Soil Physical Properties

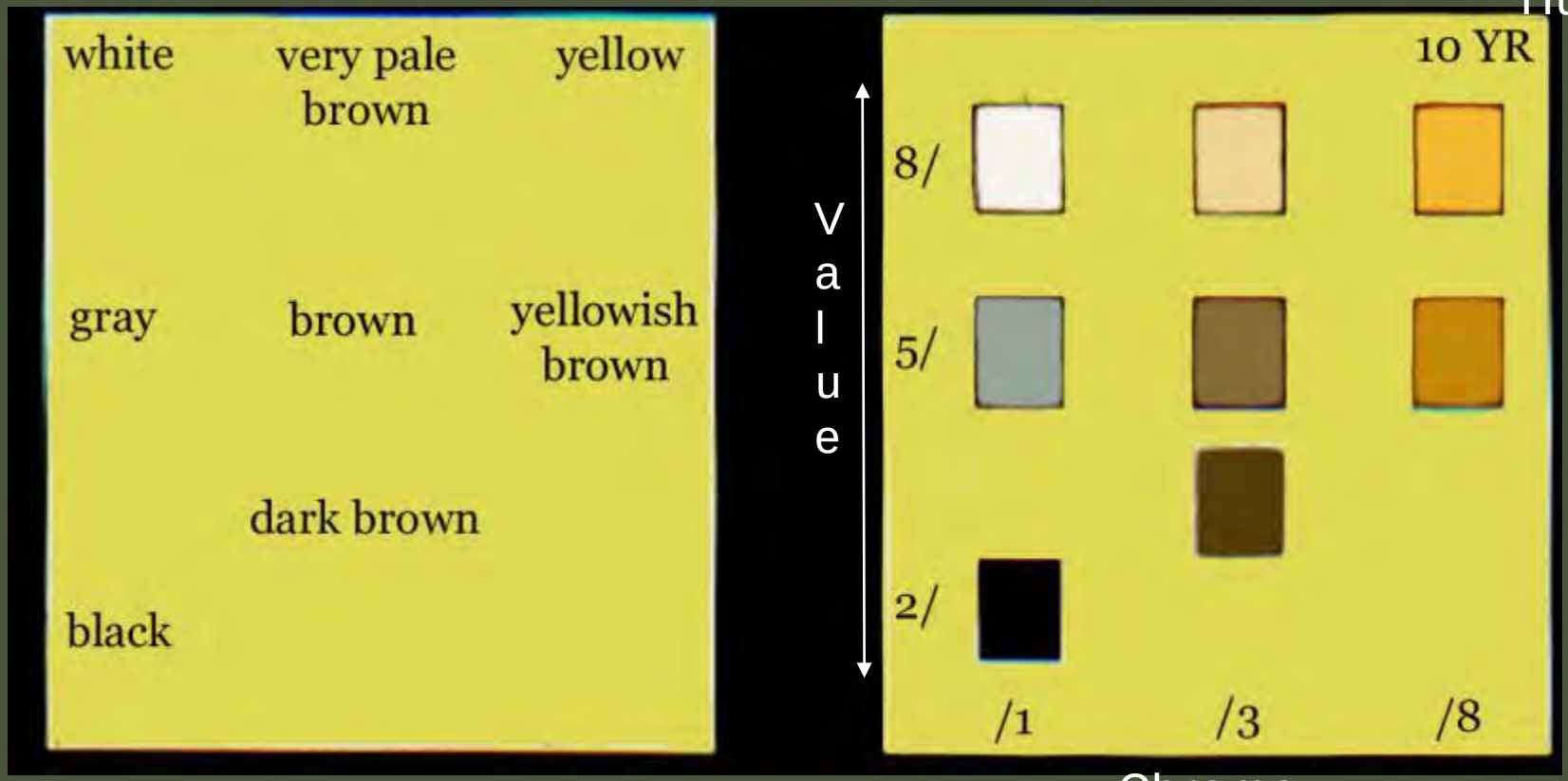
Dr. Steven Hodges
Dept. of Crop and Soil Environmental Sciences

Objectives

- Soil Color
- Soil Texture
- Soil Structure
- Density and Compaction

Munsell Color Book Summary

- Darkest shades of a hue are at the bottom; lightest shades are on top.
- Weakest chroma (grayest color) is at the left; strongest chroma is at the right.



- High Organic Matter (>25%)
- Dark Colors

- Heavy Minerals (Fe bearing ore)
- Dark Colors
- Quartz sands are lightly colored

- Fluctuating tides result in Fe reduction which makes the Iron soluble and thus no longer coats the soil particles.

- The yellowish brown colors throughout this soil indicate that Iron (Fe) is in the oxidized form.
- The soils with this color pattern reflect rapid internal soil drainage.

- This clayey soil has red oxidized Iron coating the soil particles.
- Iron content is 2-3% of this soil.

