Soil Development and Characterization

Soils Sustain Life

Right off the Bat!!

- A soil is not a geologic deposit, it is a product of in situ weathering.
- Engineers, archaeologists, and others have learned that anything that is not rock on the Earth's surface is soil.
- The way a soil is defined depends largely on the way you view it, eg. engineers, archaeologists, agronomists, ect.

Soil forming factors

- Hans Jenny (1941) Cl, o, r, p, t
- cl, climate
- o, biotic influence
- r, topographic relief
- p, parent material
- t, time

Development

- Each variable plays an important role
- Climate, organisms, and topographic relief, are likely to change (evolve) over the duration (2 to 20,000 years) of soil formation.
- Most important factors =
  - Climate (ppt. and temp.) AND
  - Parent material

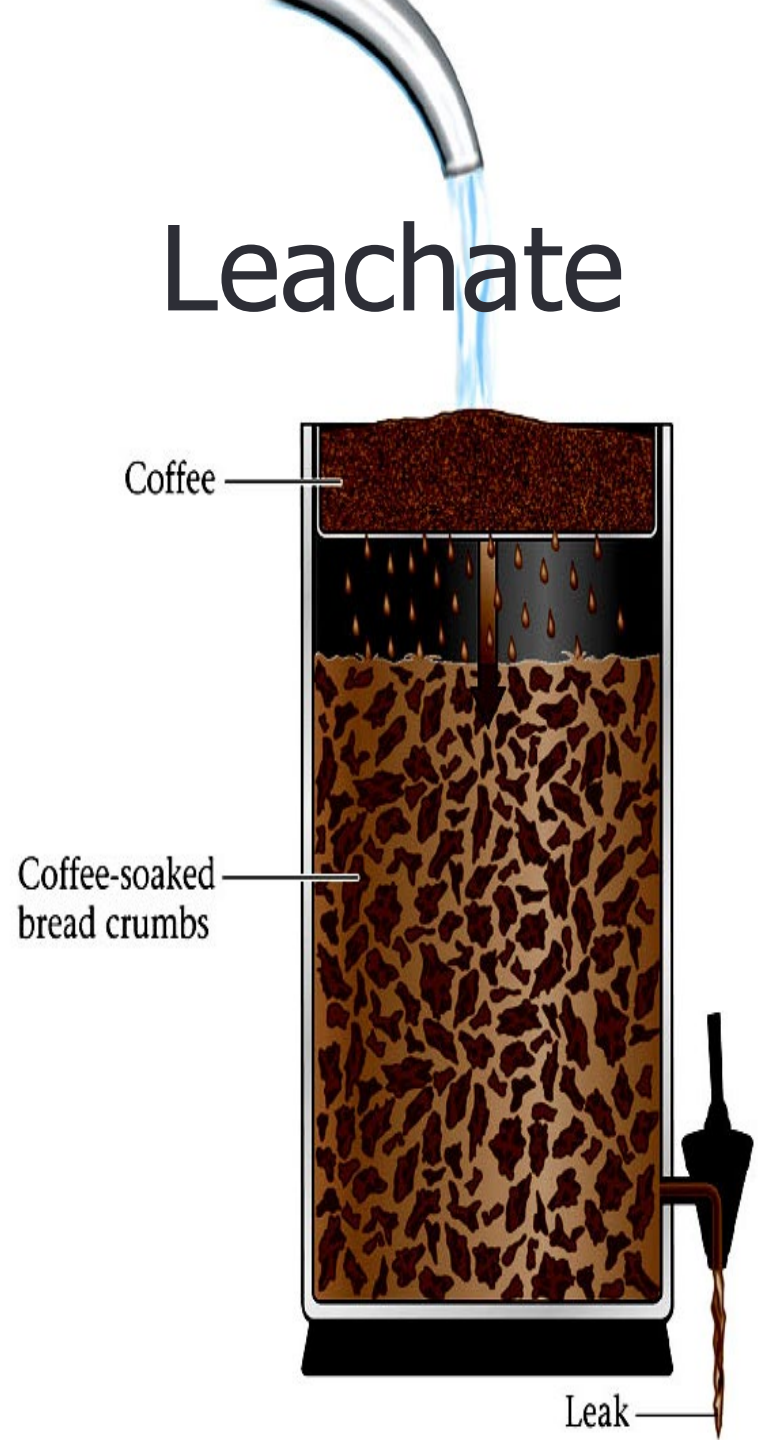
Importance of climate

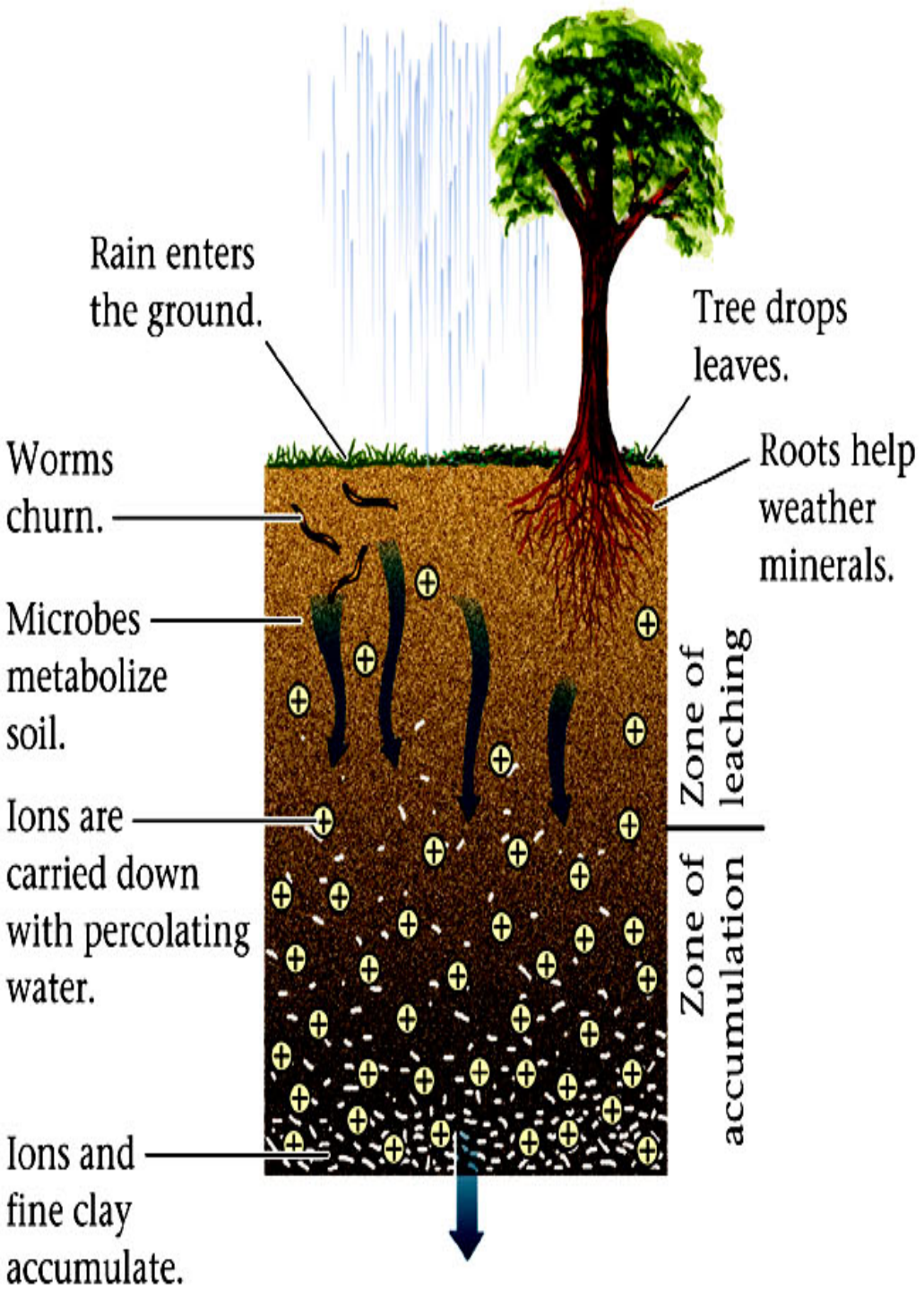
- Australian buaxite
- Parent material, 90% sandstone, 10% kaolinite
- Climate, Hot monsoons, with approx. 1500mm/yr ppt., plus time produces an abundant source of buaxite from and unlikely parent material.
- End weathering product/soil profile has leached the majority, 85% of the quartz to 8 m, the upper 5m consists of hydrated AlOH (oxides) with iron stains.

