PA Boot Camp Level 1

Basic Soil Properties

Photo Credits: Ron Nichols, USDA NRCS

Soil Basics

- Soil is a mixture of minerals, organic matter, water, and air, which forms on the land surface.
- It can support the growth of plants.
- Soil supports countless microorganisms.
- It comes in many different types.

Soil performs critical functions…

Our food comes directly or indirectly from plants anchored in and nourished by soil.

Soils provide **habitat** for soils organisms

Water we drink and use everyday has been **filtered** by soil.

Soils process and **recycle nutrients**, including carbon, so that living things can use them over and over again.

Soils serve as the **foundation** for the construction of roadbeds, dams and buildings.

-Soil Science Society of America

Soil Formation

- Unique types of soils form under unique sets of Soil Forming conditions

$$s = f(cl, o, r, p, t)$$

(H. Jenny, 1941 book “Factors of Soil Formation”)

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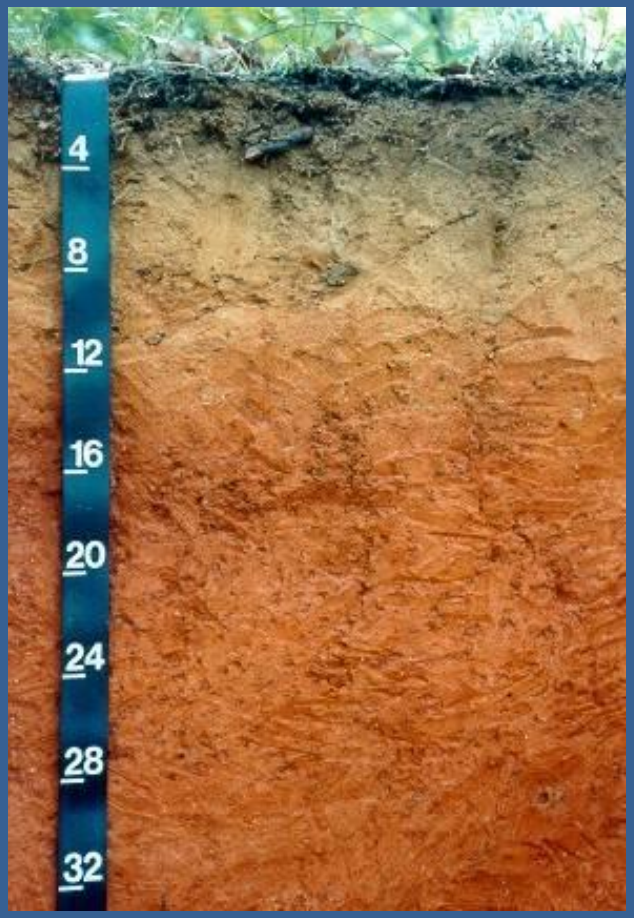
5 Soil Forming Factors

Climate
(temp and precip)

Relief
Landscapes
(topography)



Organisms
(biota)

Parent Material
(geology)

Interacting together over a period of Time

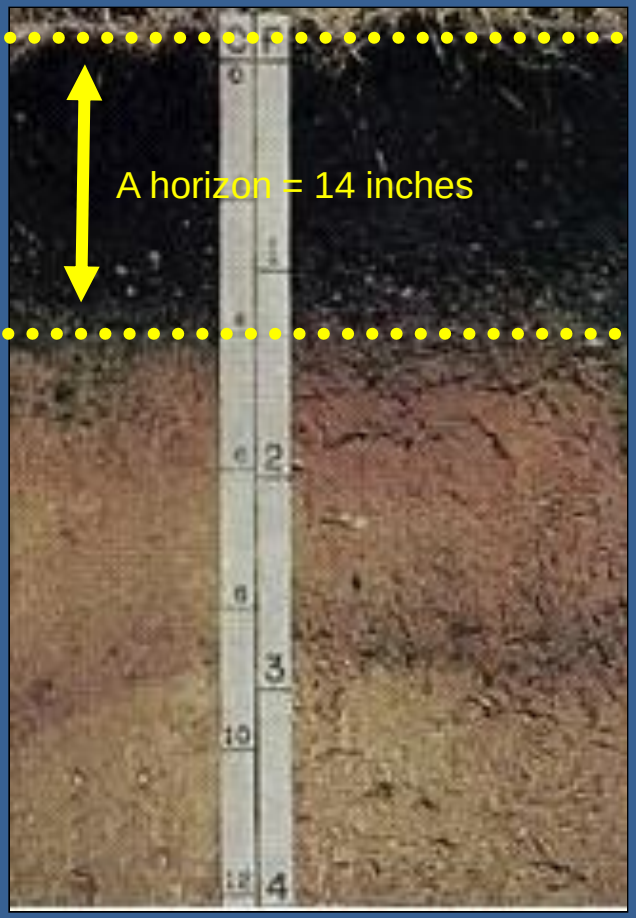
Soil Forming Factors

Climate – Soils develop faster in warm moist climates, and slower in cold or arid ones.

Organisms – Plant roots, animal burrows and bacteria break down large soil particles into smaller ones

Photo Credit: USDA NRCS

Soil Forming Factors - Organisms



Prairie

Forest

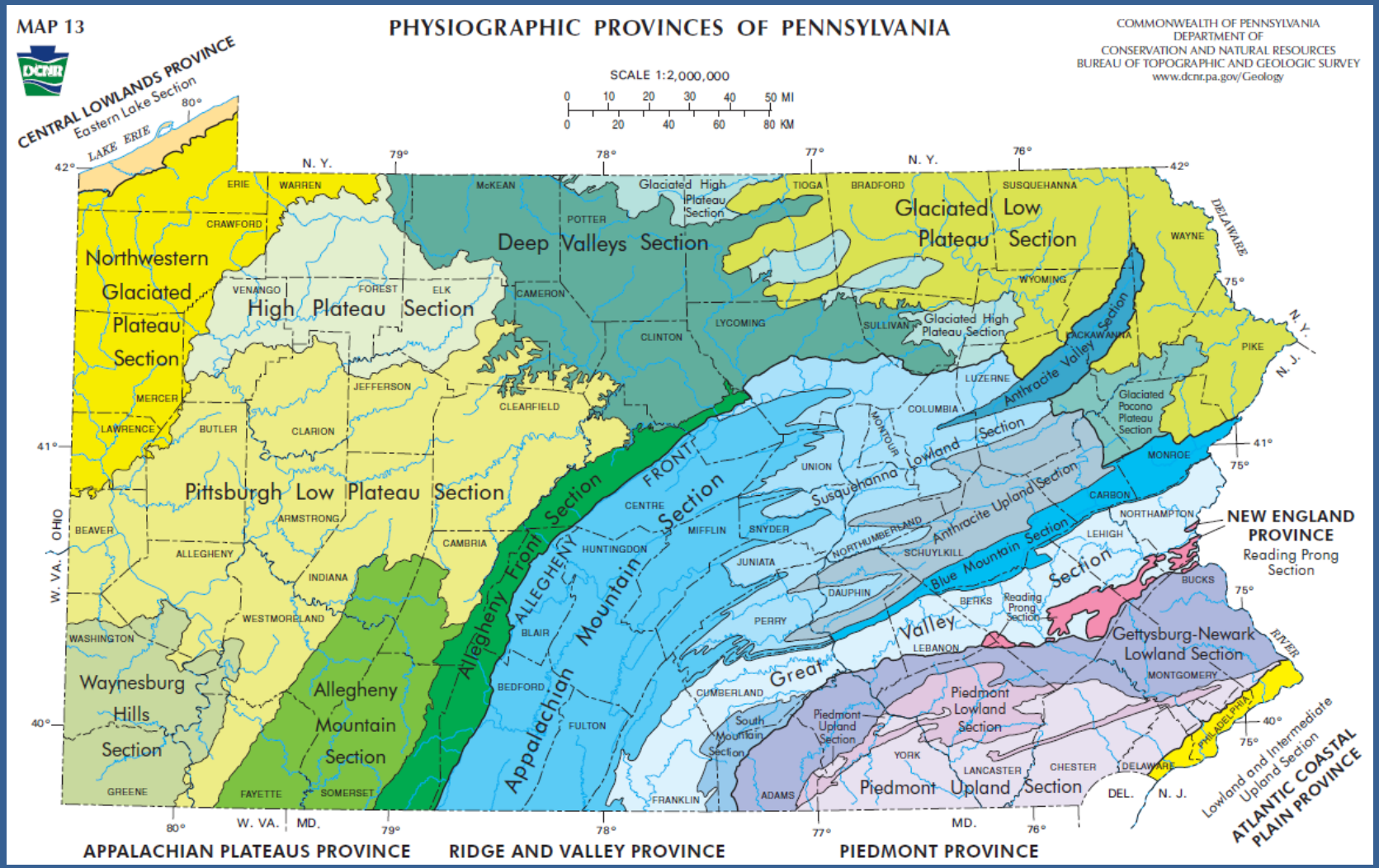
Soil Forming Factors

Parent Material – Soils inherit traits from the parent material. They may be formed in place or transported by flooding rivers, moving glaciers or blowing winds.