Aquic Conditions

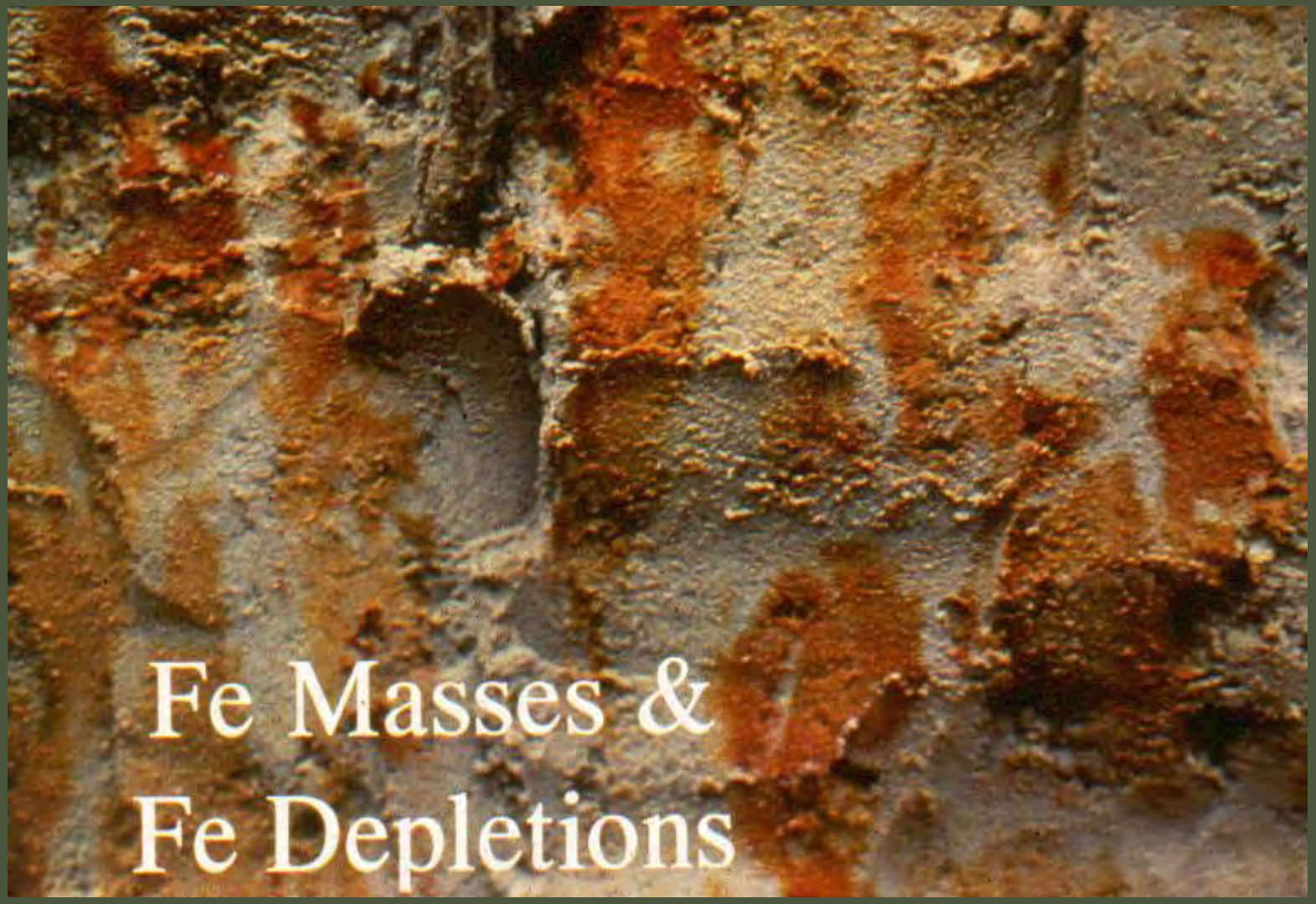
Identifying an aquic moisture regime
requires that soils:

- are saturated with water for prolonged periods
- are reduced (low oxygen)
- have redoximorphic features (reduced and oxidized conditions)

Types of Redoximorphic Features

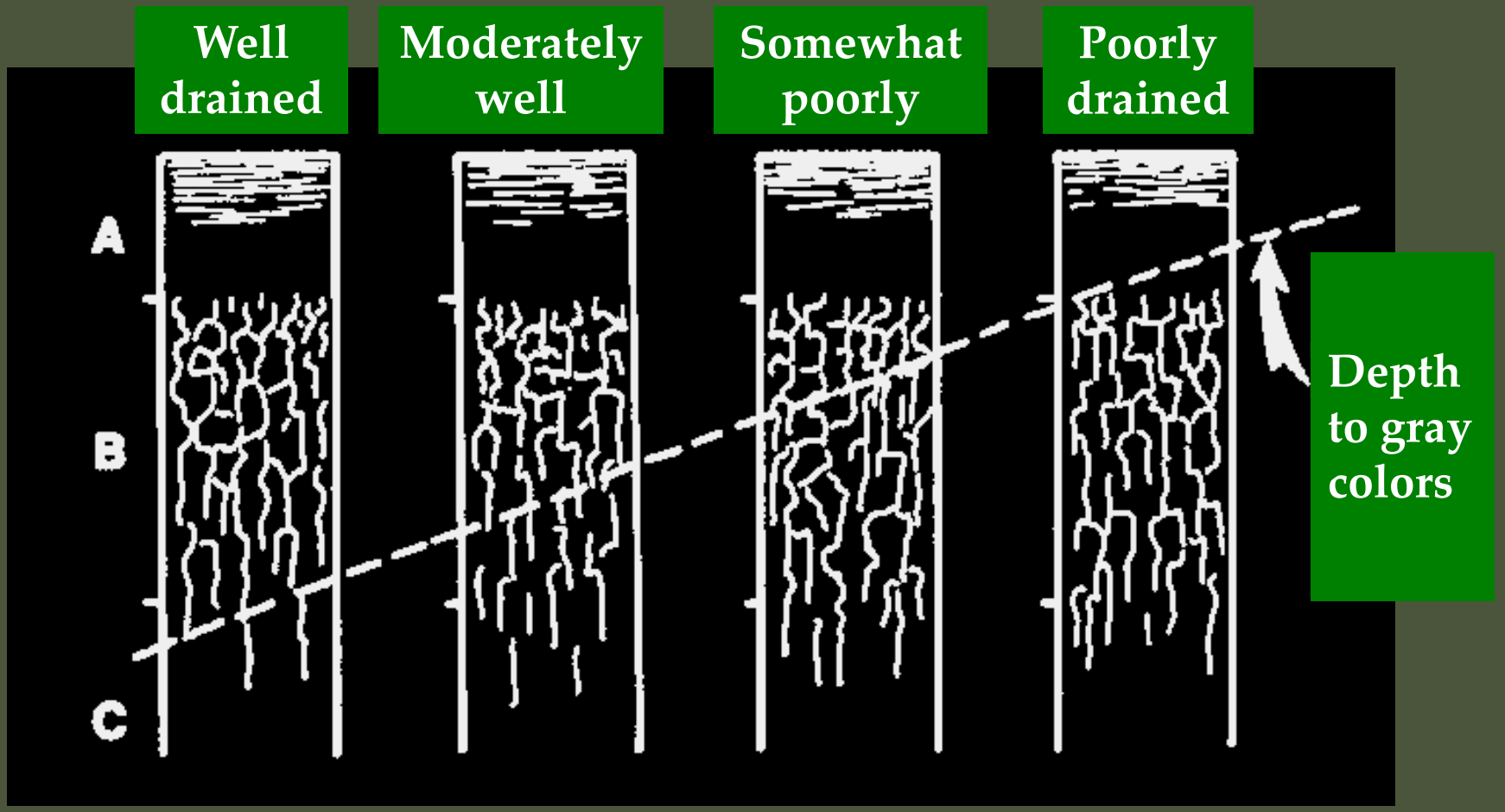
- Redox Concentrations – areas of oxidized iron
- Redox Depletions – areas where iron is depleted
- Reduced Matrix – except for concentrations, soil shows effects of reduced oxygen conditions