Jenny's individual soil functions

- s or S = f (cl, o, r, p, t) climofunction
- s or S = f (o, cl, r, p, t) biofunction
- s or S = f (r, cl, o, p, t) topofunction
- Lithofunction
- Chronofunction
- To solve each function, the first factor listed (cl) is allowed to vary while the others remain constant. It is then possible to statistically determine the dependancy of one (or more) soil properties on a single factor

Leachate


Coffee
Coffee-soaked bread crumbs
Leak

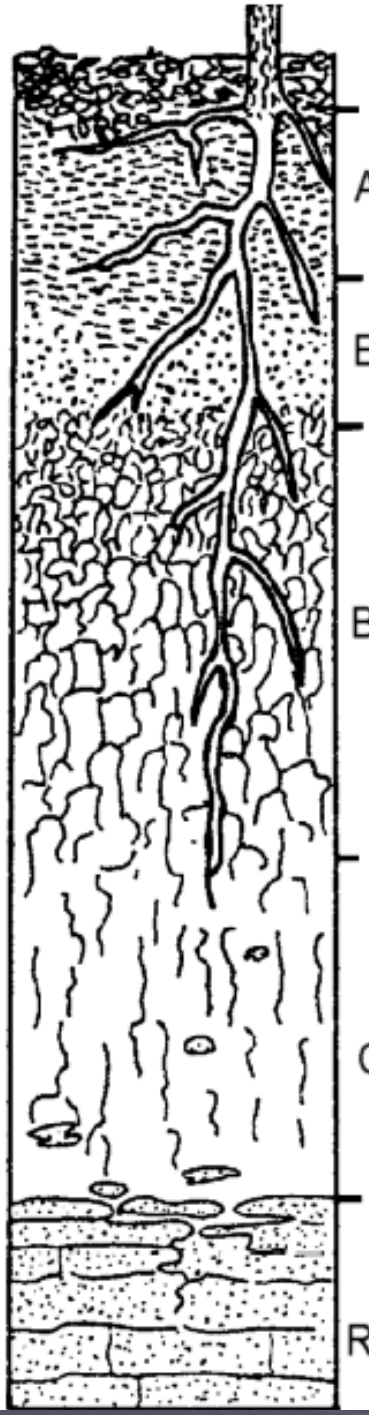

Rain enters the ground.
Tree drops leaves.
Worms churn.
Roots help weather minerals.
Microbes metabolize soil.
Ions are carried down with percolating water.
Zone of leaching
Zone of accumulation
Ions and fine clay accumulate.

Horizons

- Distinctive weathered zones that are roughly parallel to the land surface and are the product of weathering processes.
- Master horizons are O, A, E, B, C, and R.
- Sub-horizons

Horizons

- O – Fresh to partly decayed OM/leaves/grass
- A – Accumulated organics, dark
- E – Eluviation – leached, light in color, rich in silica
- B – Illuviation – clay, iron, aluminum accumulation, commonly subangular block, 10yr page
- C – Unconsolidated, poorly weathered/no soil stucture, yet maybe chemically different than parent material
- R – Unweathered Rock or Sediment


Leaf litter
A
Mineral horizon at the surface showing organic matter enrichment
E
Subsurface horizon showing depletion of organic matter, clay, iron, and aluminium compounds
B
Subsoil horizon showing enrichment of clay material, iron, aluminum, or organic compounds
C
Horizons of loosened or unconsolidated material
R
Hard Bedrock


0
1
2
3
4
5

Sub-horizons – Common in Iowa

- b – buried soil
- d – dense unconsolidated material
- g – gleyed/mottled horizon
- p - plowed
- t – clay accumulation
- w – distinctive color structure

Developing vocabulary

Mollic (A)

Argillic (Bt)

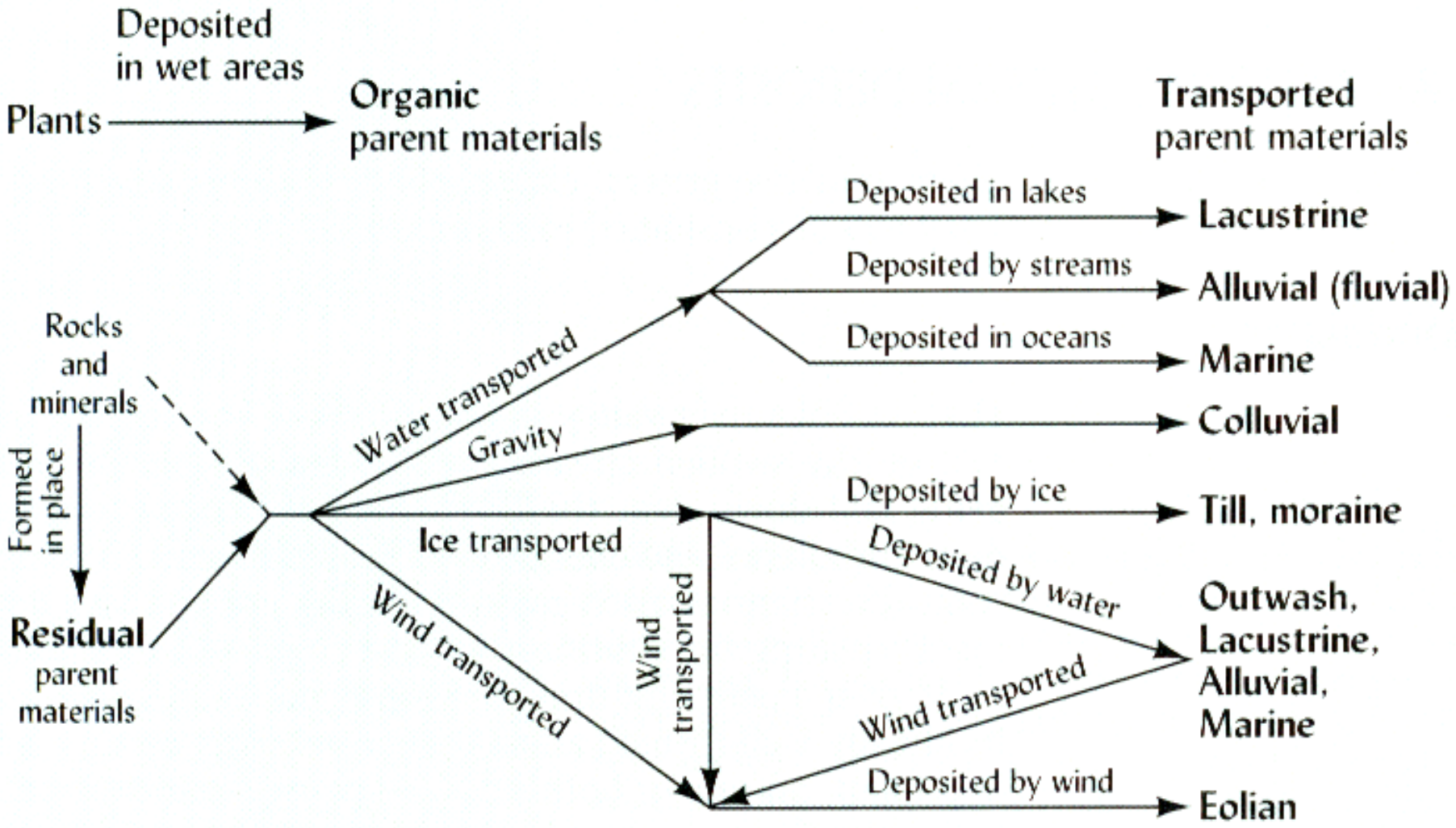
Cambic (Bw)

Fragipan (Bx)