Topography – Deeper soils form at the bottom of a hill because gravity and water move soil particles down slope.

Time – All the factors work together over time.

Soil Formation - Parent Material



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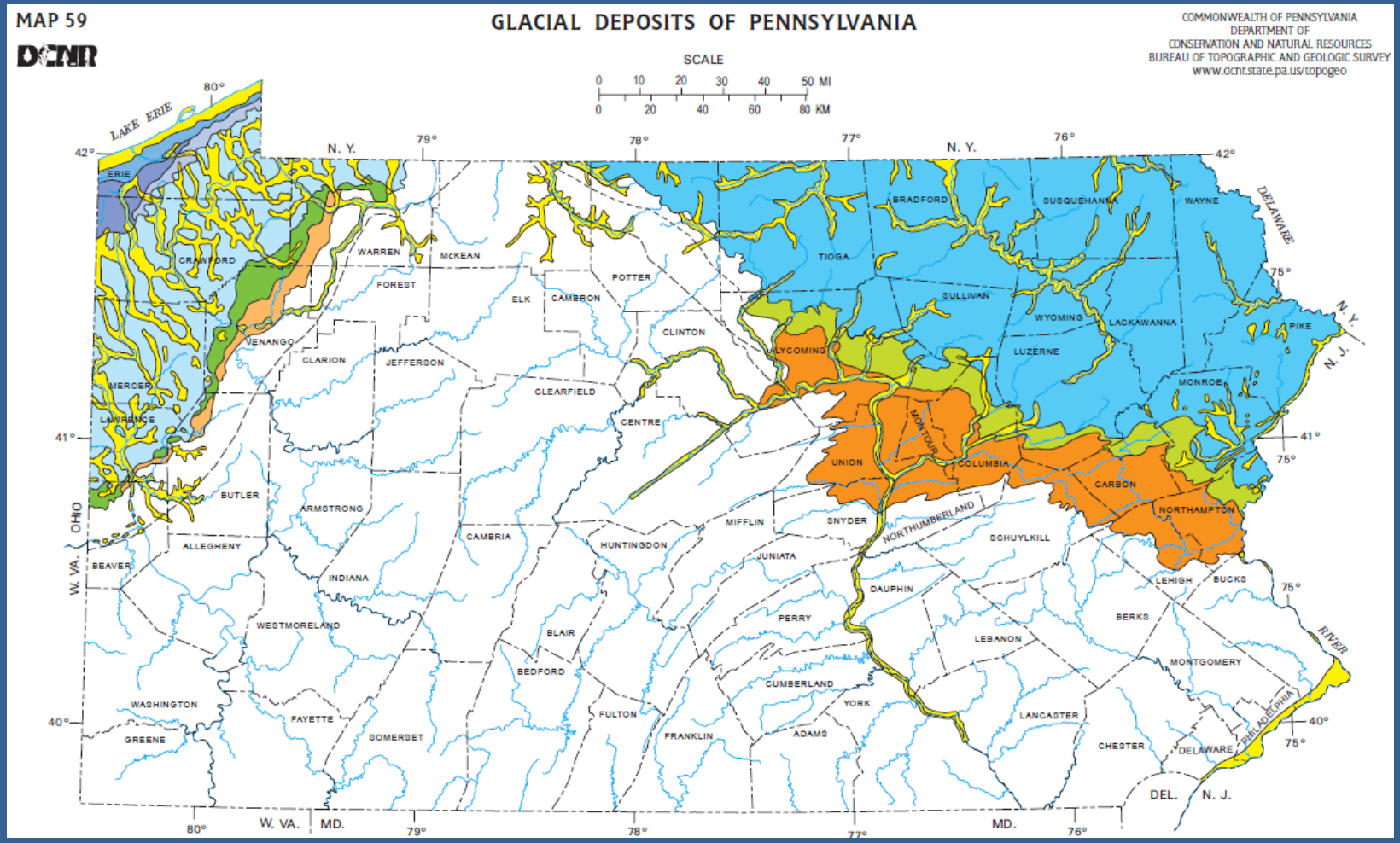
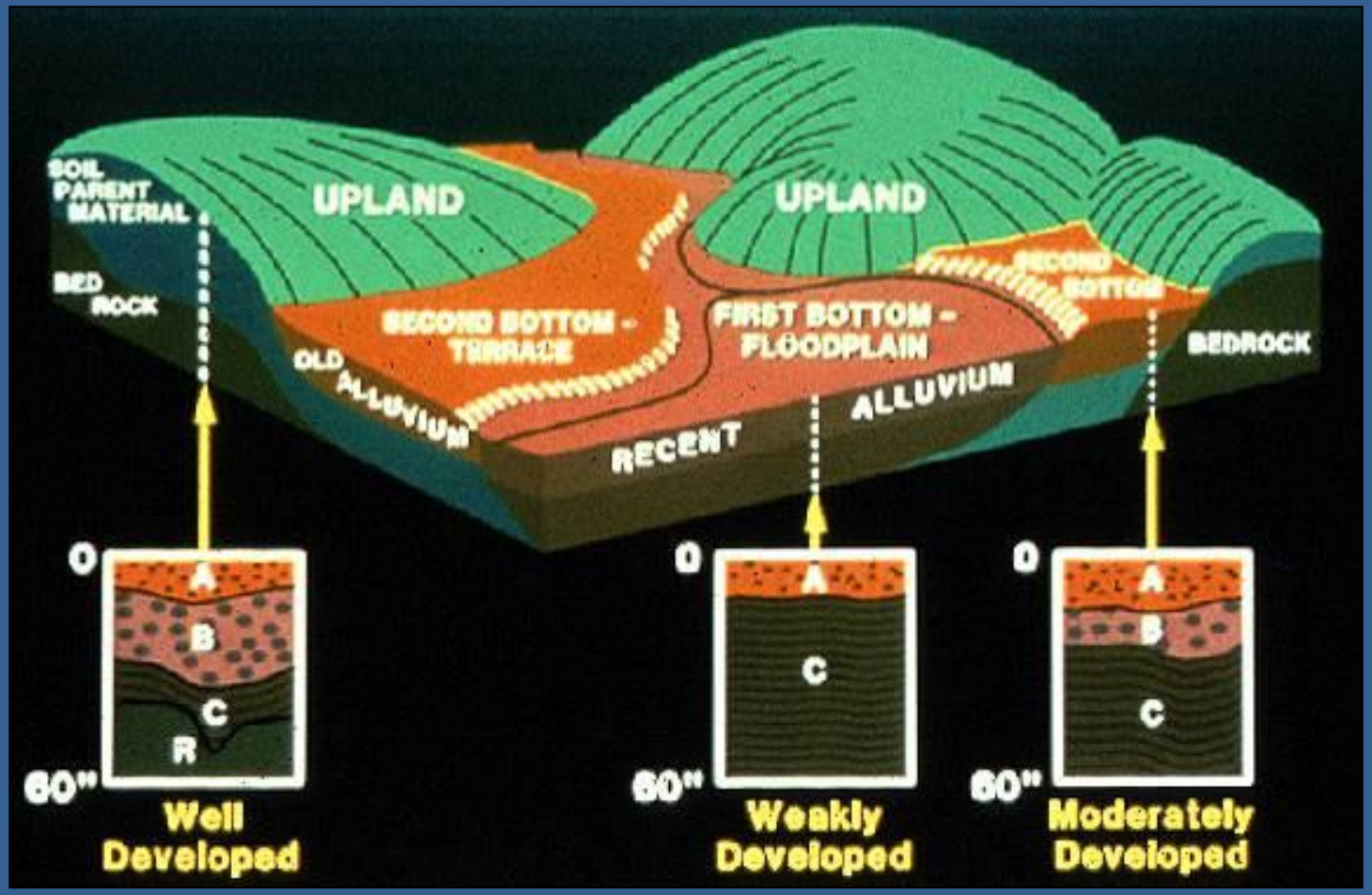
Soil Formation - Parent Material