Fe Masses & Fe Depletions



Reduced Matrix

Soil Drainage Class



Soil Texture

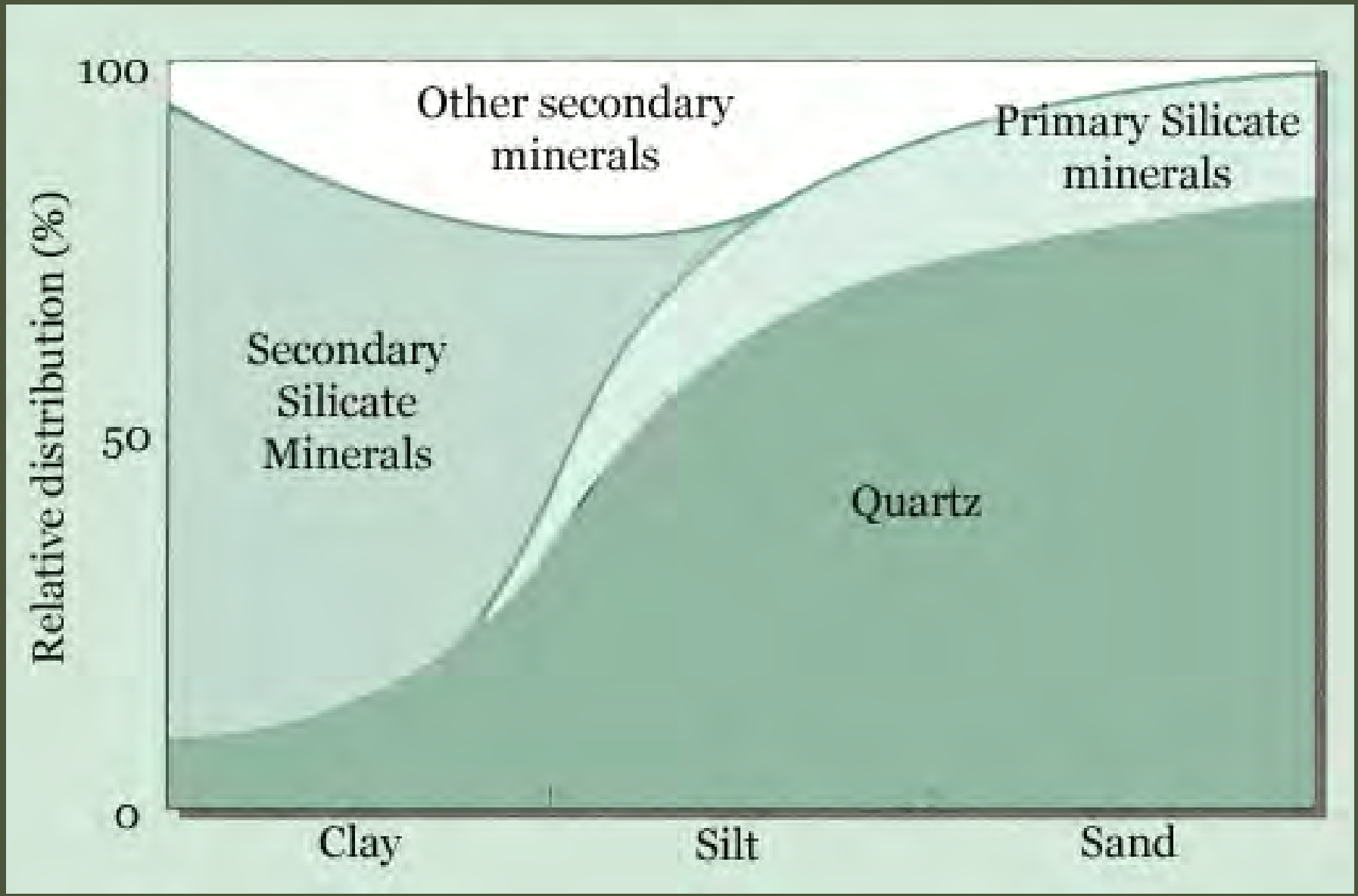
- Definition: Size distribution of mineral particles
  - Fine earth fraction: < 2 mm
  - Coarse fragments: > 2mm
- SAND – SILT – CLAY

Soil Particle Size (USDA Classification)

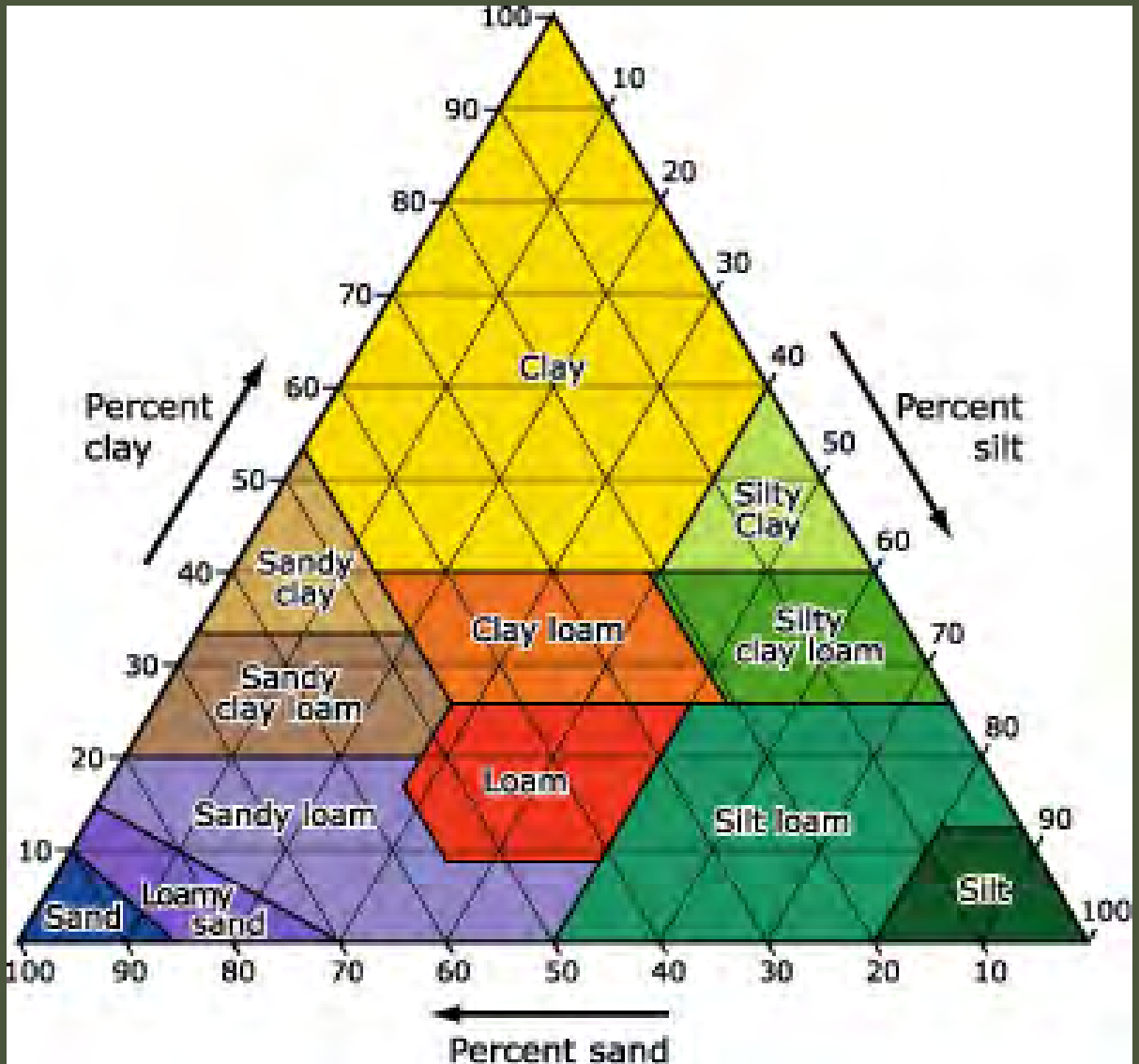
- Clay <0.002 mm
- Silt 0.002-0.05 mm
- Sand 0.05-2.00 mm

