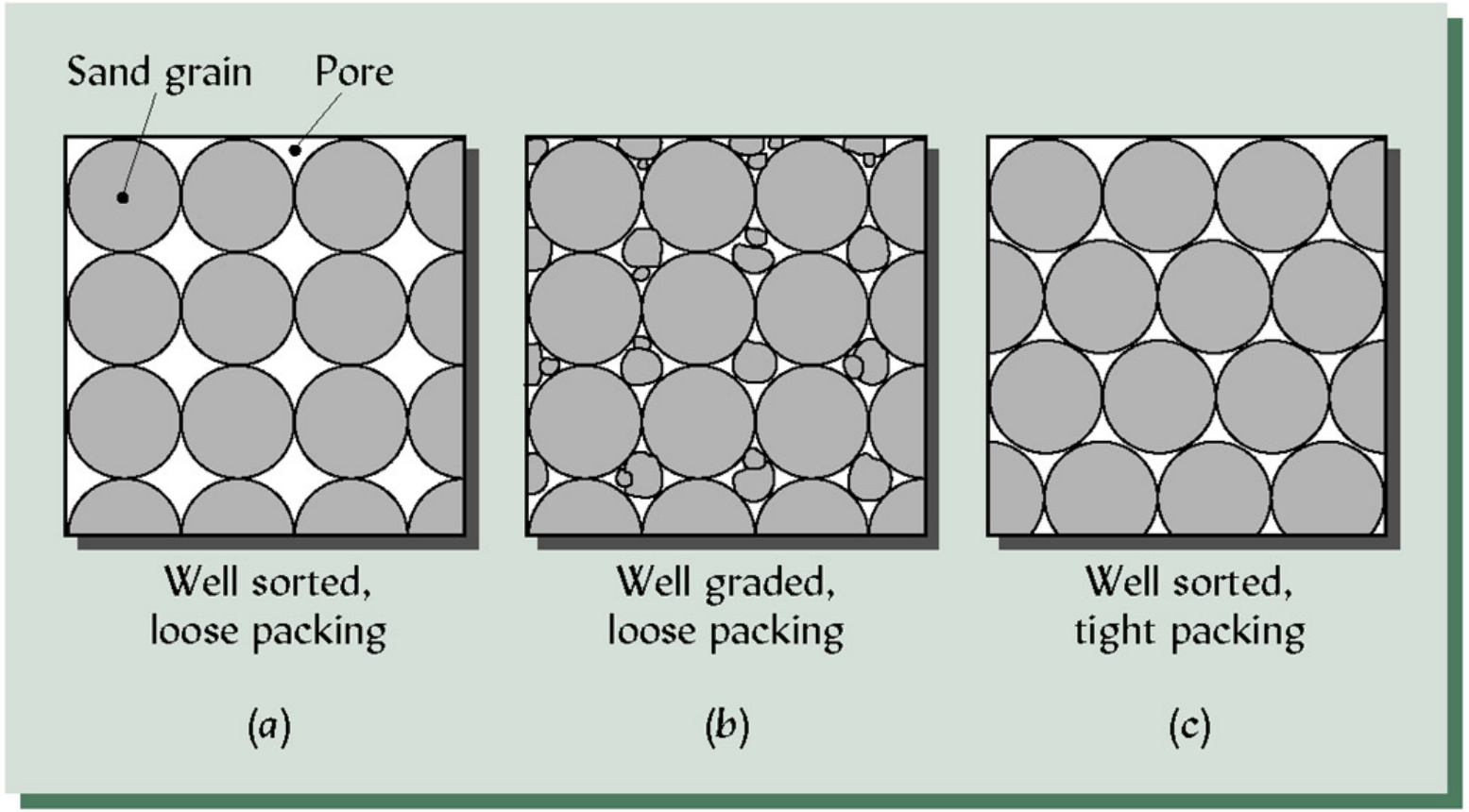

100
80
60
40
20
0
Percent particles smaller than indicated diameter
Clay soil
Silt loam soil
Sandy loam soil
Clay
Silt
Sand
Gravel
0.002
0.02
.05
2.0
Particle diameter (mm, log scale)

Figure 4.9

Figure 4.16


Sand grain
Pore
Well sorted, loose packing
(a)
Well graded, loose packing
(b)
Well sorted, tight packing
(c)