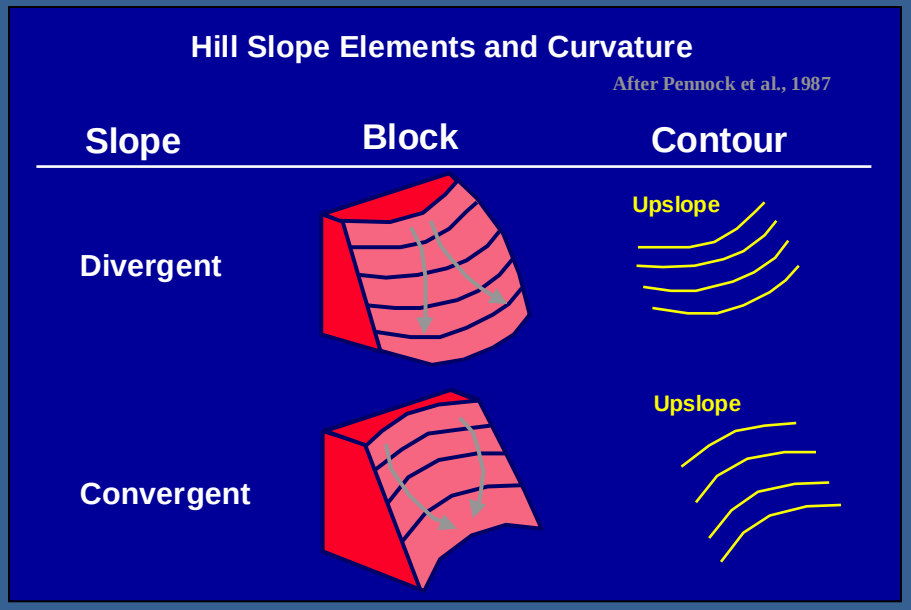
Glacial Deposits

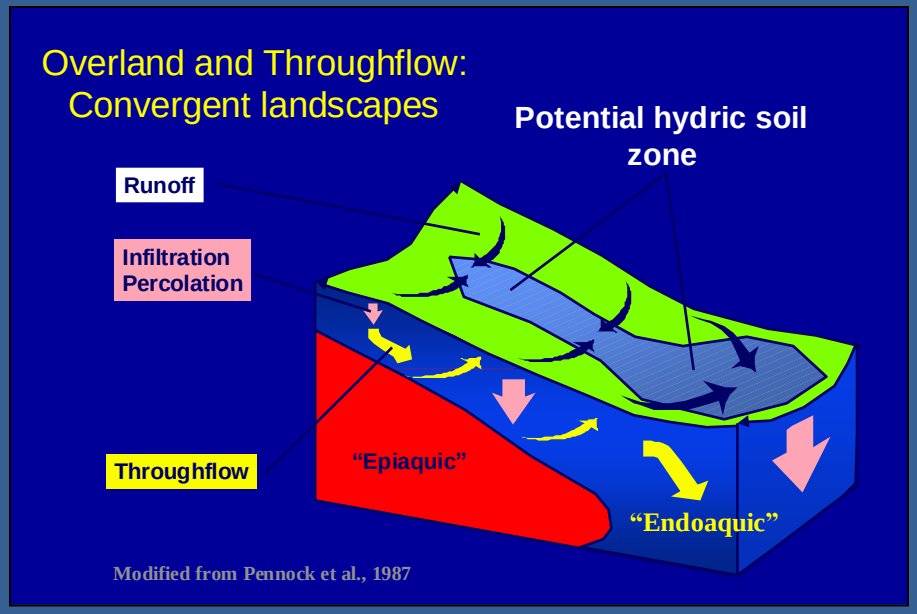
Soil Formation – Landscape Position



Soil Formation - Relief

- Influence on water flow and soil formation
- Most wetlands are on some sort of concave surface



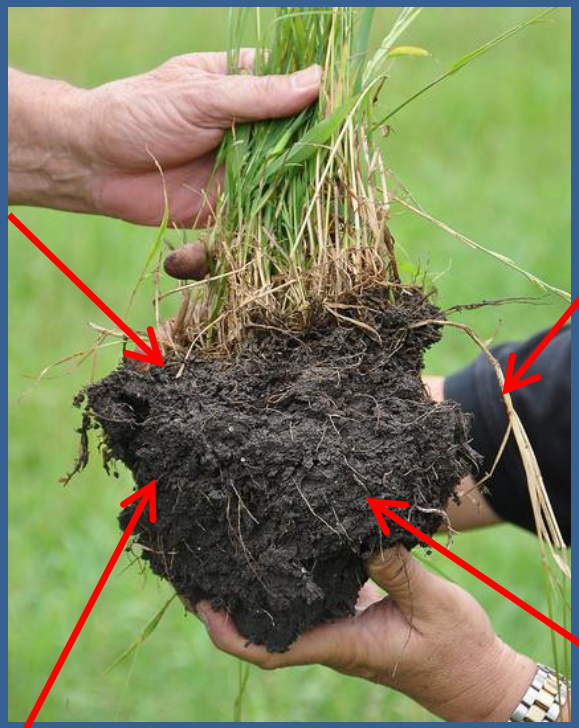


Average Soil Composition

25% Water

45% mineral

Pore space 50%



Solids 50%

25% Air

5% Organic Matter

Soil Organic Matter –
Influences on Physical and Chemical Properties

1) Improves physical condition

   Plant and animal residues contribute to aggregation of soil particles

2) Increased water infiltration

   Allows water saturation by acting as an absorbent

3) Improves Soil Tilth

   Allows for more uniformity of the soil aggregates in proportion to the plant, animal and mineral residues present

Soil Organic Matter

1. Living portion – microorganisms, insects, plant roots and earthworm break down crop residues and manures. Sticky substances produced by earthworms and fungi help bind soil particles together and form stable aggregates .

2. Dead Organic Matter – dead micro-organisms, insects, earthworms, roots, crop residues and manures. Decay and releases plant nutrients, builds soil structure, food for living microorganisms.

Organic Soils

Organic horizons

Consist of decomposed organic material

- Peat (fibric) – least decomposed
- Mucky peat (hemic)
- Muck (sapric) – most decomposed