Very Fine Sand	**0.05-0.10 mm**
Fine Sand	**0.10-0.25 mm**
Medium Sand	**0.25-0.50 mm**
Coarse Sand	**0.50-1.00 mm**
Very Coarse Sand	**1.00-2.00 mm**

Clay-sized minerals and Clay Minerals



Soil Textural Triangle



- Sand Texture

- Loamy Sand Texture

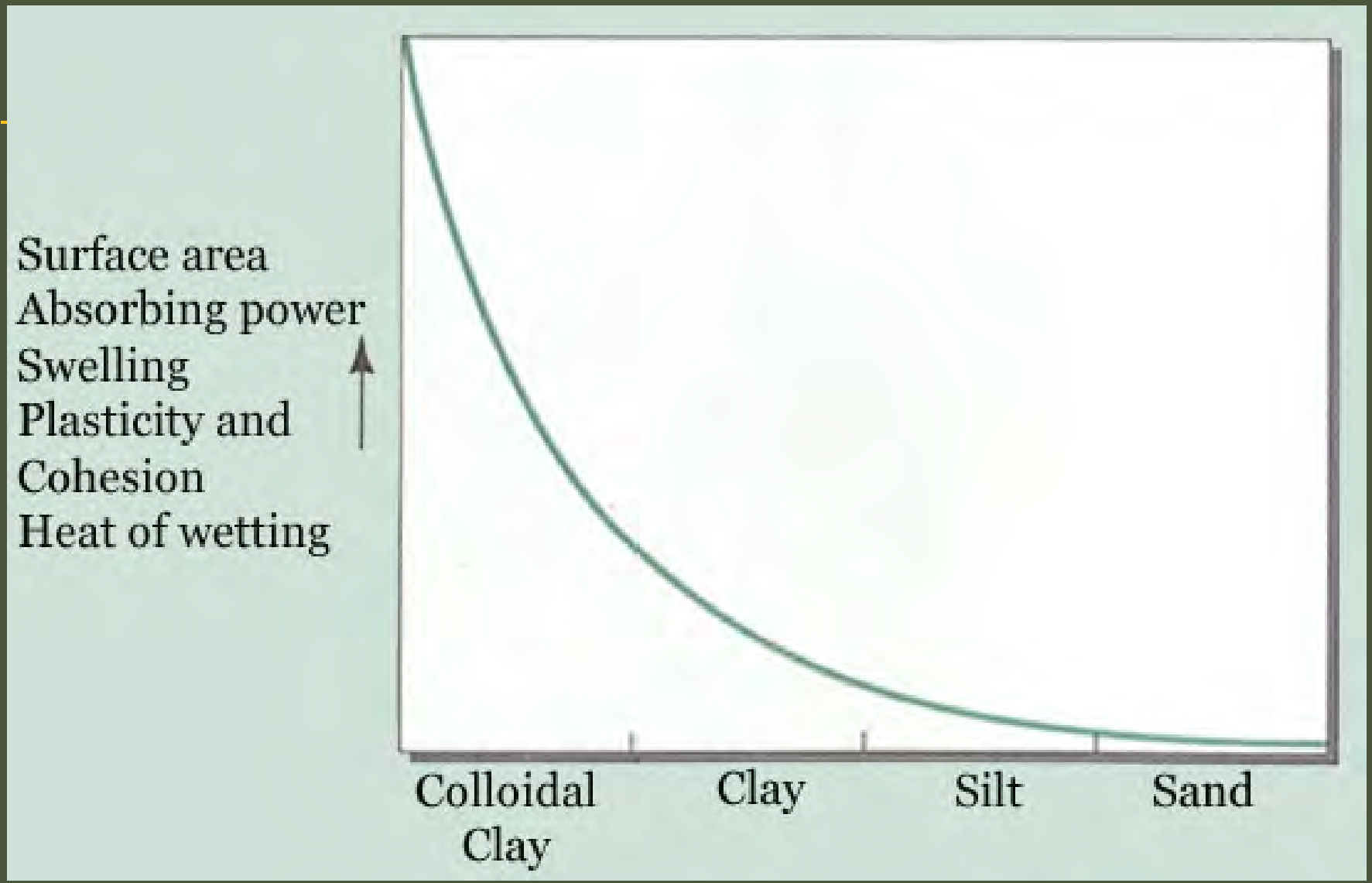
- Sandy Loam Texture

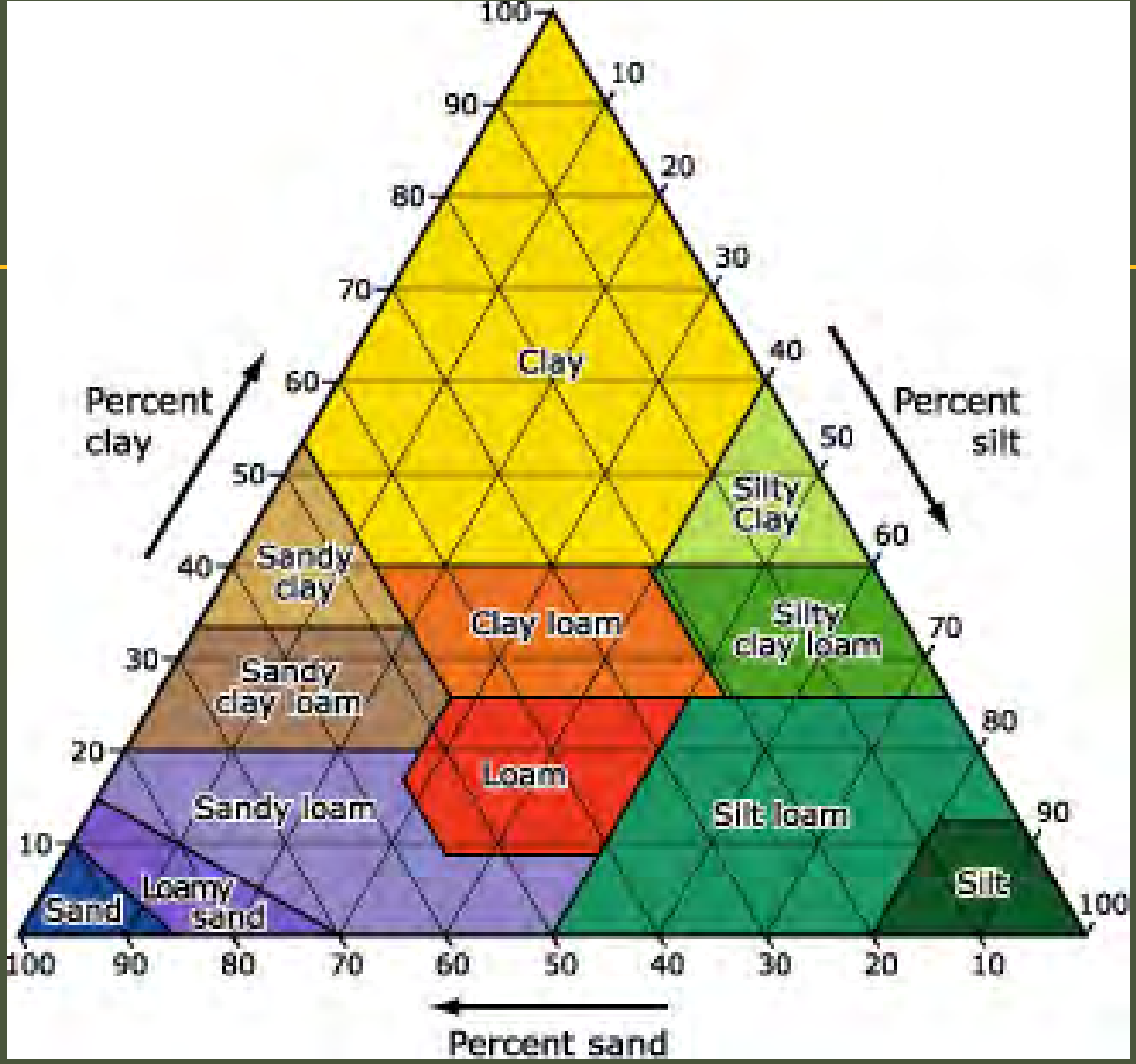