Surface horizons = epipedons	
Mollic (A)	Thick, dark-colored, high base saturation, strong structure
Umbric (A)	Same as mollic except low base saturation
Ochric (A)	Too light-colored, low organic content or thin to be Mollic; may be hard and massive when dry
Melanic (A)	Thick, black, high in organic matter (>6% organic C), common in volcanic ash soils
Histic (O)	Very high in organic content, wet during some part of year
Anthropic (A)	Human-modified molliclike horizon, high in available P
Plaggen (A)	Human-made sodlike horizon created by years of manuring
Subsurface horizons	
Argillic (Bt)	Silicate clay accumulation
Natric (Btn)	Argillic, high in sodium, columnar or prismatic structure
Spodic (Bh, Bs)	Organic matter, Fe and Al oxides accumulation
Cambic (Bw, Bg)	Changed or altered by physical movement or by chemical reactions, generally nonilluvial
Agric (A or B)	Organic and clay accumulation just below plow layer resulting from cultivation
Oxic (Bo)	Highly weathered, primarily mixture of Fe, Al oxides and non-sticky-type silicate clays
Duripan (Bqm)	Hardpan, strongly cemented by silica
Fragipan (Bx)	Brittle pan, usually loamy textured, dense
Albic (E)	Light-colored, clay and Fe and Al oxides mostly removed
Calcic (Bk)	Accumulation of $CaCO_3$ or $CaCO_3 \cdot MgCO_3$
Gypsic (By)	Accumulation of gypsum
Salic (Bz)	Accumulation of salts
Kandic (Bt)	Accumulation of low-activity clays
Petrocalcic (Ckm)	Cemented calcic horizon
Petrogypsic (Cym)	Cemented gypsic horizon
Placic (Csm)	Thin pan cemented with iron alone or with manganese or organic matter
Sombric (Bh)	Organic matter accumulation
Sulfuric (Cj)	Highly acid with Jarosite mottles

Transitional horizons

Parent Material

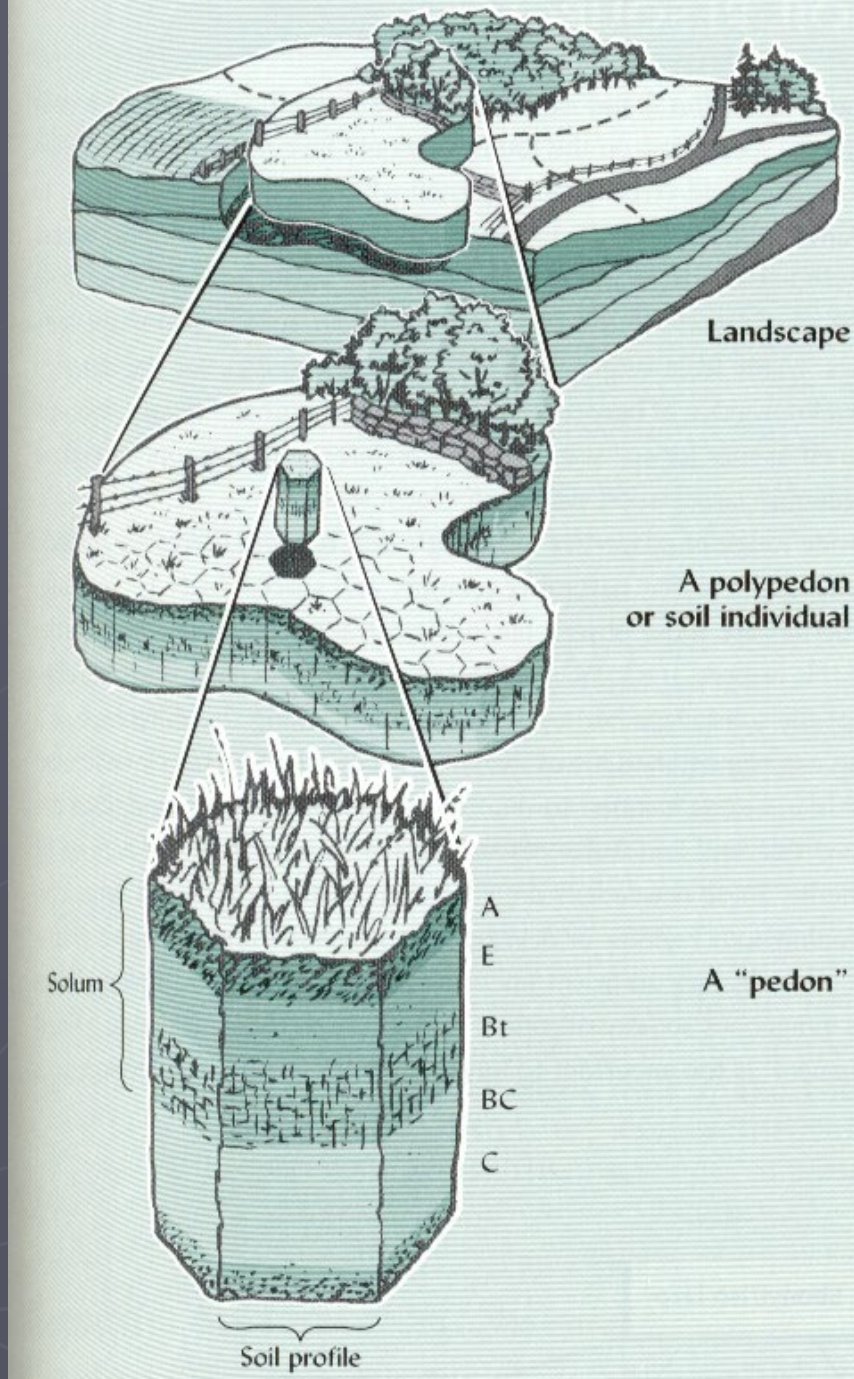


Soil Classification

- Why develop a soil classification system?

Soil landscape

- Pedon - 3-D soil body
- Solum – Surface and subsurface master horizons that are chemically and physically different from the parent material (A-B and/or BC, NOT C)



Epipedon

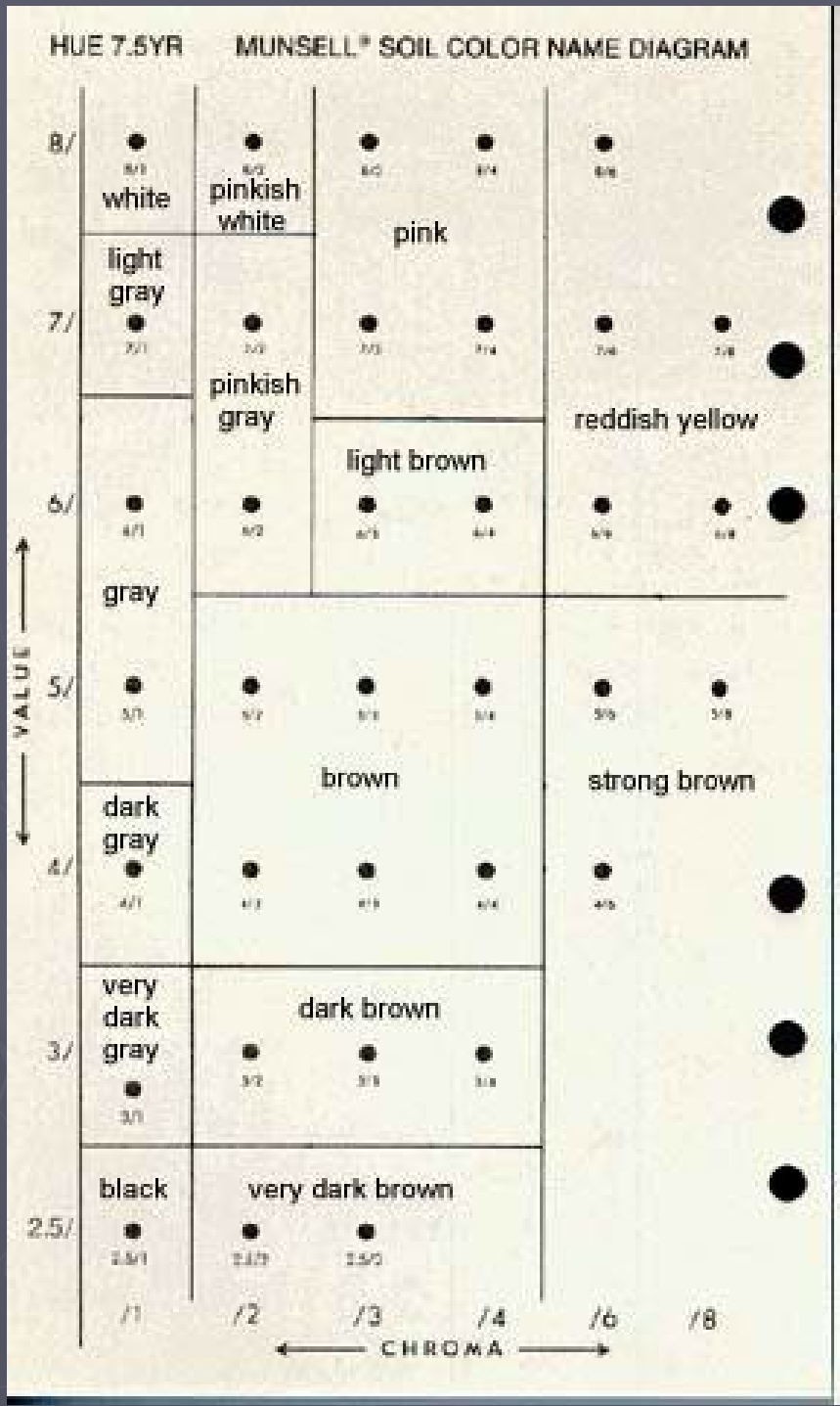
- Upper portion of the soil that is darkened by organic matter and/or the upper illuvial horizons.
- The epipedon may extend into the B-horizon if (darkened by organic material)