Mineral Soils

Mineral horizons

- Primarily sand, silt, and clay, with varying amounts of organic matter

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Soils Have Texture

Sand

2 to 0.05 mm

Particles visible without a magnifying glass

Feels coarse and gritty

Silt

0.05 to 0.002 mm

Not typically visible by the unaided eye

Feels smooth and floury

Clay

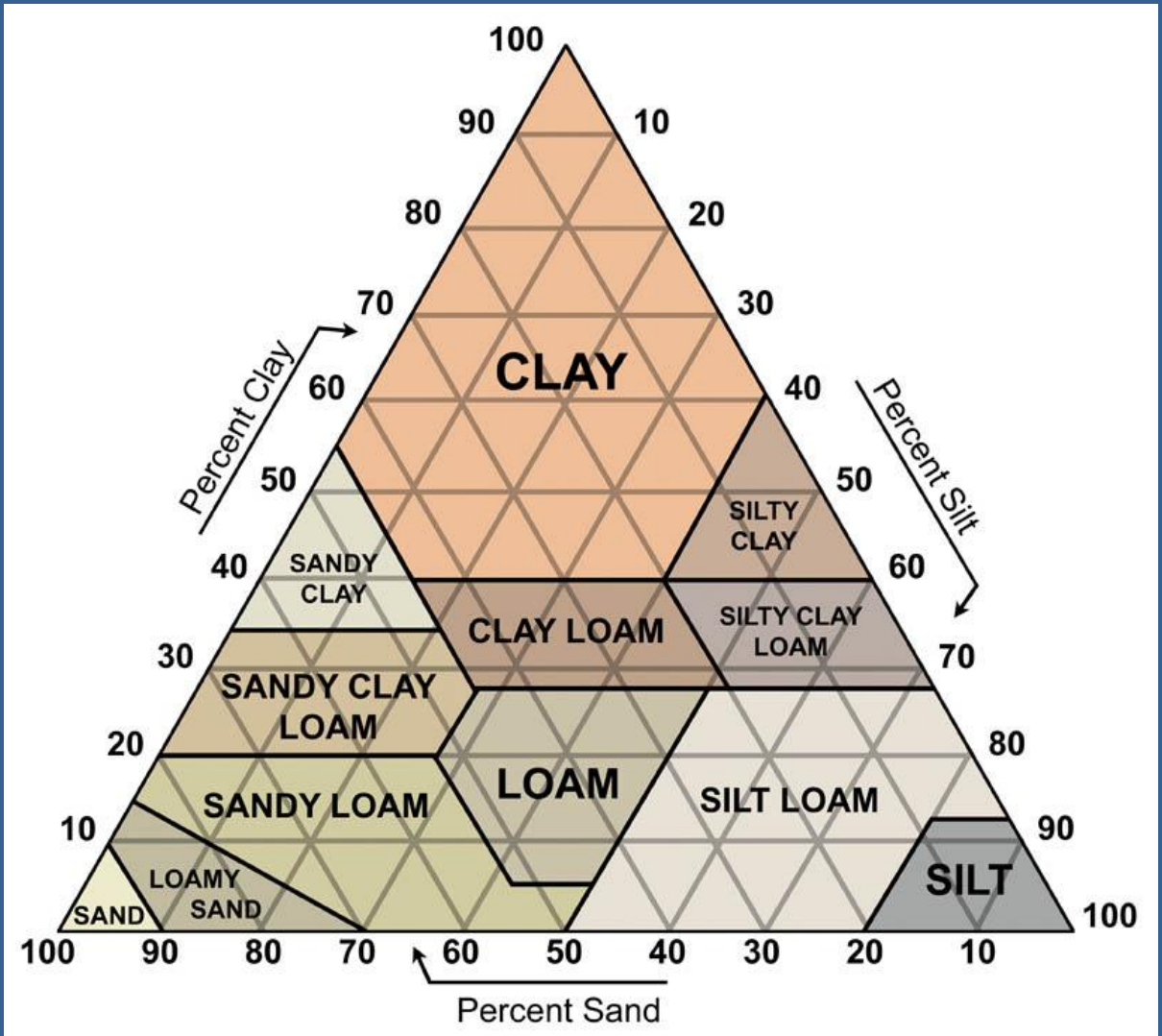
< 0.002 mm

Seen only with an electron microscope

Feels stiff and sticky

Photos by Jim Baker, Virginia Tech

Soil Texture Triangle



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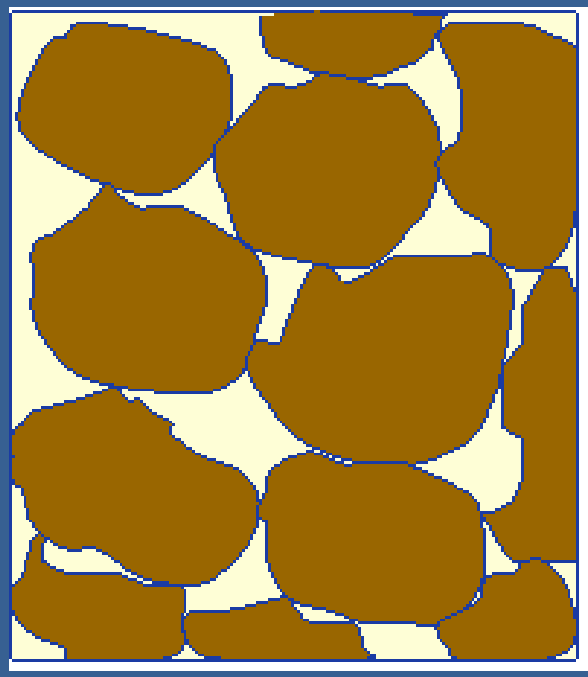
Soil Texture - Particle-Size Distribution

Soil Mineral Particles Settled in Cylinder

Remember Stokes Law: The bigger they are, the faster they fall (in water)!

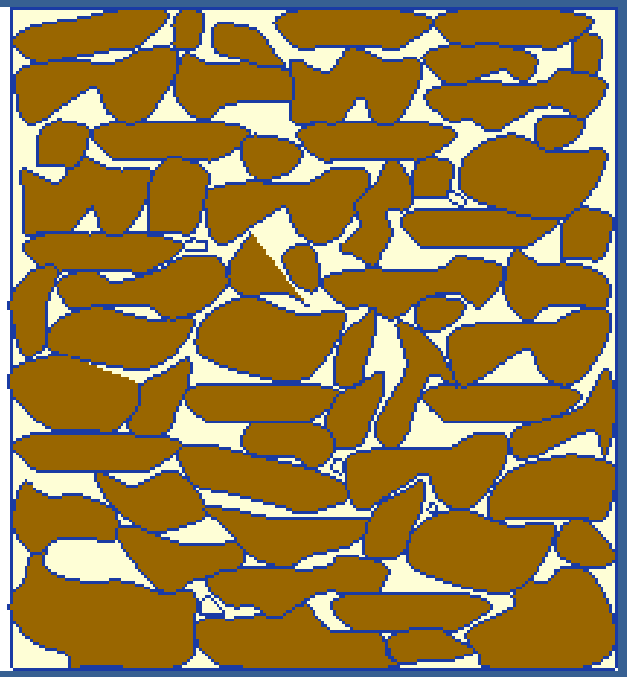
Texture and Pore Space

Coarse Textured Soil



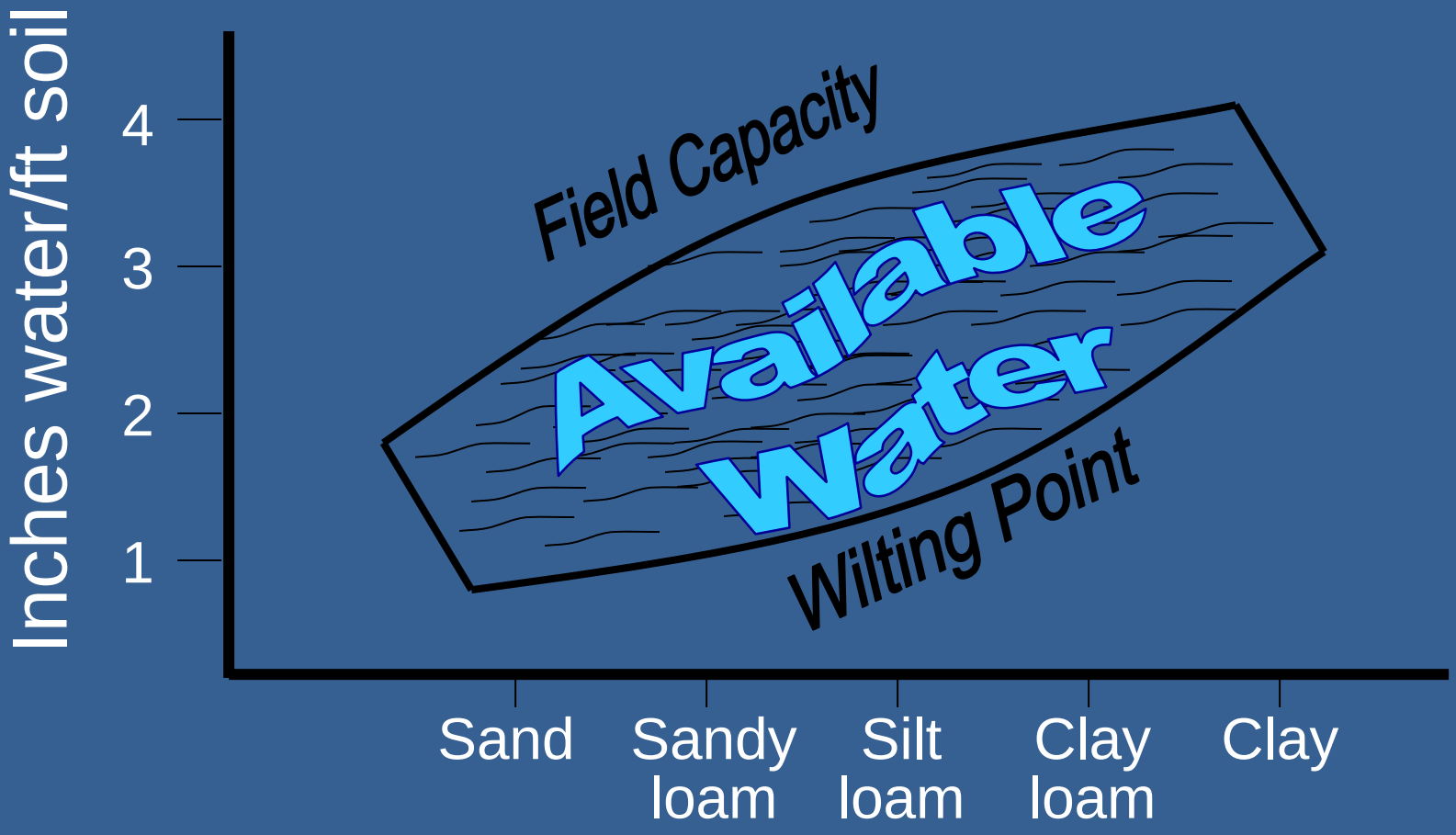
Less porespace but more macropores

Fine Textured Soil



More total porespace

Plant Available Water



Soils Have Structure

- Soil structure is the arrangement of soil particles into small clumps, called “peds”.
- Soil structure and texture affect how the soil will hold water and nutrients.

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Common Types of Soil Structure

Granular

Platy

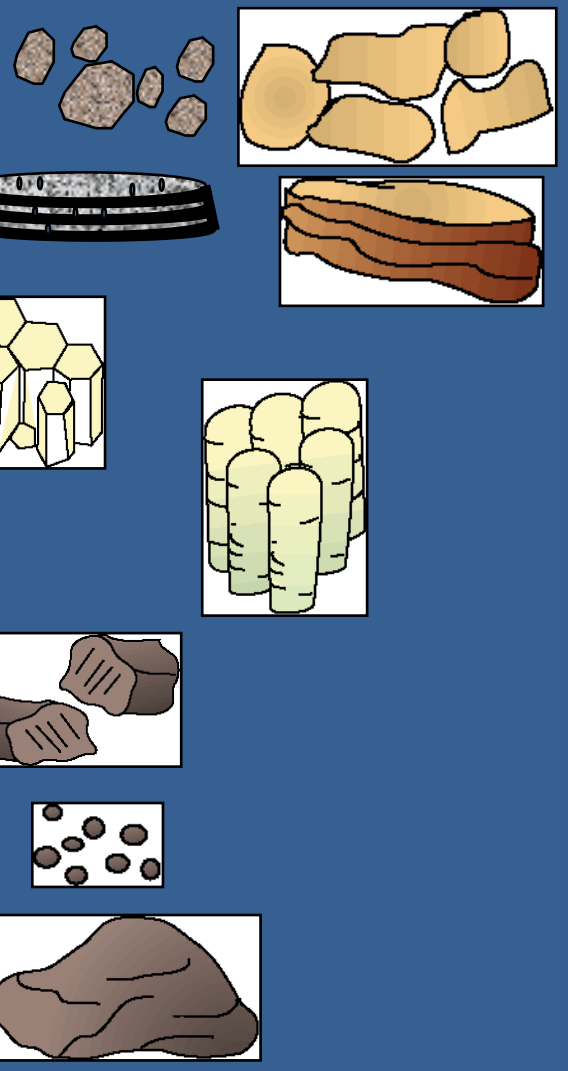
Prismatic

Columnar

Blocky

Single Grain

Massive



Maintaining Soil Structure

- Granular, loamy textured soils make the best farmland.
- Compaction from heavy traffic destroys soil structure and prevents good plant root development.