- Loam Texture

- Silt Loam Texture
- Dark color is due to ~2% organic matter

- Silty Clay Loam Texture

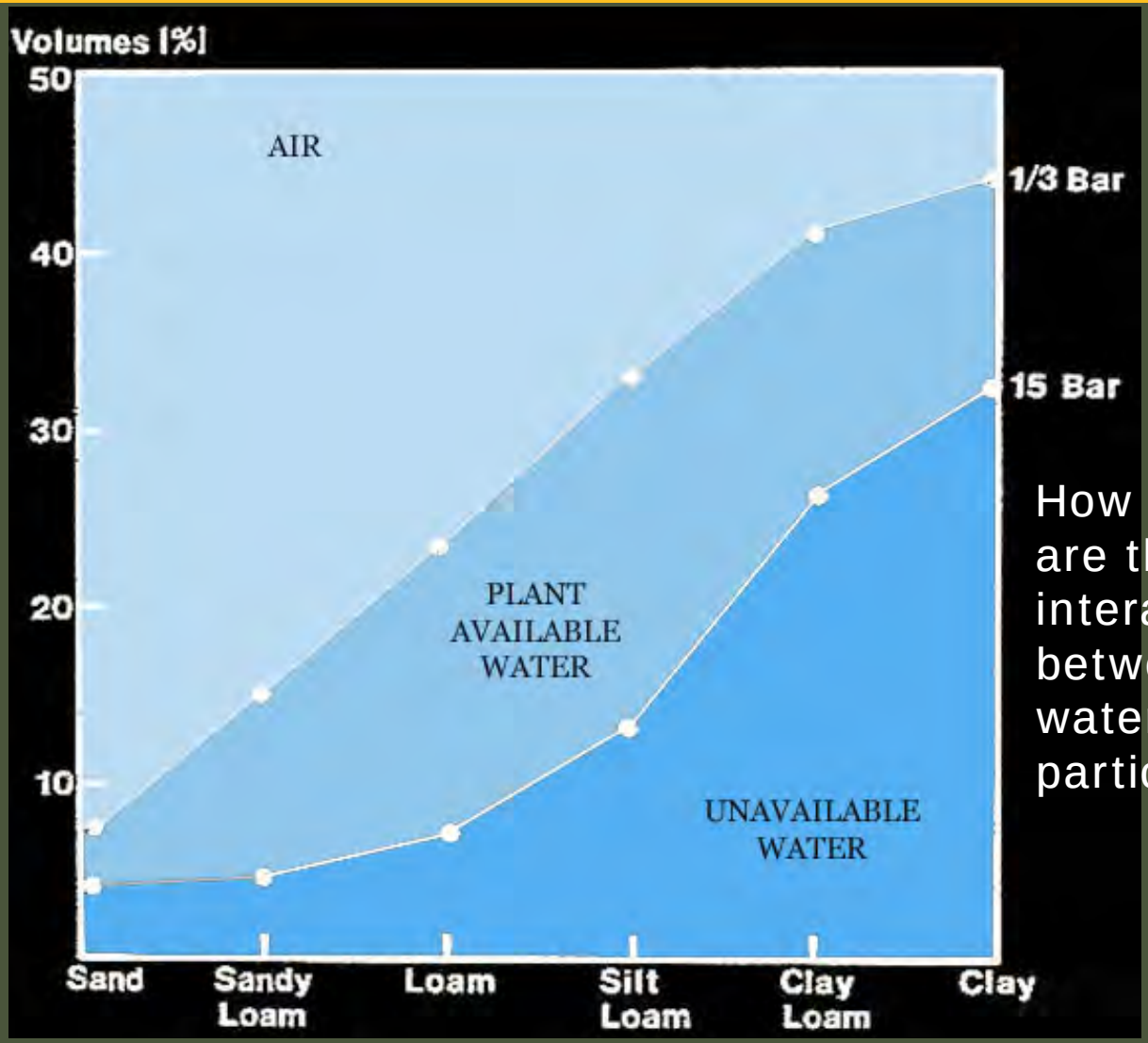
- Clay Texture


Surface area
Absorbing power
Swelling
Plasticity and
Cohesion
Heat of wetting
Colloidal Clay
Clay
Silt
Sand



- Percentage of sand, silt and clay in the major soil texture classes.