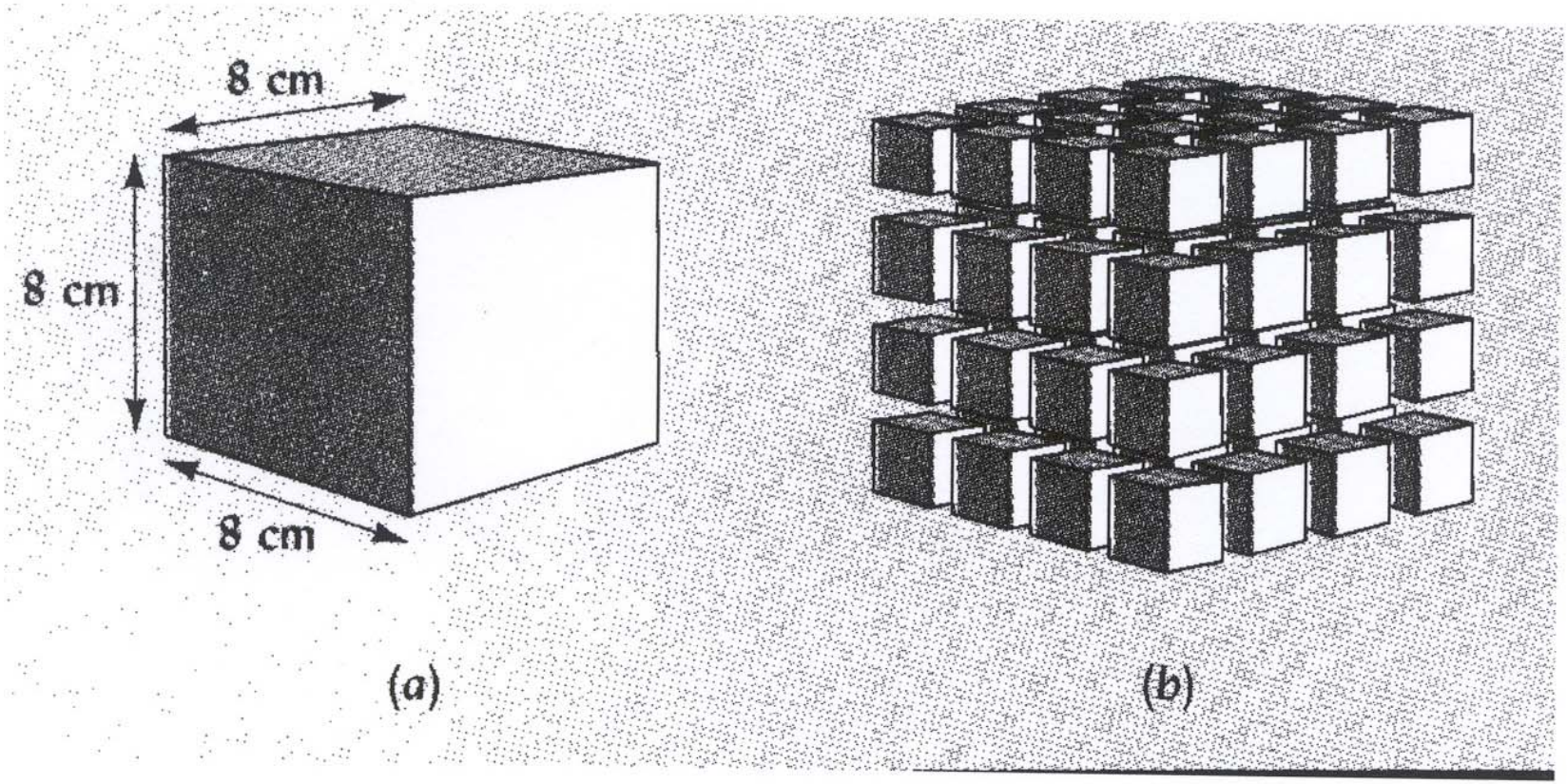
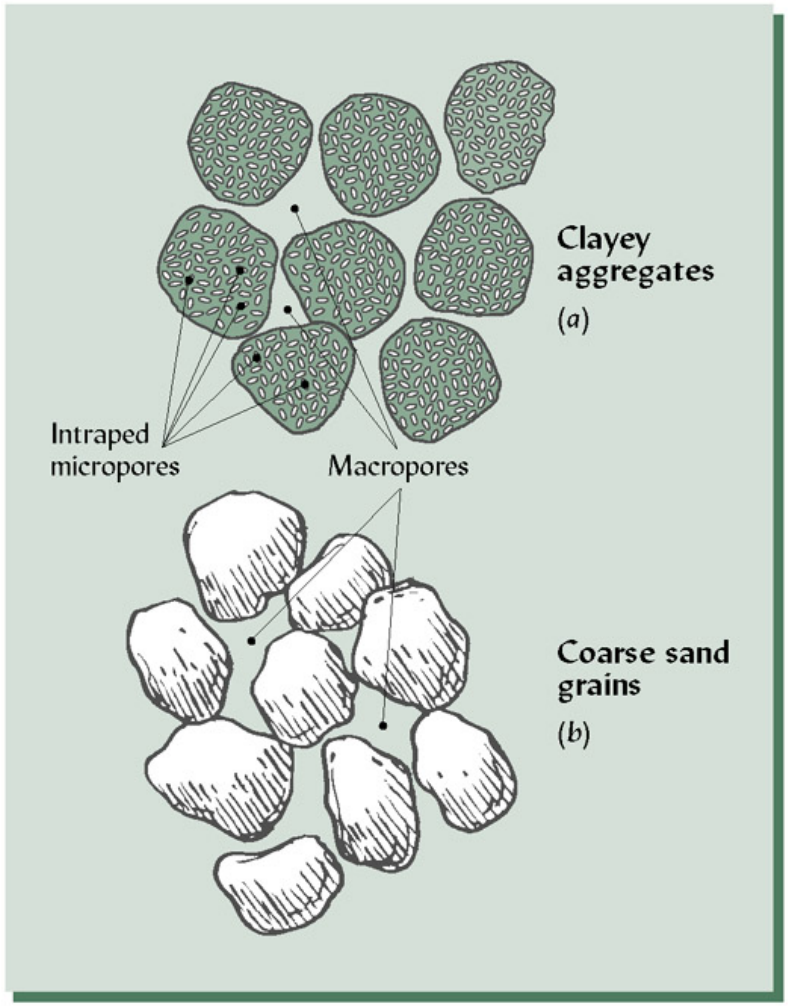
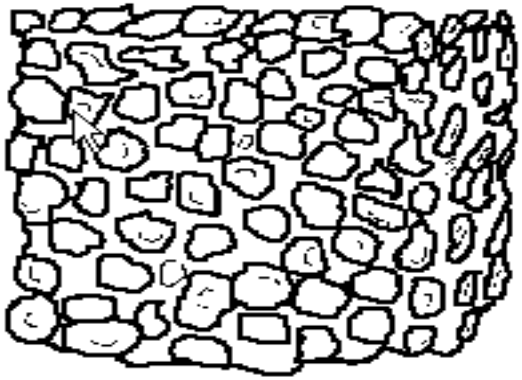