Photo Credit: USDA NRCS

Soils Have Color

Color can tell us about the soil's mineral content.

- Soils with a lot of organic matter are dark brown or black.
- Soils high in iron are deep orange-brown and yellowish-brown.

Photo Credit: Soil Science Society of America

Soil Color

Color tells us how a soil behaves.

- A soil that drains well is brightly colored.
- A soil that is often wet may have mottles of grays, reds, and yellow.

Soil Color
Oxidation State of Iron

GOOD AERATION

1. Iron is oxidized
2. Fe^{+++}
3. bright colors (yellows, browns)
4. well drained

POOR AERATION

1. Iron is reduced
2. Fe^{++}
3. dull colors (grays, blue)
4. poorly drained

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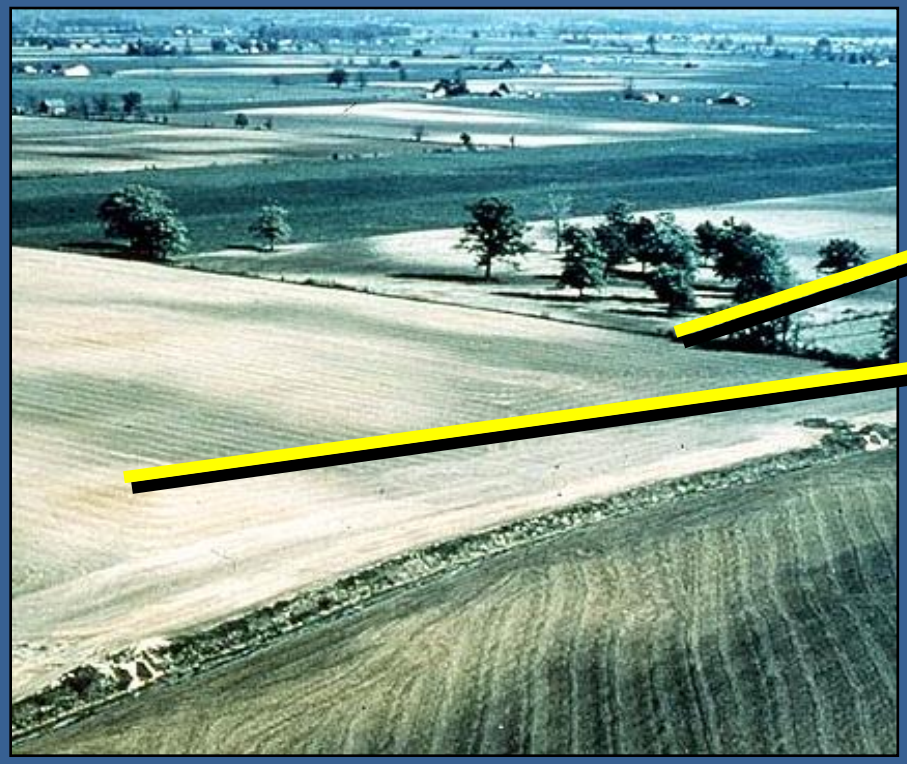
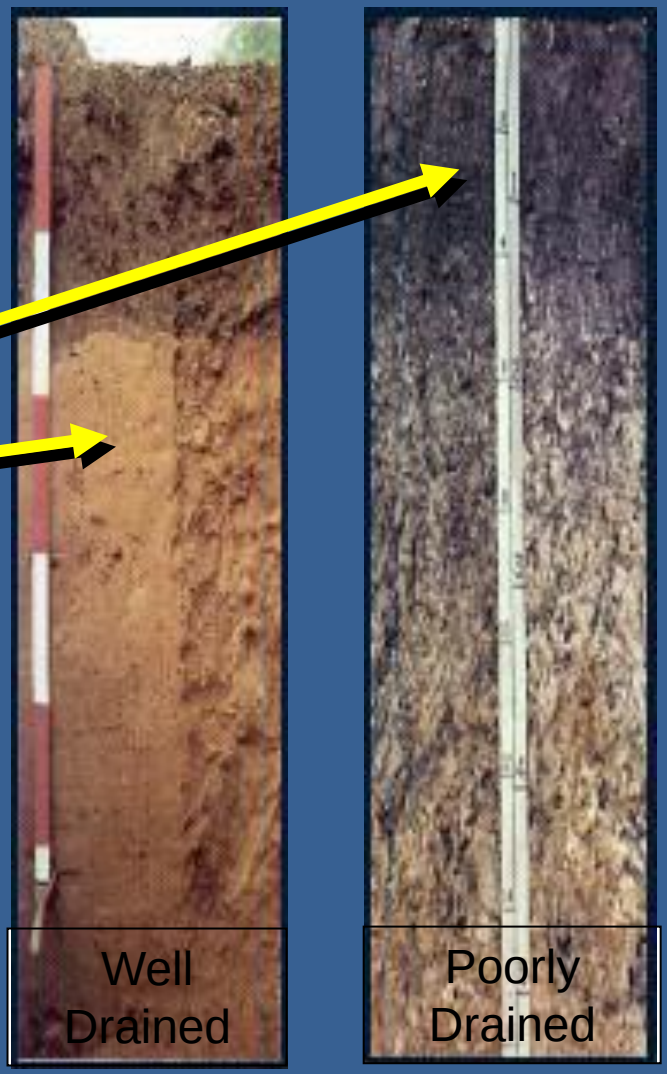
Soil Color

Drainage on this farm?