Textural Class & Water Retention in Soils



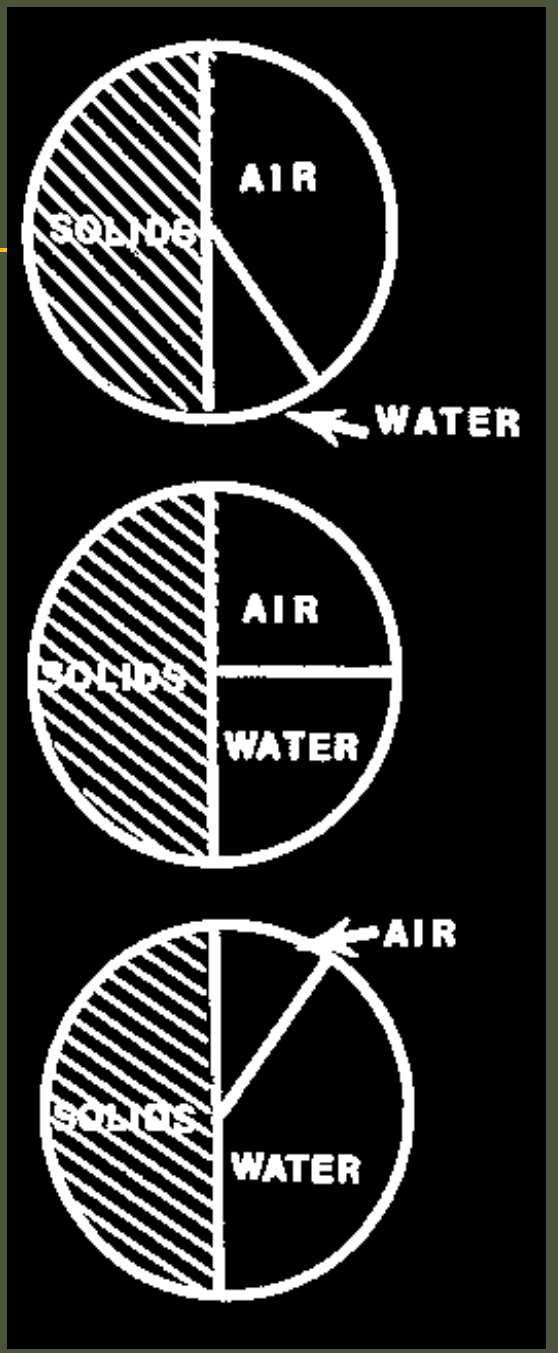
How strong are the interactions between water and soil particles?

Soil Pore Space

Sands

Loams

Clays



Coarse Fragments

- Gravels and pebbles: 2 mm – 3″
- Cobbles (round) and/or flags (flat): 3″ – 10″
- Stones and boulders - >10″

- The upper horizons have <5% stones
- The lower horizons have 40-50% stones
- Increased stone content decreases soil water holding capacity.

- Surface coarse fragments impede tillage and when in the extreme, make grazing by animals difficult.

- This stony soil has 50% + coarse fragments.
- Bedrock is shown at the bottom of the profile.
- This soil is droughty.

Structure

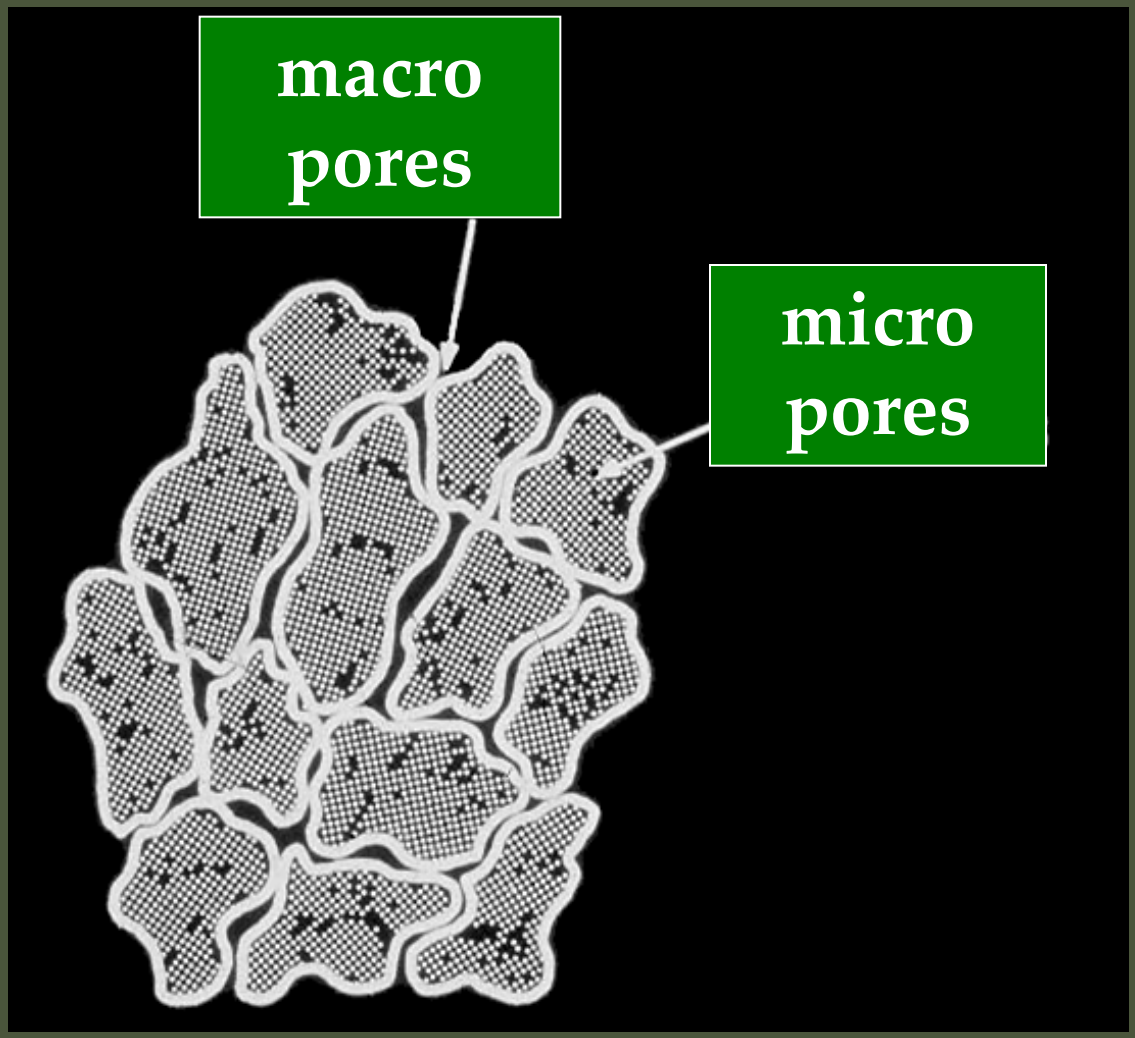
- Arrangement or grouping of primary soil separates (sand, silt, clay, organic matter) into secondary groupings