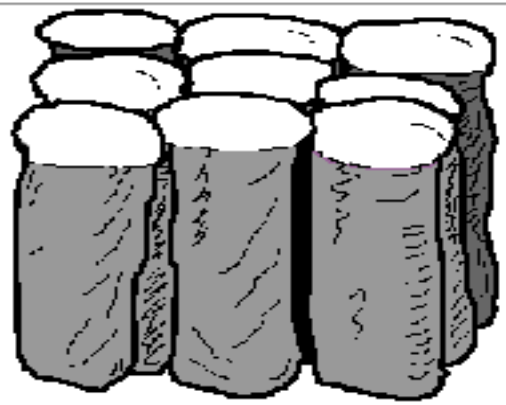
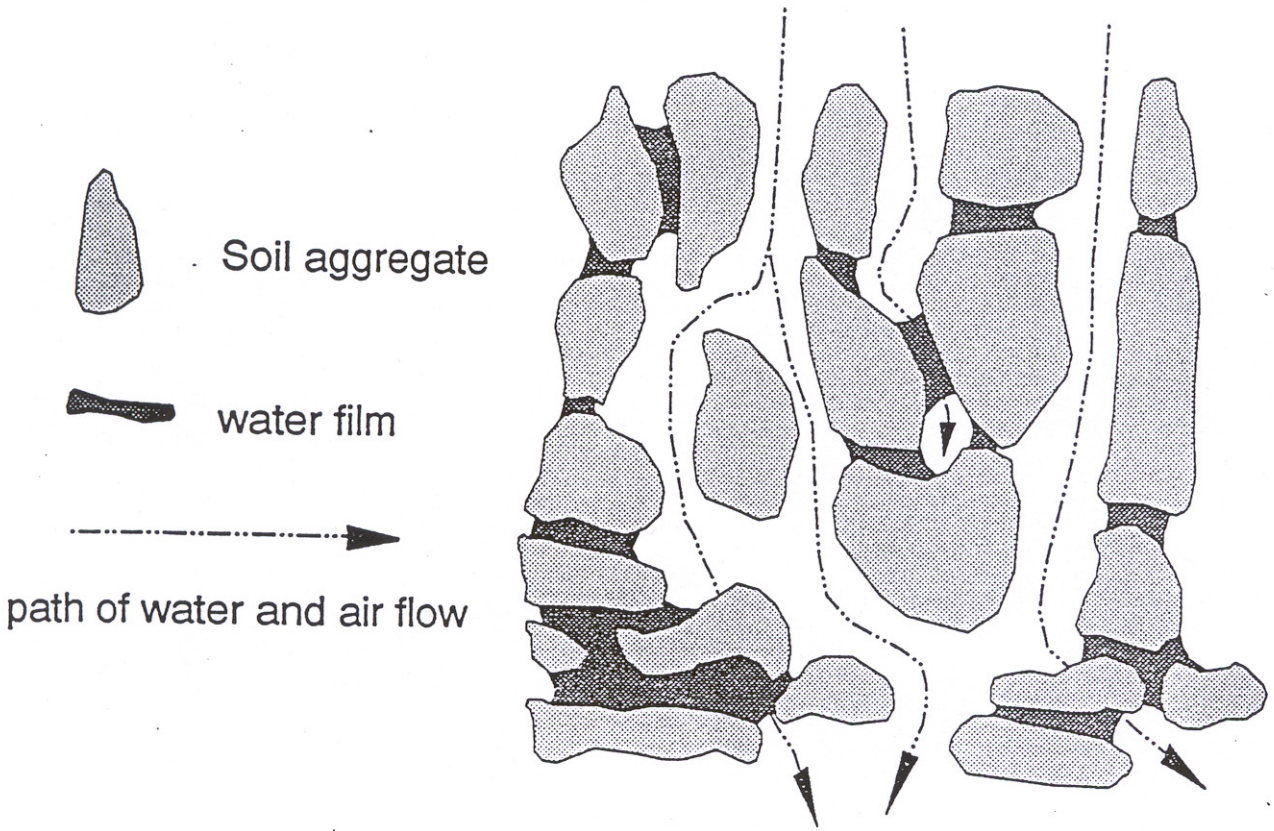