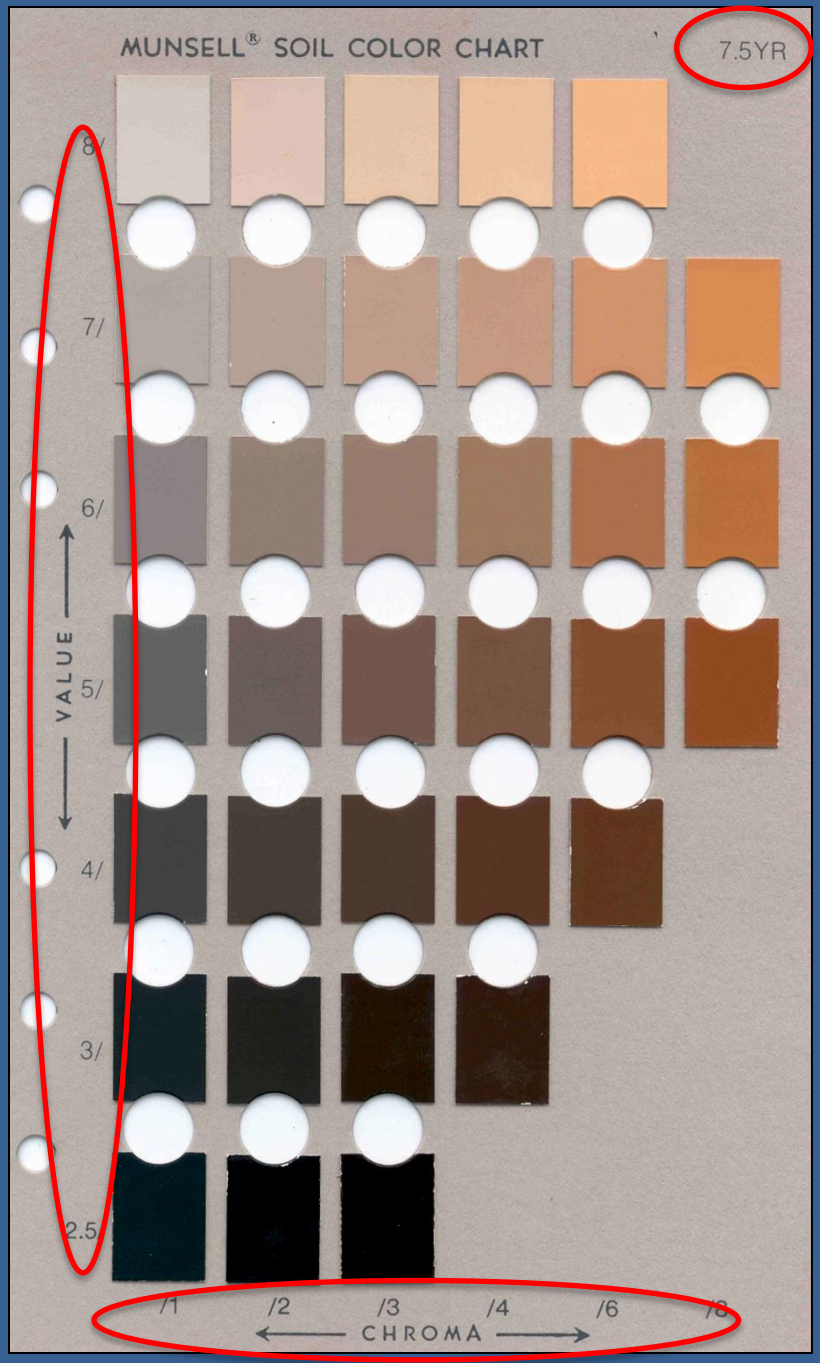




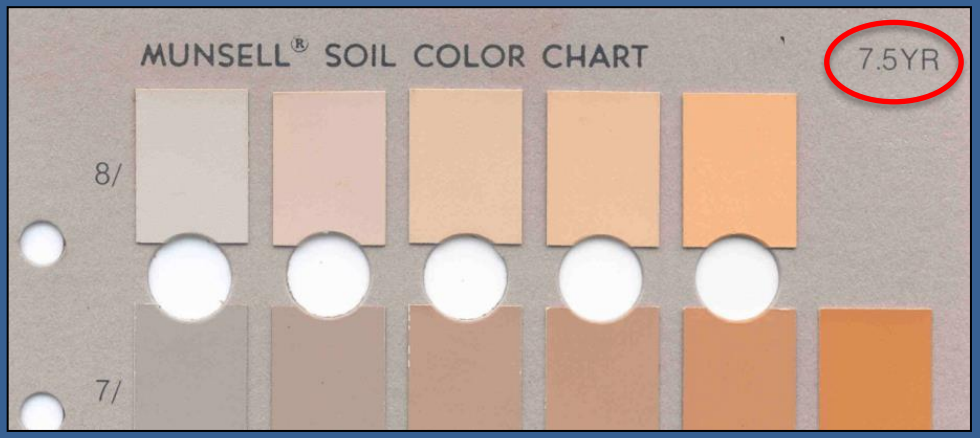
Soil Color

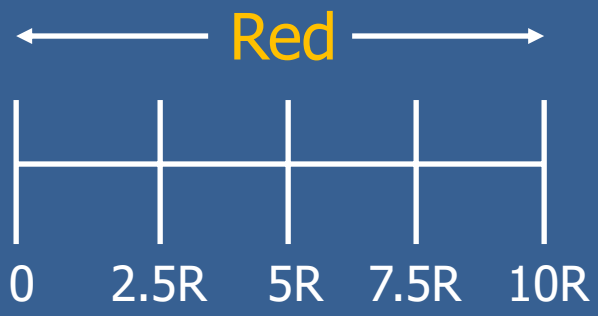
Munsell®

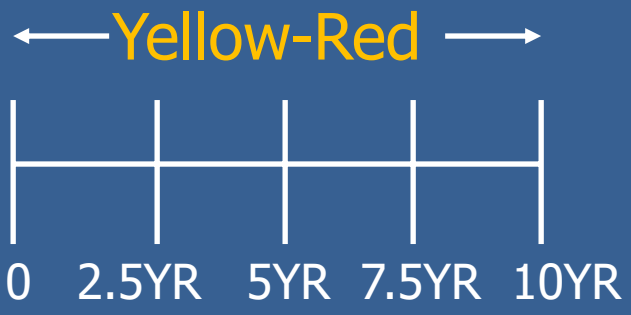
- Hue
- Value
- Chroma

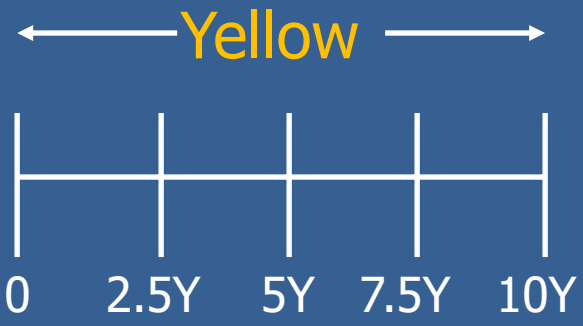


Hue


MUNSELL® SOIL COLOR CHART
7.5YR
8/
7/


Red
0
2.5R
5R
7.5R
10R


Yellow-Red
0
2.5YR
5YR
7.5YR
10YR

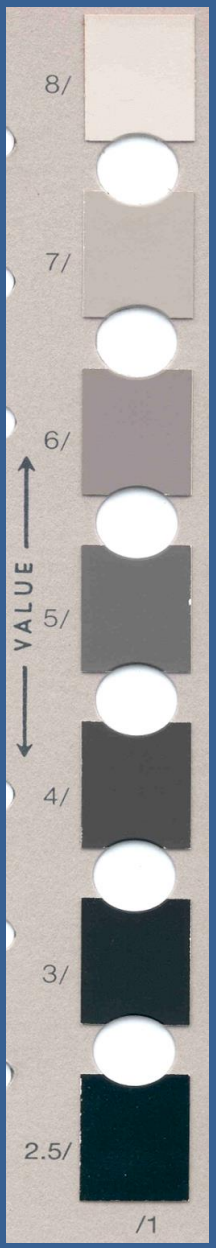

Yellow
0
2.5Y
5Y
7.5Y
10Y

Value

The Lightness or Darkness of Color

- 10/0 - Pure White
- 5/0 - “Gray”
- 0/0 - Pure Black

7.5 YR **2.5**/2



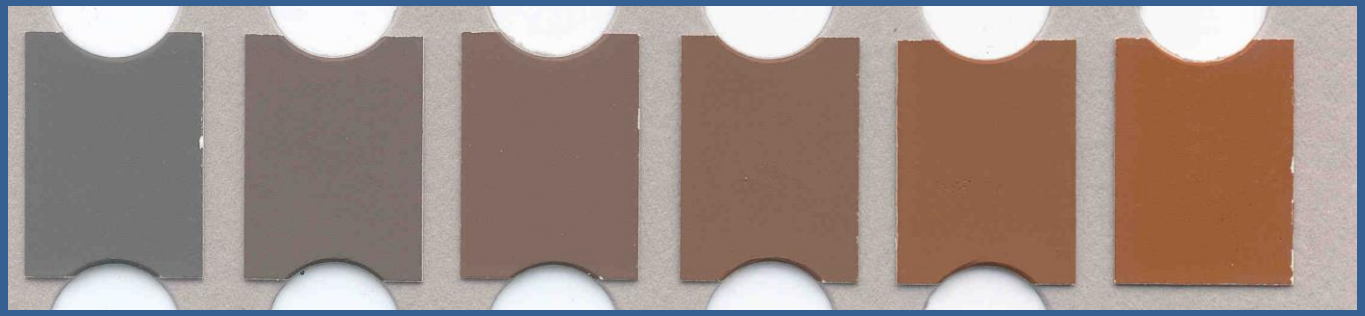
Chroma

7.5 YR 5 / **8**

"Neutral" Gray — "Pure" Color

/0 /2 /4 /6 /8

Increasing strength of color →

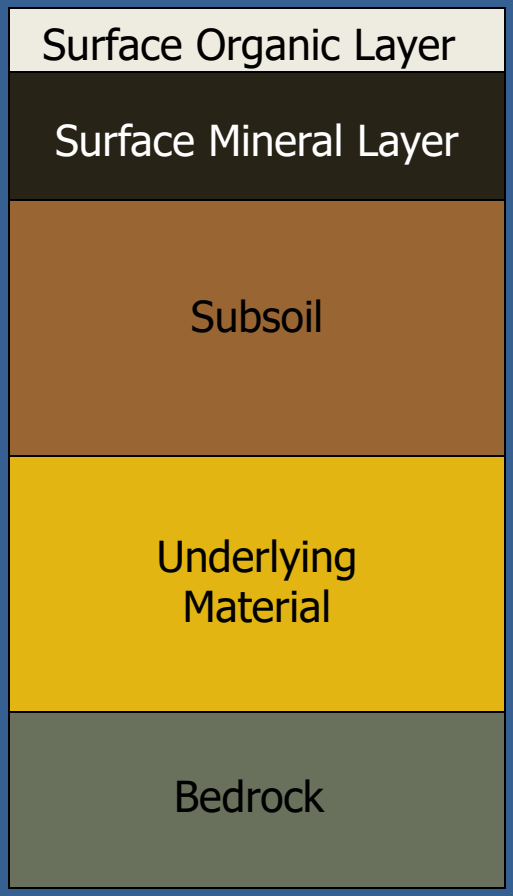


← Increasing grayness

Soil Horizons

- A Horizon
- B Horizon
- C Horizon

Major Horizon Designations



O Horizon

A Horizon

B Horizon

C Horizon

R Horizon

There is no set number of horizons a soil profile can have.