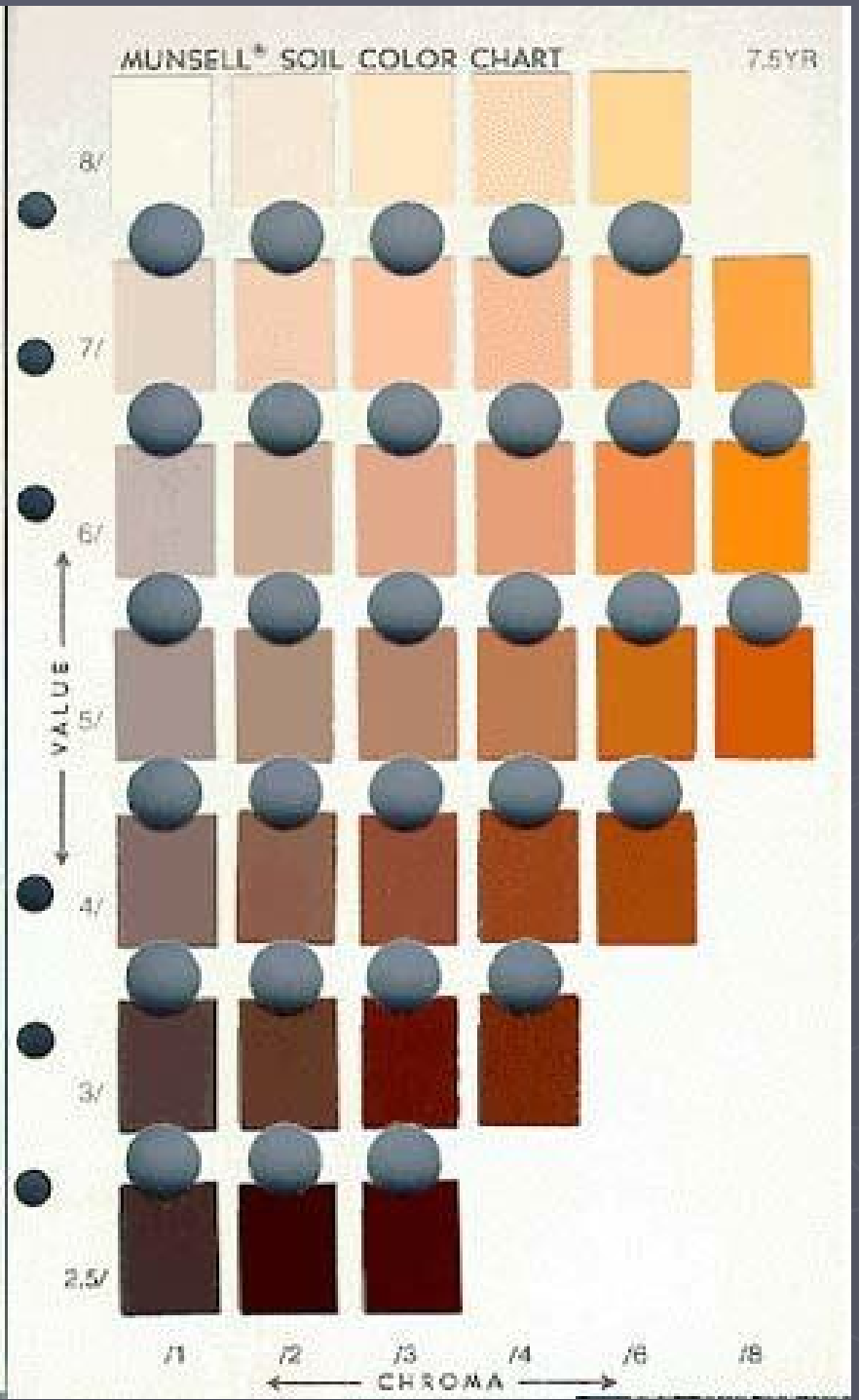
Soil Taxonomy

- Order 12
- Suborder 63
- Great Group 319
- Sub Group 2, 484
- Family 8, 000
- Series 19, 000

Describing a soil

- Color
- Thickness
- Structure
- Texture

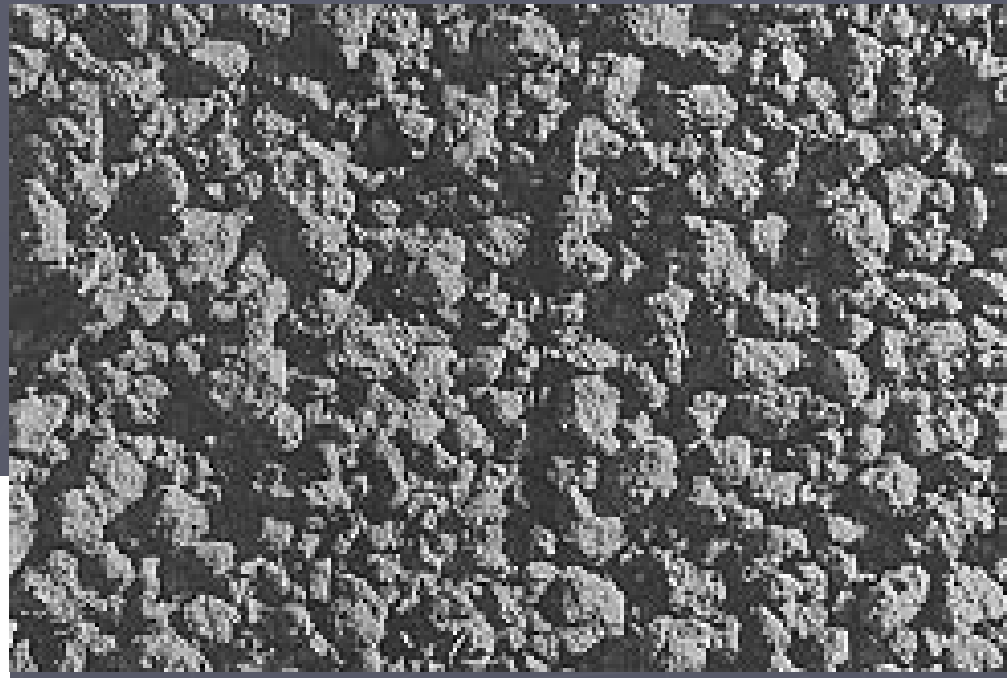

HUE 7.5YR
MUNSELL® SOIL COLOR NAME DIAGRAM
8/
7/
6/
5/
4/
3/
2.5/
VALUE
white
pinkish white
pink
light gray
pinkish gray
reddish yellow
light brown
gray
brown
strong brown
dark gray
very dark gray
dark brown
black
very dark brown
/1
/2
/3
/4
/6
/8
CHROMA