8 cm
8 cm
8 cm
(a)
(b)

Figure 4.15


Clayey aggregates
(a)
Intraped micropores
Macropores
Coarse sand grains
(b)

		
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.

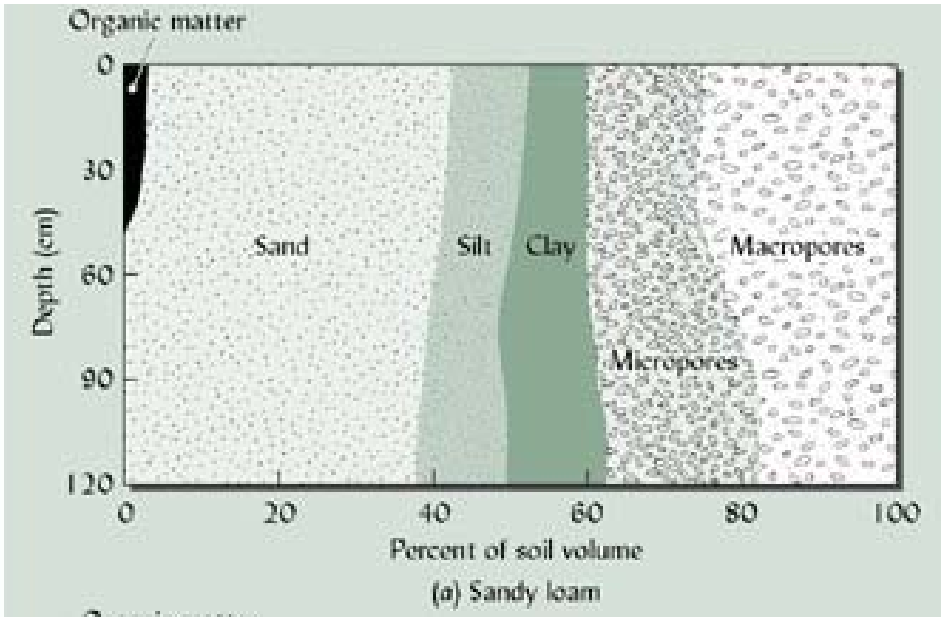

Soil aggregate
water film
path of water and air flow

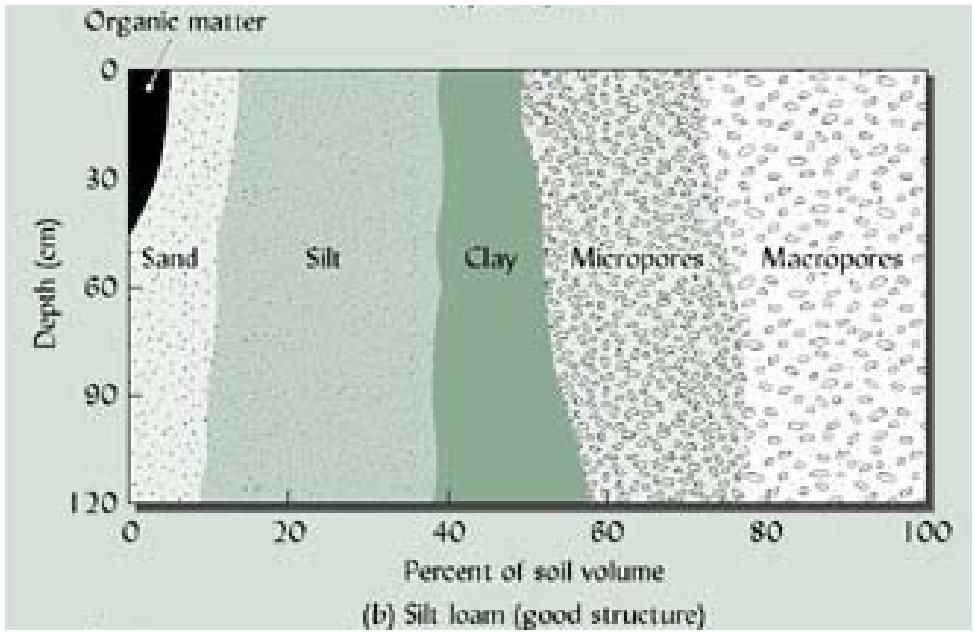
SOIL PORES:

Small pores	-	hold water well (+)
	-	restrict aeration (-)
Large pores	-	hold water poorly (-)
	-	permit free air flow (+)

Soil is a 3-phase system:

Soil Air - connection to atmosphere
Soil Solution - solvent for reactions
Soil Solids - reservoir of nutrients


Organic matter
0
30
60
90
120
Depth (cm)
Sand
Silt
Clay
Macropores
Micropores
0
20
40
60
80
100
Percent of soil volume
(a) Sandy loam


Organic matter
0
30
60
90
120
Depth (cm)
Sand
Silt
Clay
Micropores
Macropores
0
20
40
60
80
100
Percent of soil volume
(b) Silt loam (good structure)

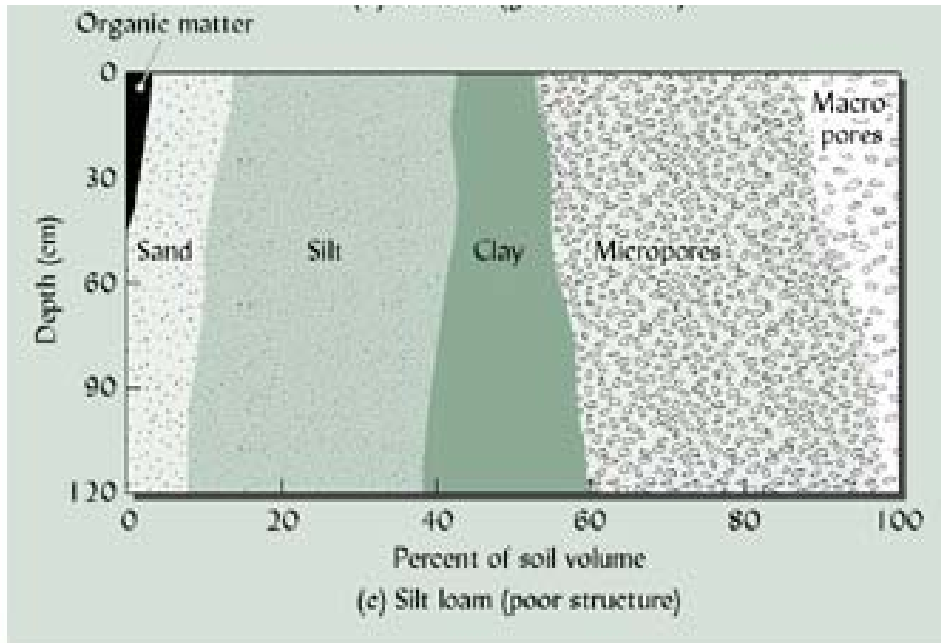

Organic matter
0
30
60
90
120
Depth (cm)
Sand
Silt
Clay
Micropores
Macro
pores
0
20
40
60
80
100
Percent of soil volume
(c) Silt loam (poor structure)

Figure 4.26

PORES

Pores are the tortuous pathways through which water & air flow

Pores can occupy almost half the soil volume.

INTERAGGREGATE PORES	vs.	INTRAAGGREGATE PORES
larger,important in water flow, gas exchange		smaller, little contribution to water flow, gas exchange

Macropores - large, allow rapid water flow

Micropores - small, resist rapid water flow

Origin of pores:

- roots --> decay to leave channel
- worms & other animals --> burrow
- soil drying --> shrinking and cracking

Bulk Density:

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

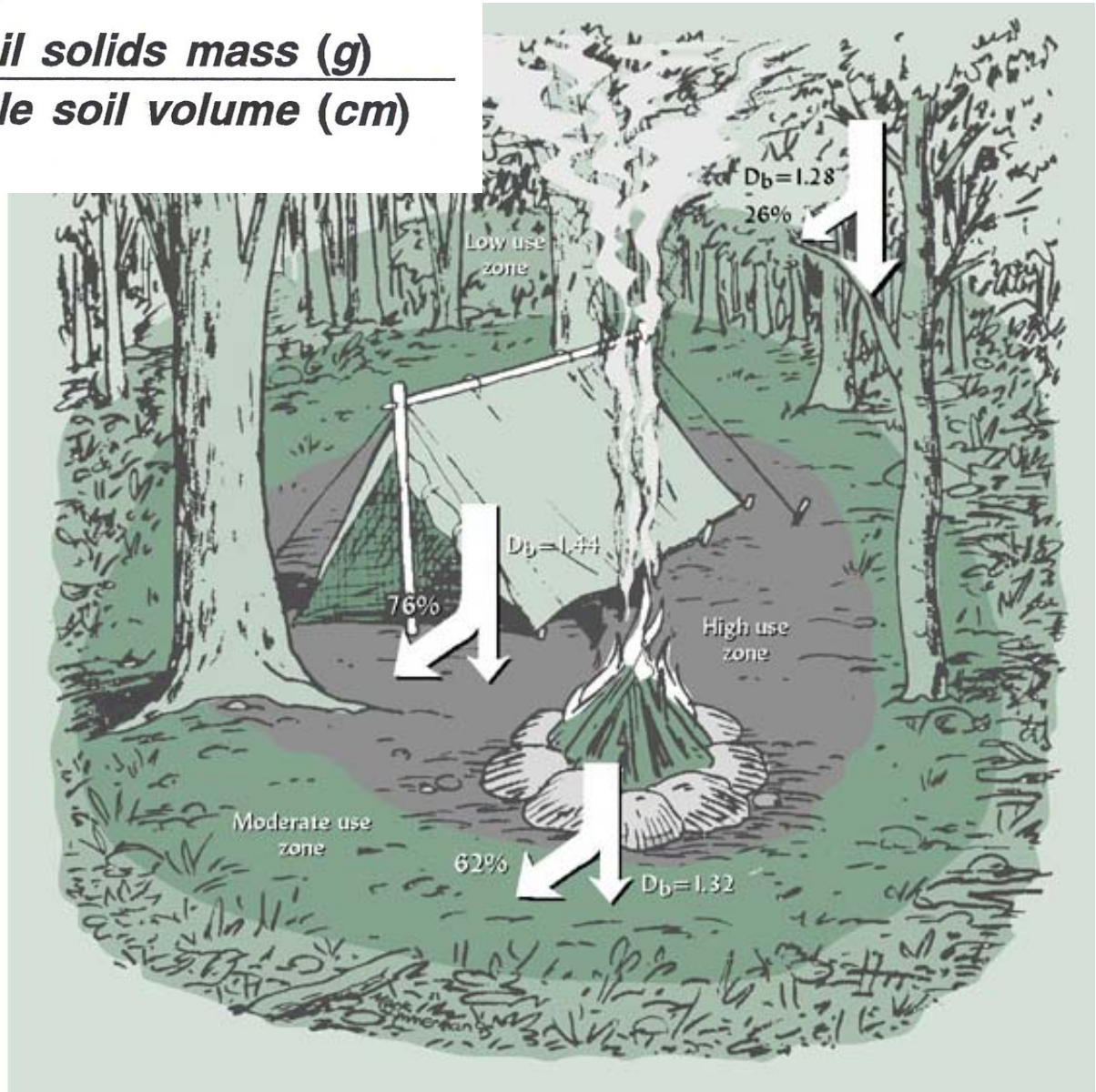
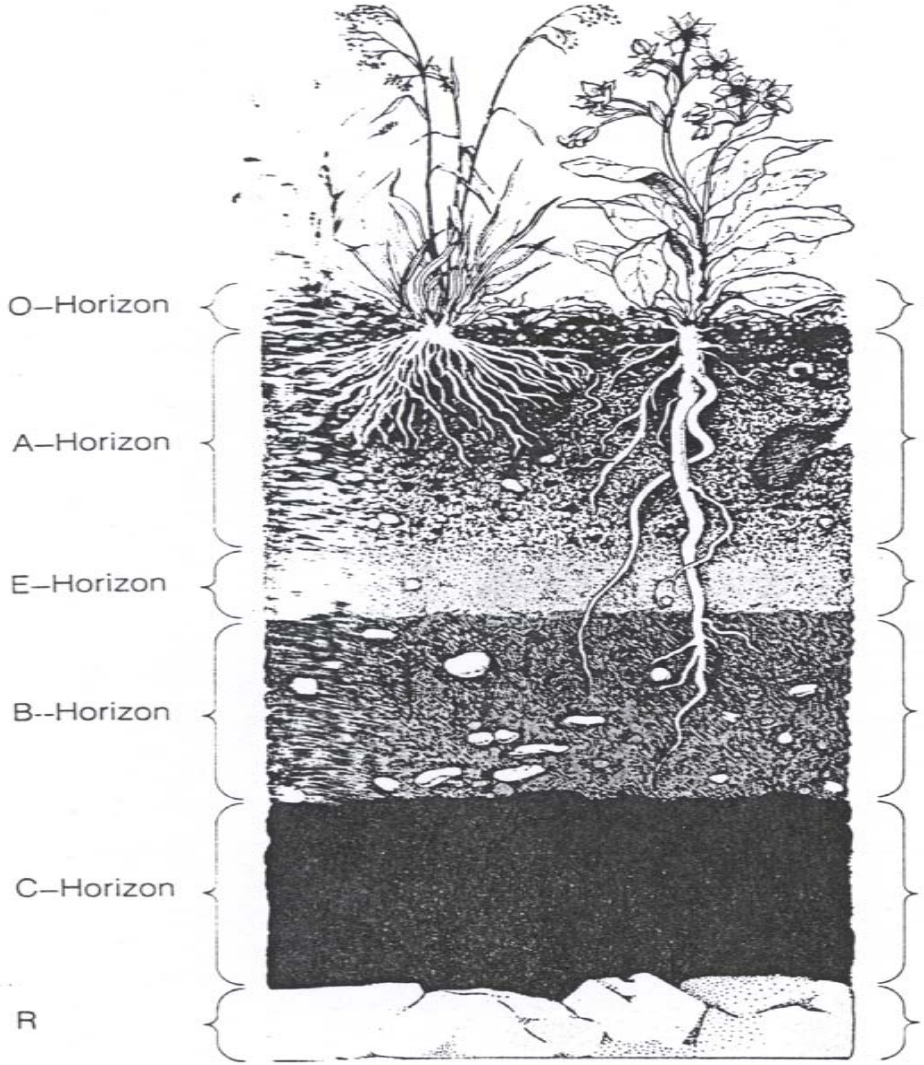