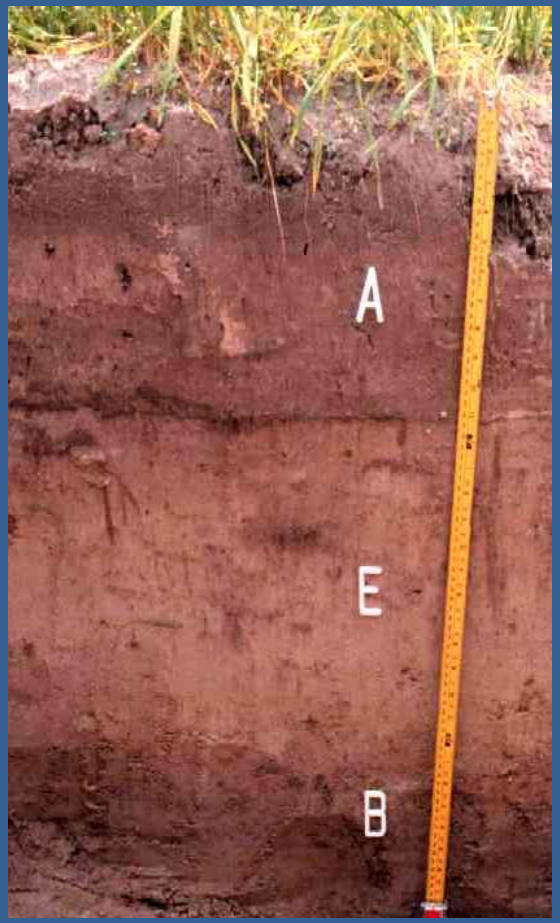
Horizons are differentiated by changes in:

1. Color
2. texture
3. roots
4. structure
5. rock fragments
6. redoximorphic features (mottling)

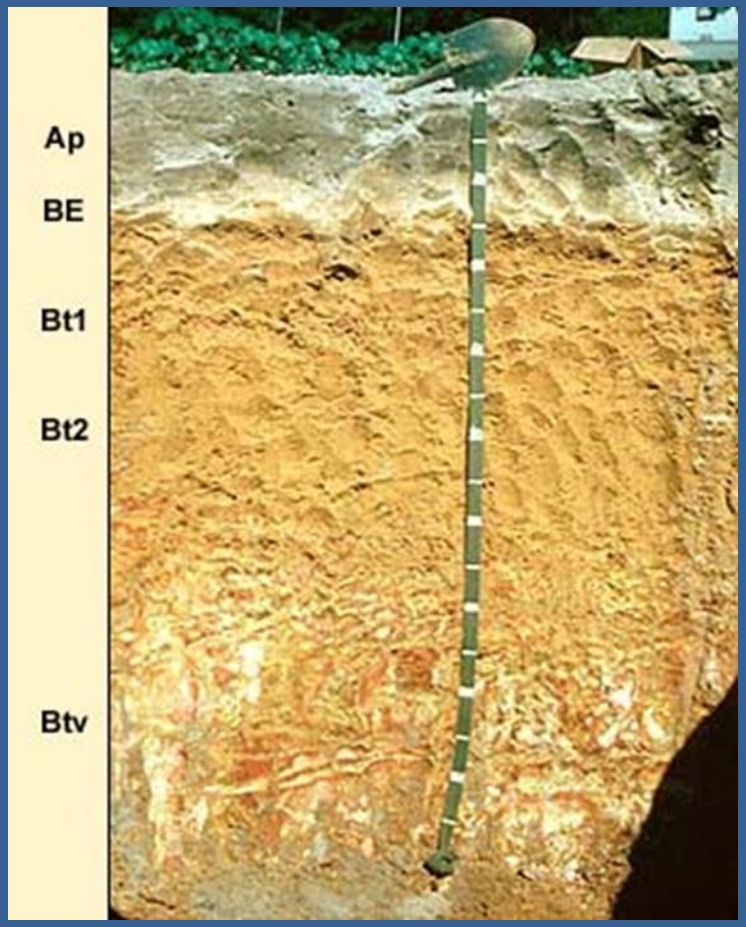
O horizon - Predominantly organic matter (litter and humus)

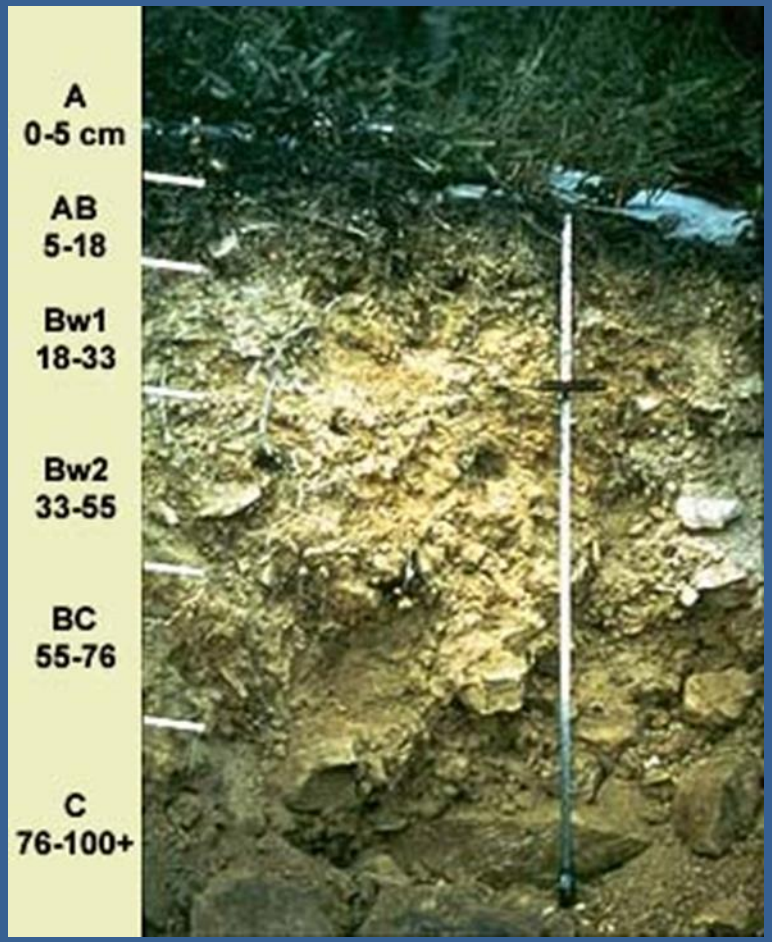
A horizon -
Zone of organic matter accumulation

E horizon -
Zone of eluviation (loss of clay, Fe, Al)