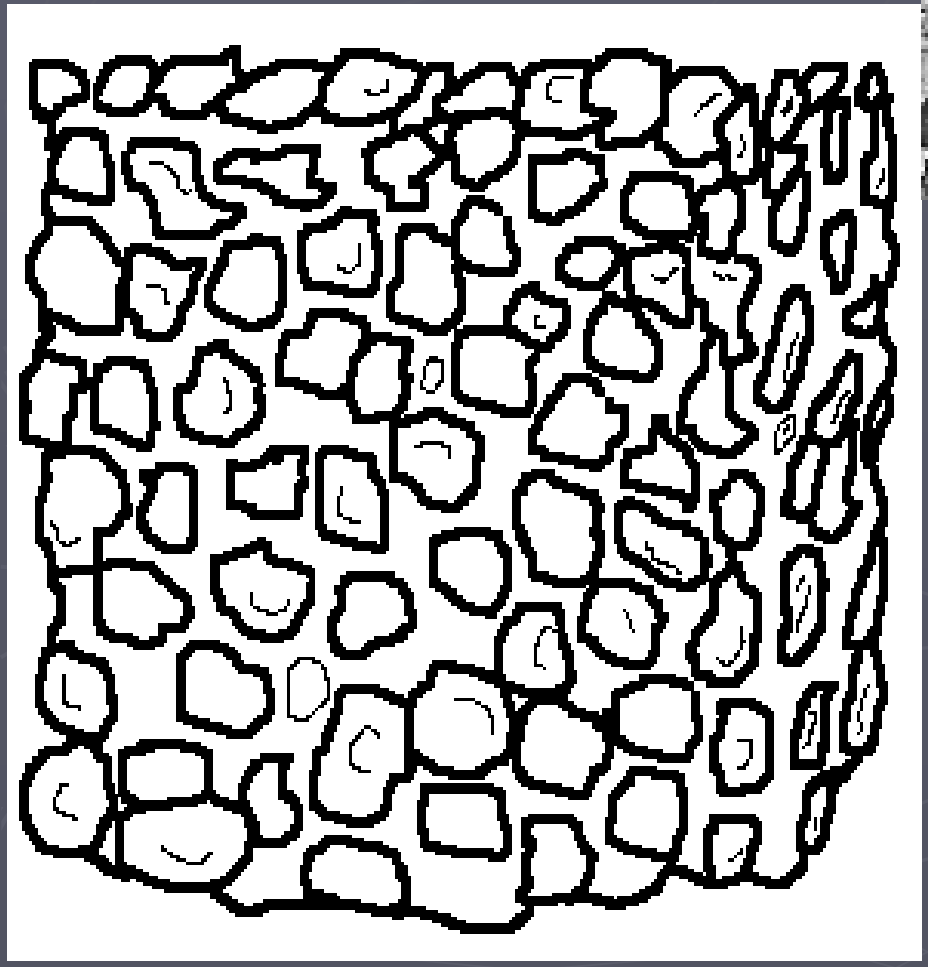

MUNSELL® SOIL COLOR CHART
7.5YR
8/
7/
6/
5/
4/
3/
2.5/
VALUE
/1
/2
/3
/4
/6
/8
CHROMA

Structure

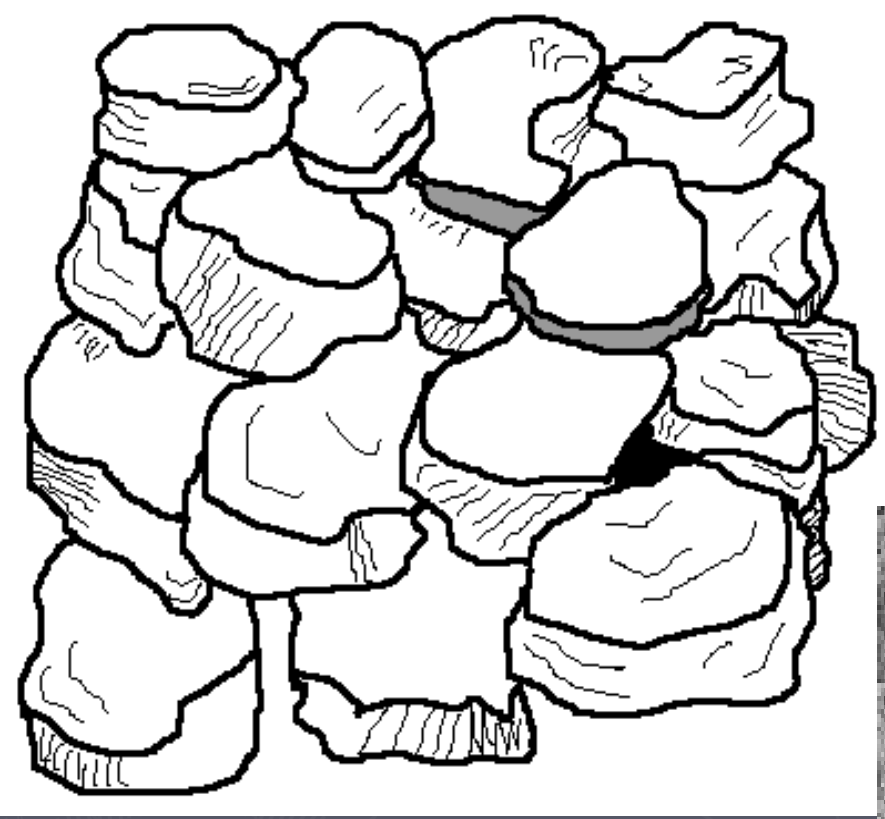
- As a soil develops, soil peds begin to form shapes or a structure