Figure 4.18

hermes.ecn.purdue.edu:8001/ http_dir/acad/agr/...



Surface litter:
Freshly fallen leaves and organic debris and partially decomposed organic matter

Topsoil:
Partially decomposed organic matter (humus), plant roots, living organisms, and some inorganic minerals

Zone of leaching:
Area through which dissolved or suspended materials move downward

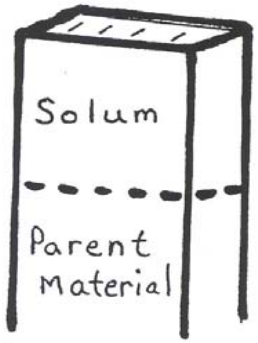
Subsoil:
Unique colors and often an accumulation of iron, aluminum, and humic compounds, and clay leached down from above layers

Parent material:
Partially broken-down inorganic materials

Bedrock:
Impenetrable layer, except for fractures

SOIL MORPHOLOGY

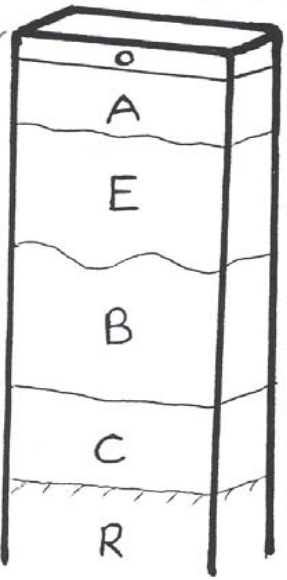
Soil is a three-dimensional body-- a PEDON



Solum differentiated from parent material by climate & biological activity

Soil horizons - distinguishable layers that make up the solum

Master Horizons - O, A, E, B, C, R



Solum

Parent Material

organic material is dominant

highest biological activity, most humus

eluviation zone (e.g.-clay & iron oxide lost)

illuviation zone (e.g.-clay & iron oxide gained)

unconsolidated parent material, unaltered

bedrock

DESCRIPTION OF SOILS

MINERAL SOILS -
Master Horizons A,O,E,B,C and R

A - mineral soil layer at surface (unless buried)

- maximum biological activity
  --> humus accumulation (dark)
  --> rapid mineral weathering
  --> ELUVIATION of soluble products

O - predominantly organic surface horizon
- typical in uncultivated forest soils

E - found below an A or O horizon
- mineral horizon, strongly eluviated
- organic acieds are leached from above, weather & translocate silicate clay, Fe, Al
- often composed of mainly resistant minerals (e.g. quartz)
- usually lighter than A (above) or B (below)

B - **zone of illuviation**
- **eluviated clays, Fe & Al, $CaCO_3$, humus, silica, salts, may accumulate**
- **common types of B-horizons:**

B_h, B_s **humus & sesquioxides ---> cool, humid climates, on coarse parent material, coniferous forest.**