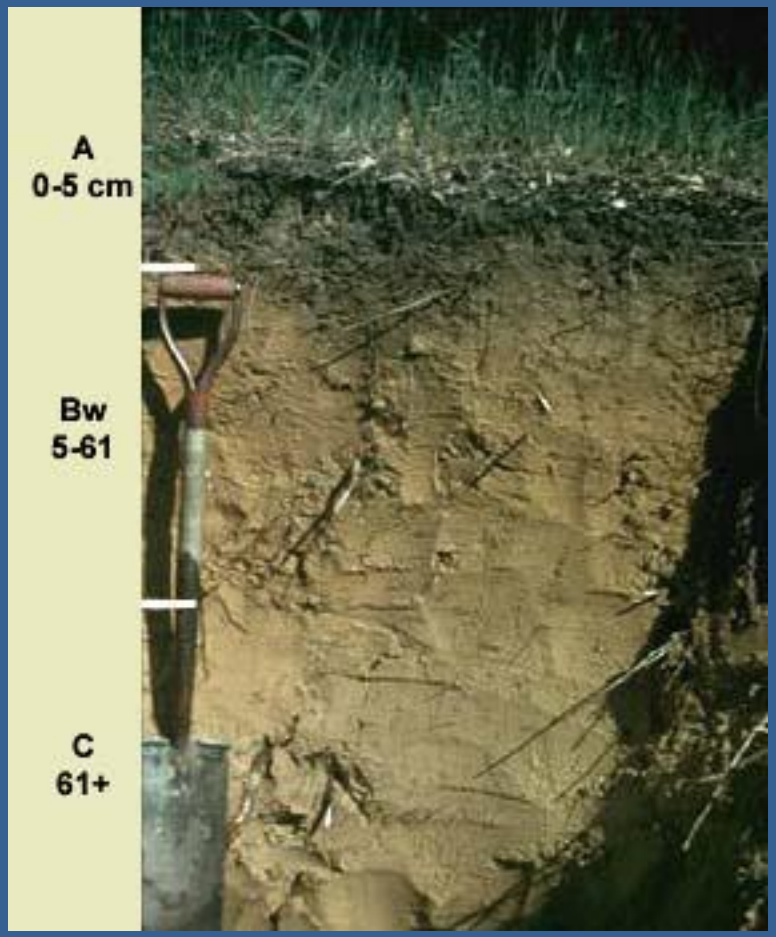


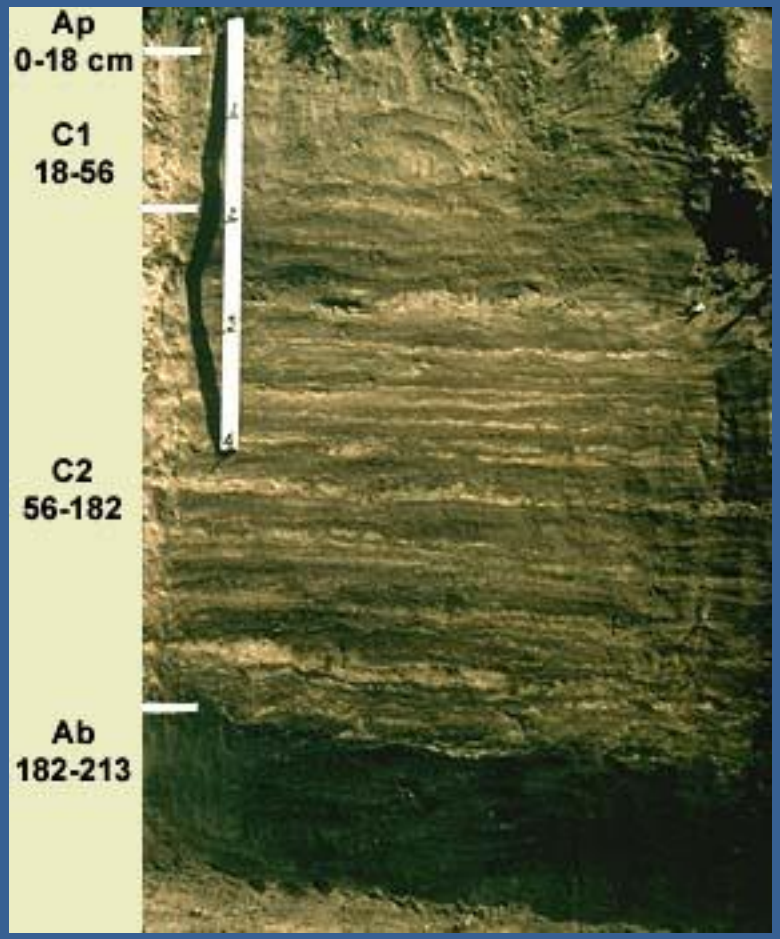
B horizon -
Zone of accumulation (clay, Fe, Al, $CaC0_3$, salts…).
Forms below O, A, or E horizon





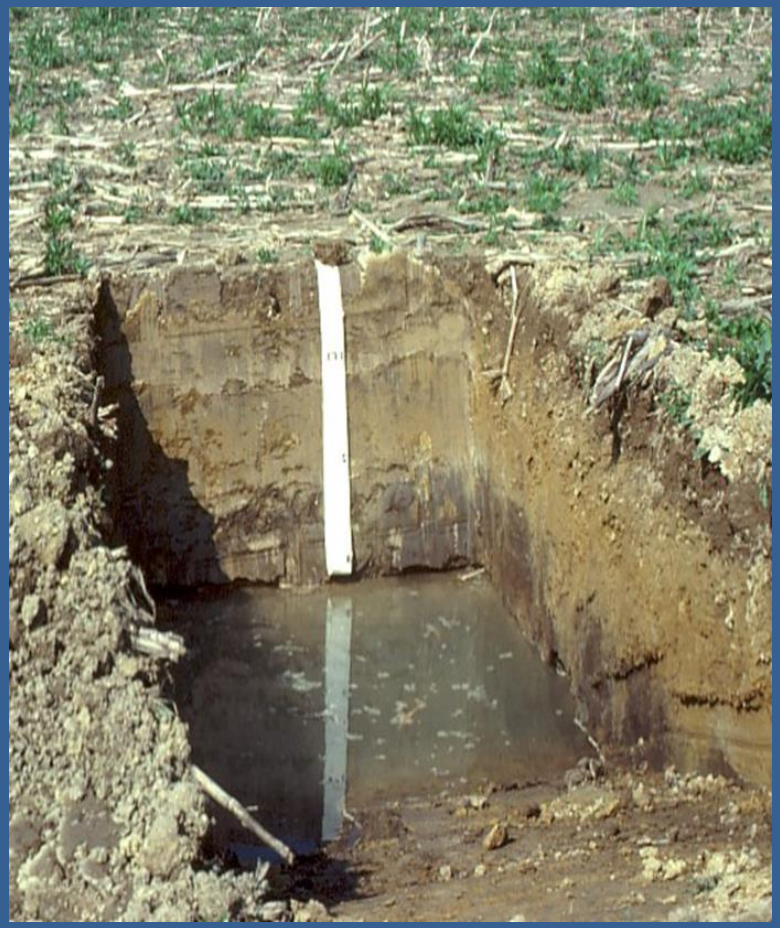
C Horizon Zone of little or no biological activity and physical and chemical weathering.





Drainage Classes

- Frequency and duration of wetness under which the soil formed.
- Depth to gray mottles (chroma <2 redoximorphic features)

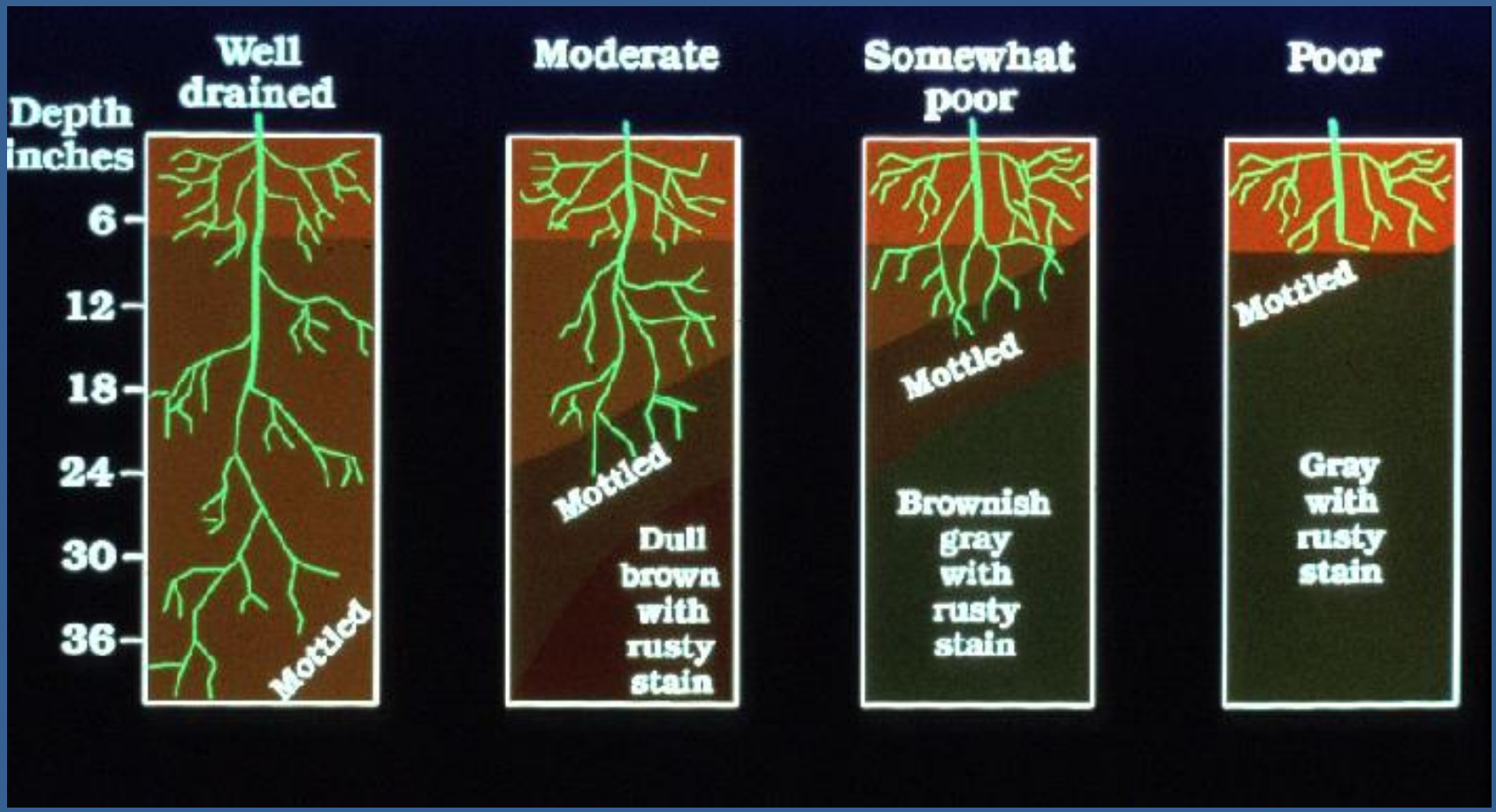


Drainage Classes

Drainage	Depth to Evidence of Wetness
excessively drained	> 60”
somewhat excessively drained	> 60”
well-drained	> 40” (or 36”)
moderately well-drained*	20-40”(or 18-36”)
somewhat poorly drained	8-20”
poorly drained	0-8”
very poorly drained	0

*In Pennsylvania, moderately well drained soils sometimes have some redoximorphic features (mottles) between 10 and 20”, but < 2% of the matrix.

Drainage Classes



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Soil Depth – Depth to Restrictive Layer

Depth Classes

Depth Class	Depth
Very deep	> 60”
Deep	40 - 60”
Moderately Deep	20 - 40”
Shallow	10 - 20”
Very Shallow	0 - 10”

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