Granular



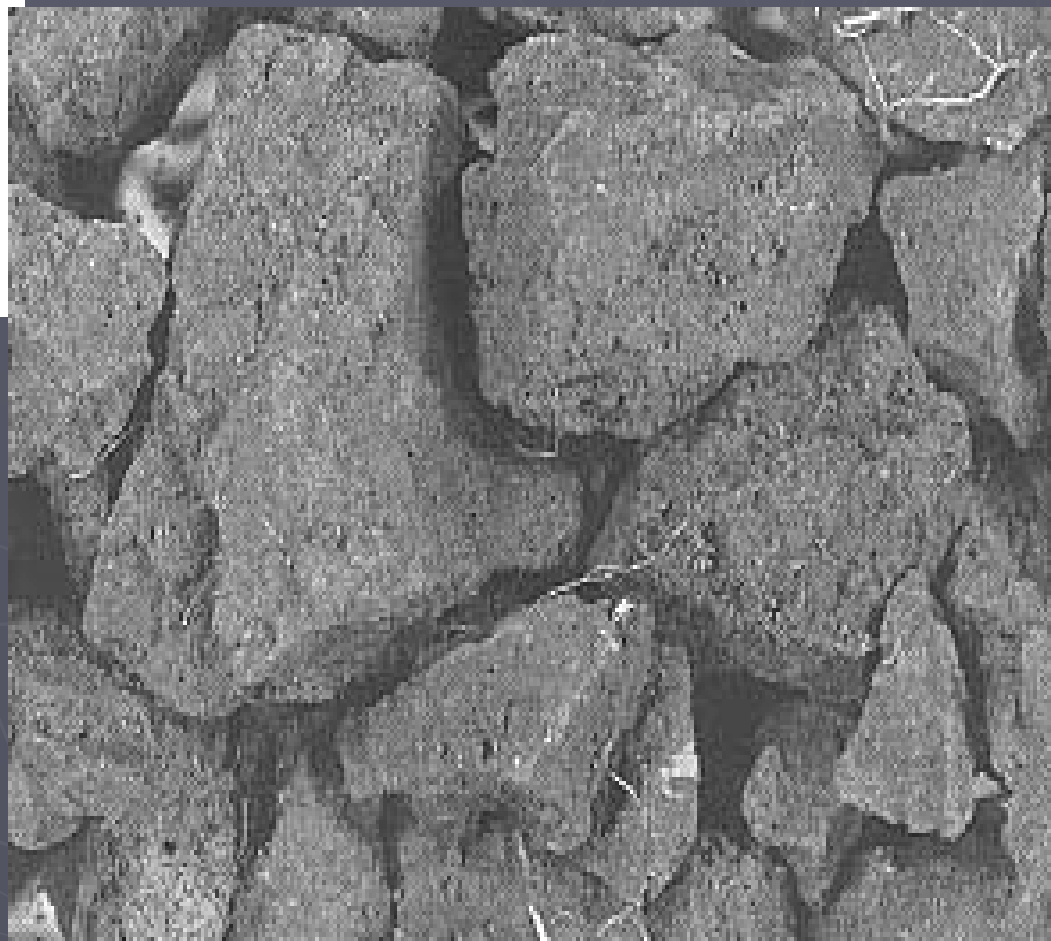


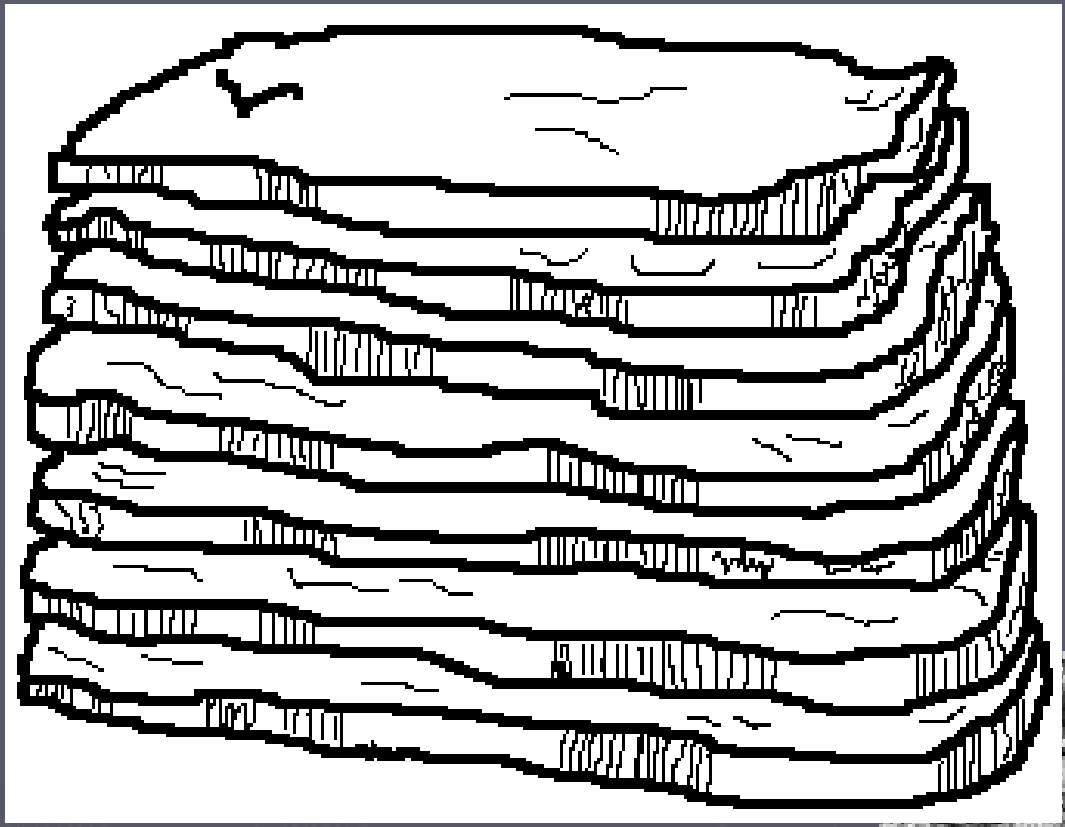
A-horizon



Blocky

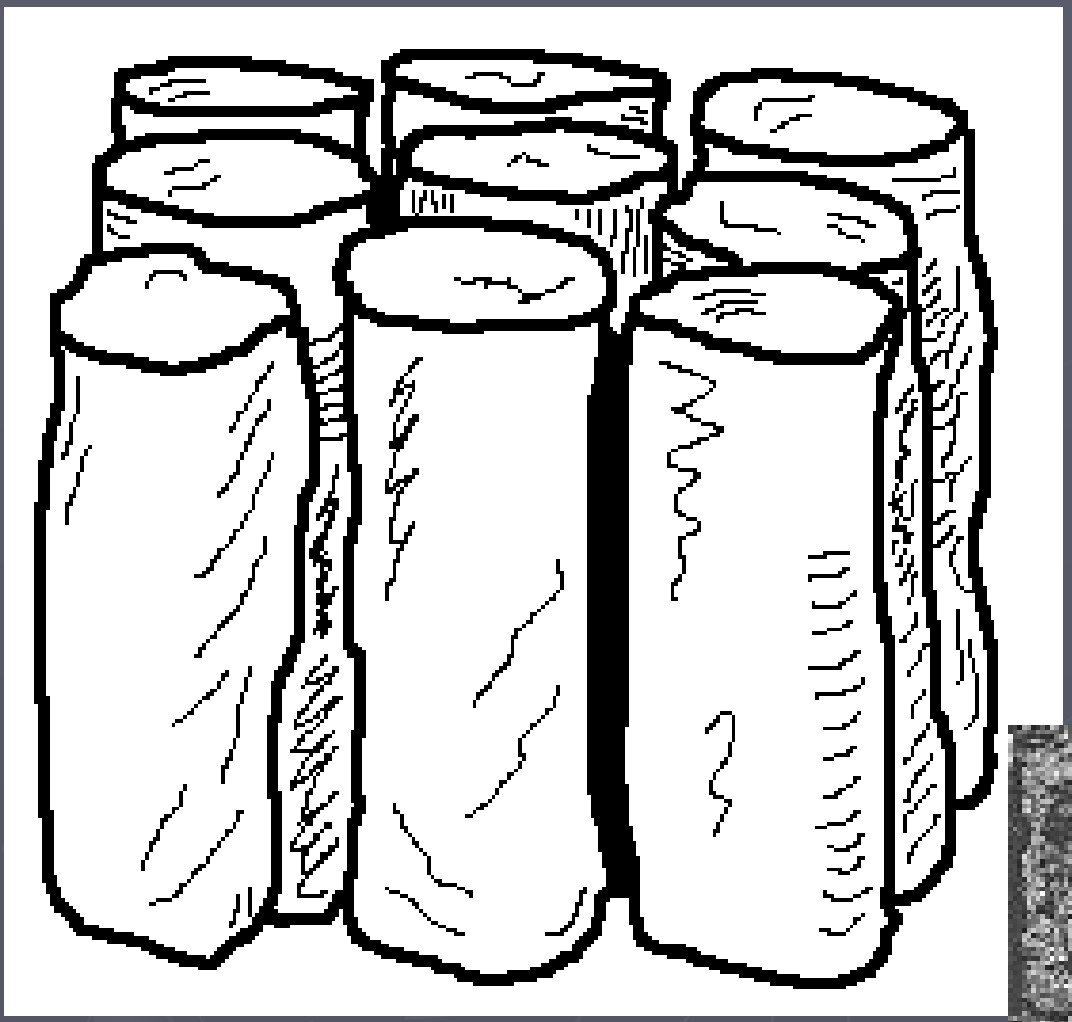
B-horizon



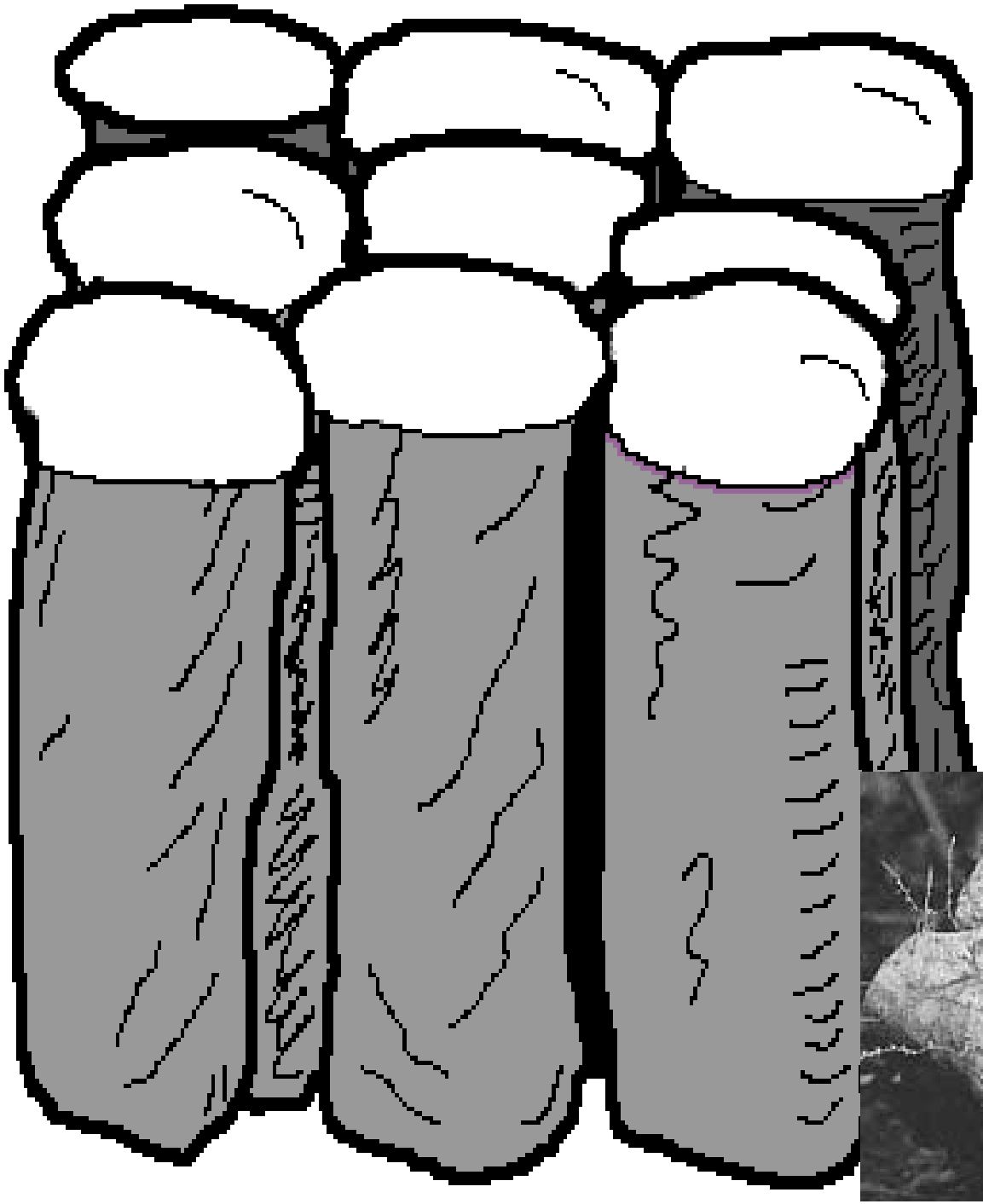


Platy

Prismatic

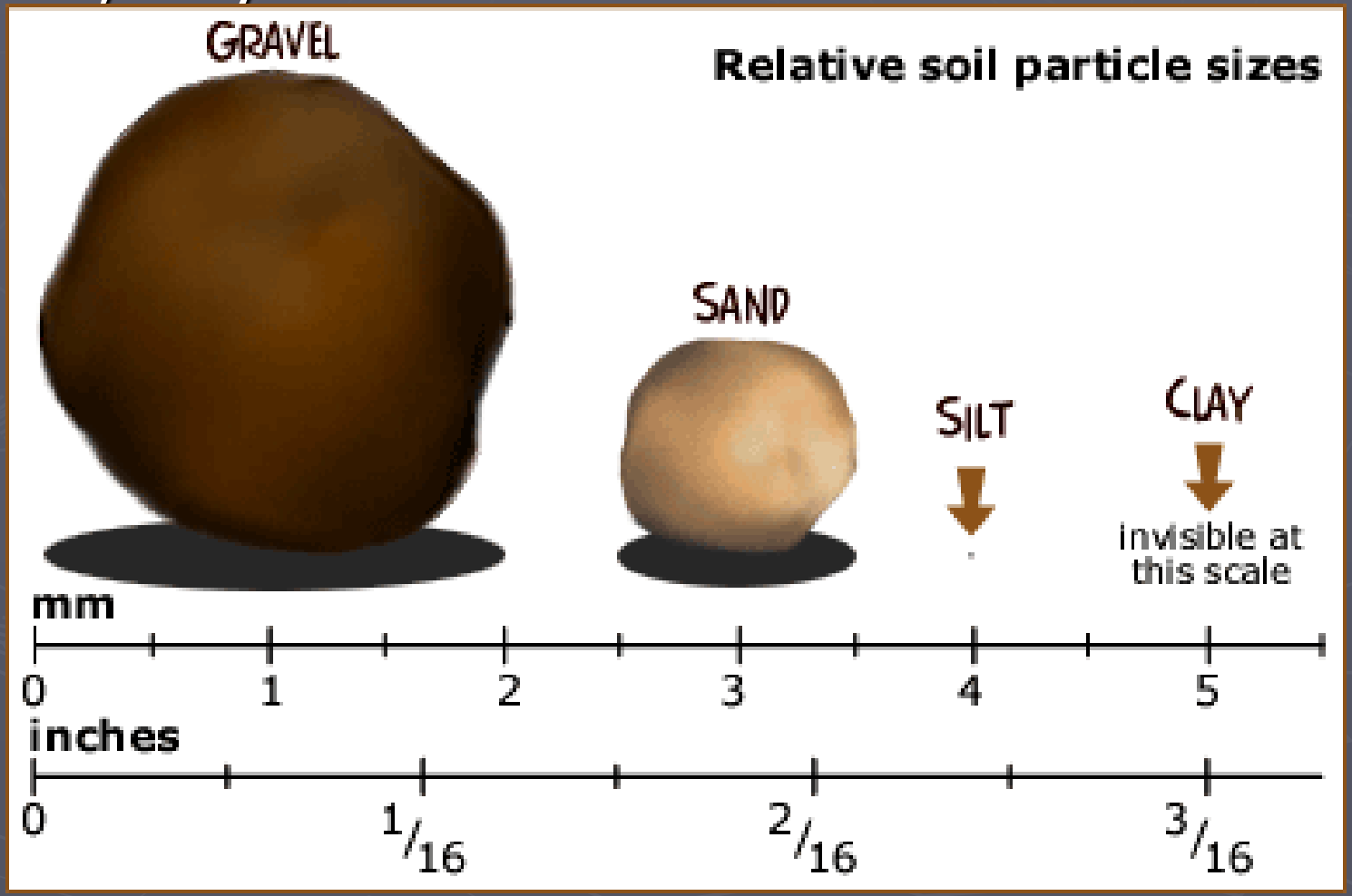


Columnar

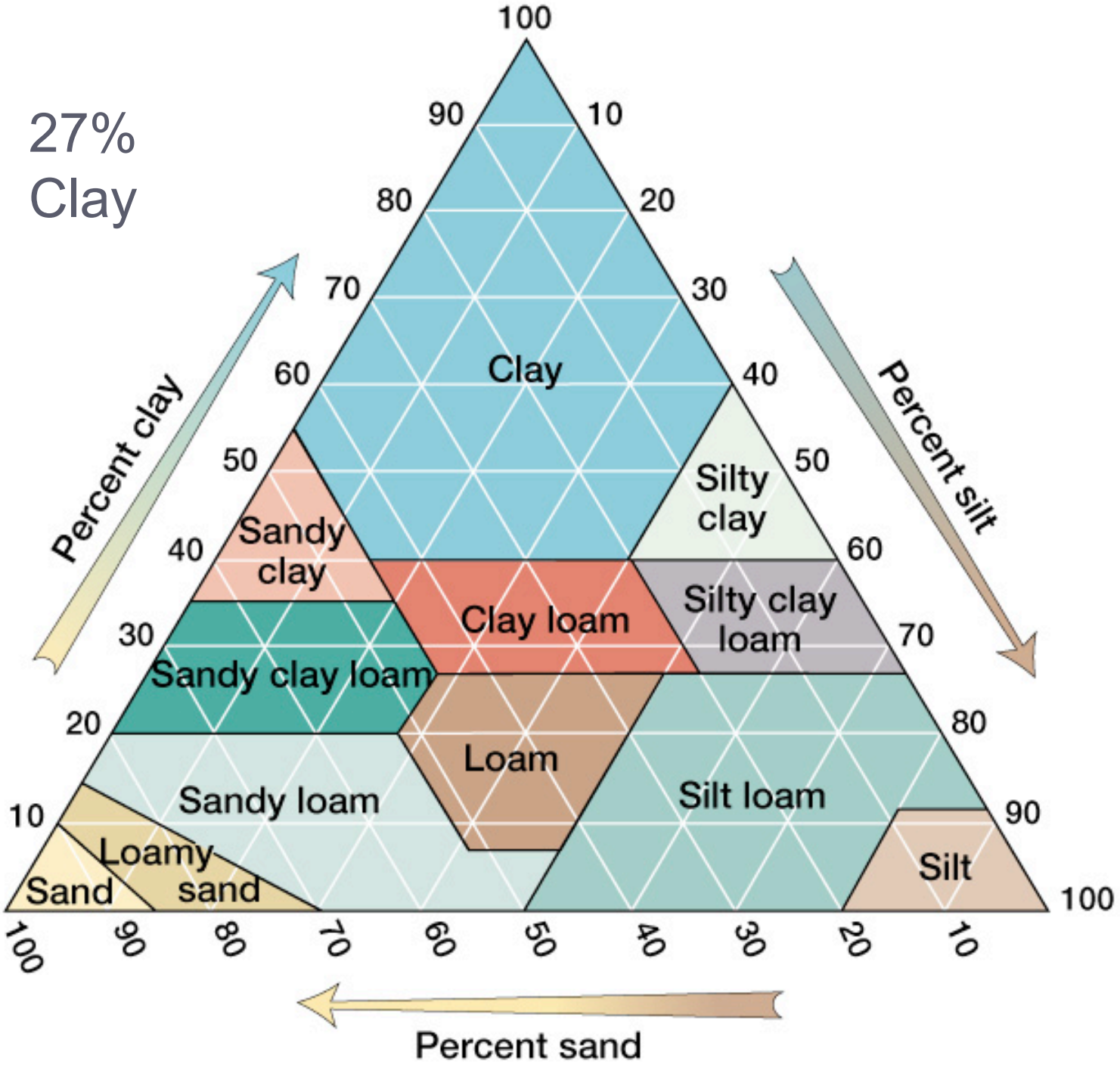


Texture

- Size of the individual peds
  - Sand, Silt, Clay



27%
Clay


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