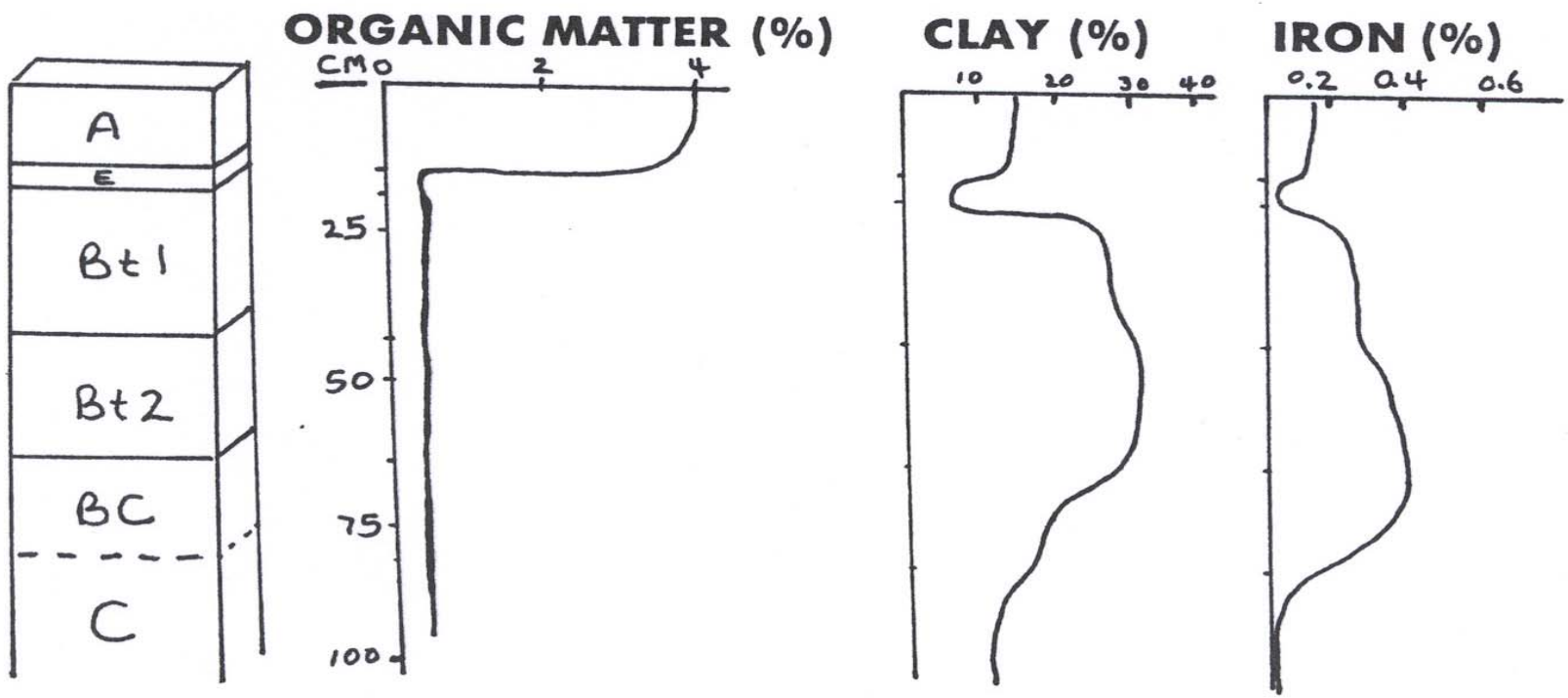
Fe, Al - oxides ± hydroxides

B_t clay illuviation (most climates)

B_k carbonate (arid/semi-arid climate)

B_x fragipan

C, R - parent material


ORGANIC MATTER (%)
CLAY (%)
IRON (%)
A
E
Bt1
Bt2
BC
C
CM 0
2
4
25
50
75
100
10
20
30
40
0.2
0.4
0.6

Lower Case Symbols to designate distinctions within Master Horizons

a. Organic Matter, highly decomposed

b. Buried soil horizon

c. Cementation or nodules

d. Dense unconsolidated materials

e. Organic Matter, intermediate decomposition

f. Frozen soil

g. Strong gleying (mottling)

h. Illuvial accumulation of organic matter

i. Organic Matter, slightly decomposed

j. Jarosite

jj. Cryorturbation (frost churning)

k. Accumulation of Carbonates

m. Cementation or induration

n. Accumulation of Sodium

o. Accumulation of Fe and Al oxides

p. Plowing or other disturbance

q. Accumulation of Silica

r. Weathered or soft bedrock

s. Illuvial accumulation of OM* and Fe and Al oxides

ss. Slickensides

t. Accumulation of silicate clays

v. Plinthite (high iron, red material)

w. Distinctive color or structure

x. Fragipan (high bulk density, brittle)

y. Accumulation of gypsum

z. Accumulation of soluble salts

* OM = organic matter