Geographic variability and Soils

Small scale

Your back yard

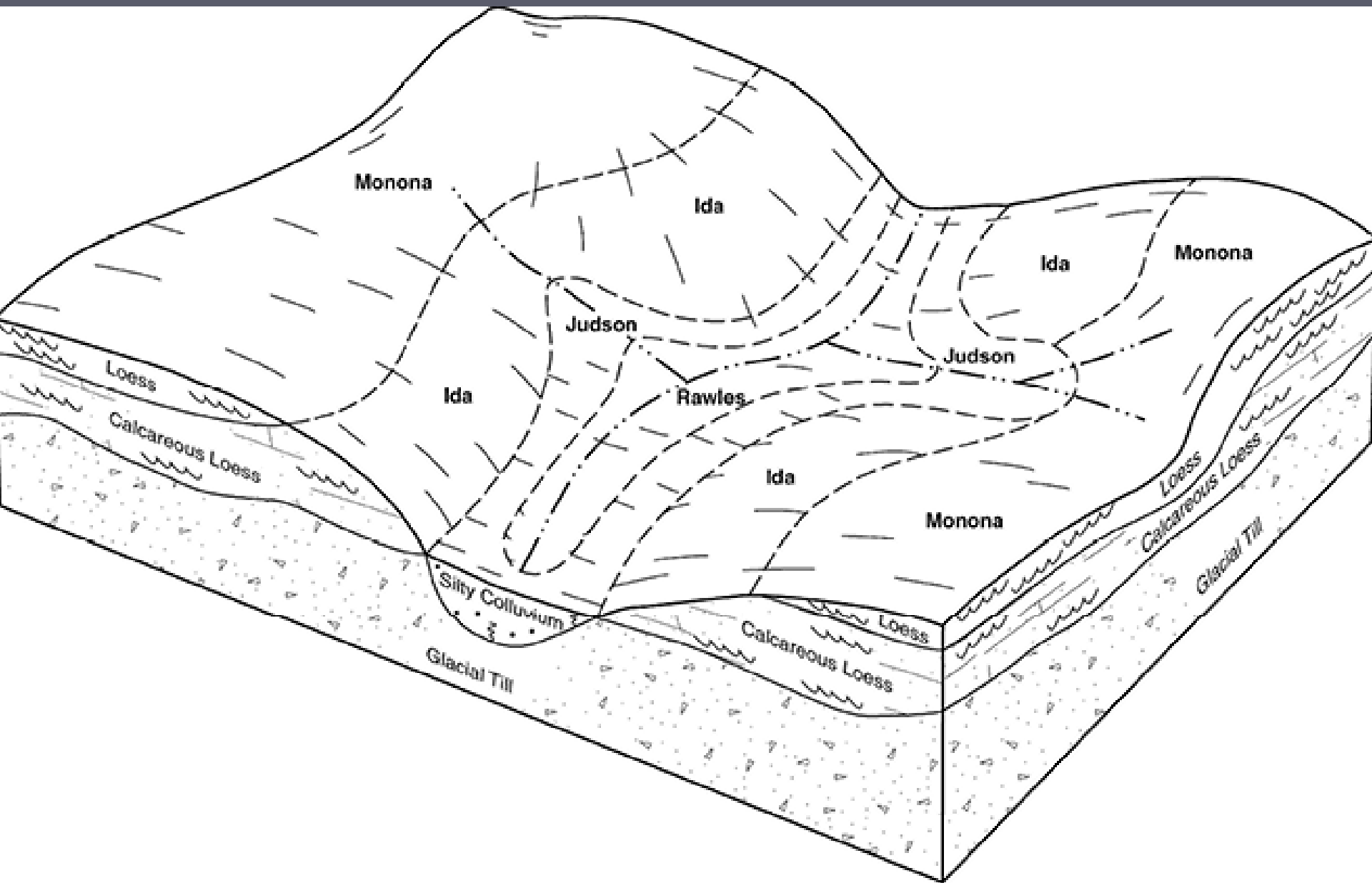
Medium scale

Slope ,pasture/field, Iowa Landform Regions

Large scale

The Great Plains

Soil associations

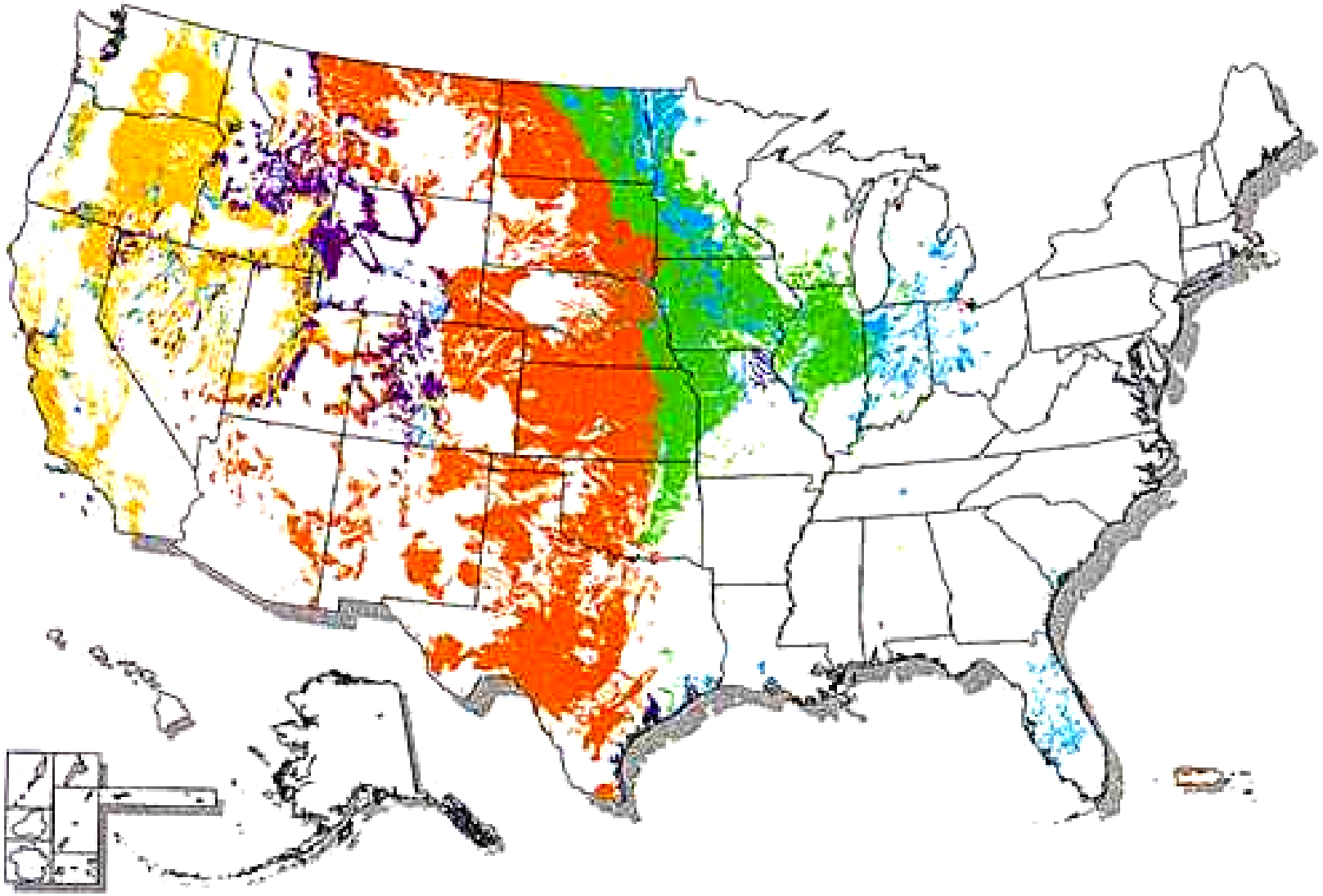


Generalizations

E.g. Oxisols, found in hot, humid, regions

Mollisols, found in Semi-arid grasslands

Aridisols, found in desert regions


Mollisols
DOMINANT SUBORDERS
Albolls
Rendolls
Xerolls
Aquolls
Udolls
Cryolls
Ustolls

Paleosols

- A soil that formed on a landscape of the past. –Ruhe 1965
- A soil that formed in a previously existing climate and may now be buried.

Paleosols

- Paleosols are ancient or fossil soils preserved in the stratigraphic record
- Paleosols generally occur beneath unconformities
- Paleosols provide good clues for the interpretation of paleoenvironments and paleoclimates