- a.k.a. aggregates or peds

Aggregation (structure)

- Creates a network of large interconnected pores
- Allows water infiltration (surface)
- Allows excess water to leave the soil, thus promoting aeration in low soil horizons

Macro vs. Micro Pores



- Left side freshly tilled
- Large Macro Pores
- Right side tilled
- Then compacted
- Slowed infiltration

Types of Structure

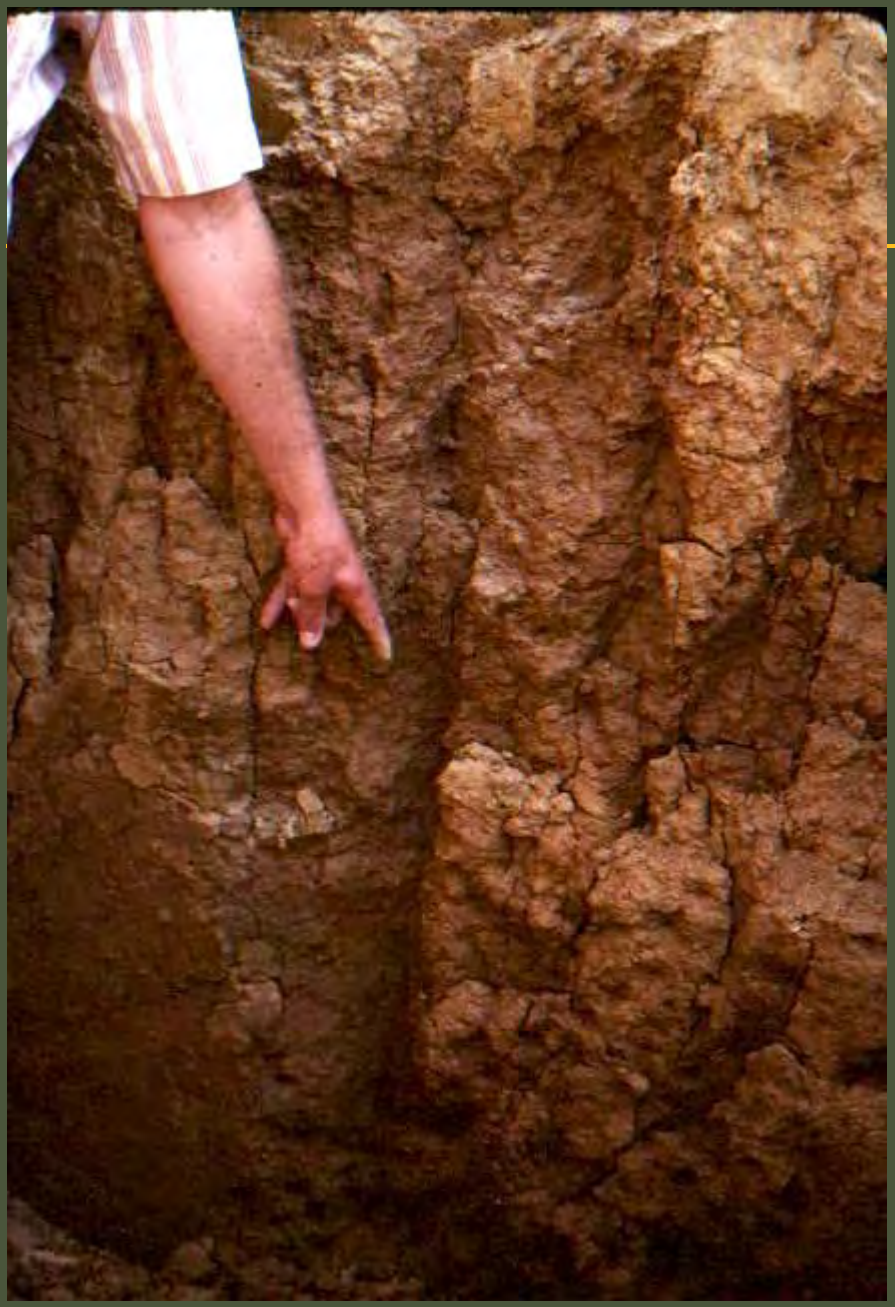
- Spheroidal
  - Granular
  - Crumb
- Blocklike
  - Angular blocky
  - Sub angular blocky
- Platy
- Prism-Like
  - Prismatic
  - Columnar
- Structureless
  - Massive
  - Single grain

- Strong, medium, granular structure

- Strong, medium, platy structure

- Fragments of platy structure

- Strong, medium, angular blocky structure



- Strong, coarse, prismatic structure

- Strong, coarse, prismatic structure

This soil shows:

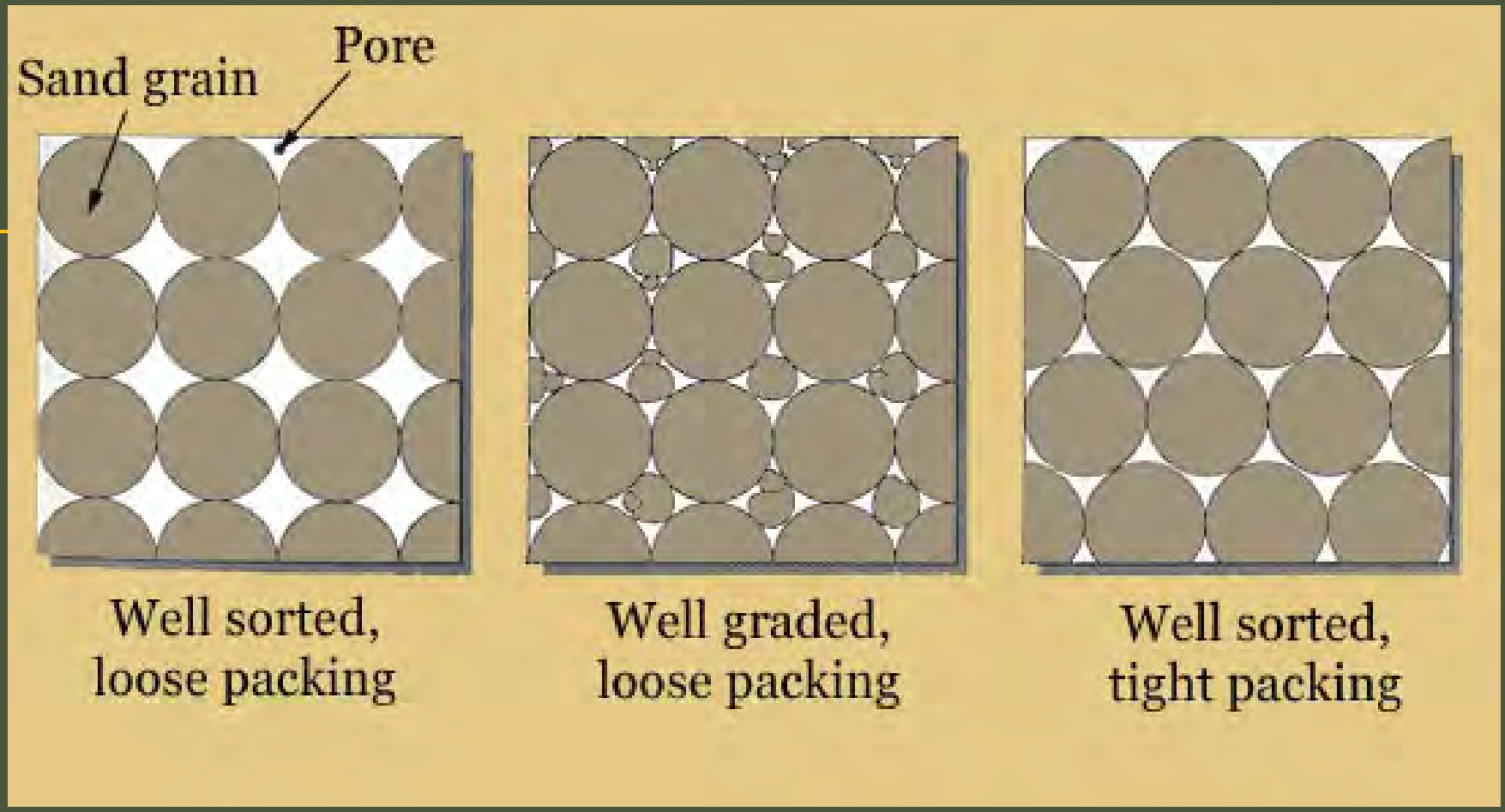
- A – Weak, Fine, Granular
- Upper B – Medium Blocky
- Lower B – Strong, Coarse, Blocky

This soil shows:

- A – Weak, Fine, Granular
- Upper B – Medium Blocky
- Lower B – Strong, Coarse, Blocky

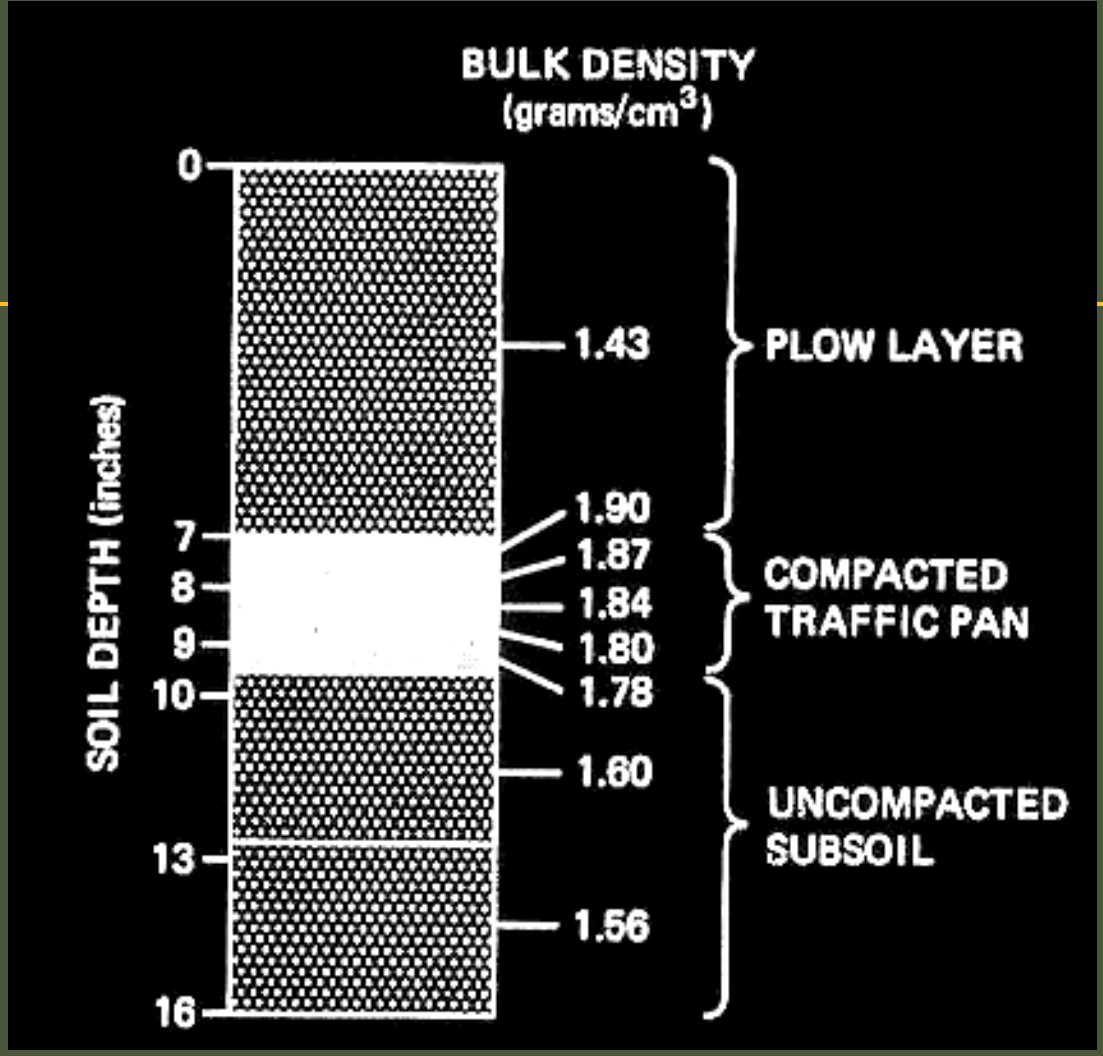
Compaction

High Bulk Density = Lower Pore Space

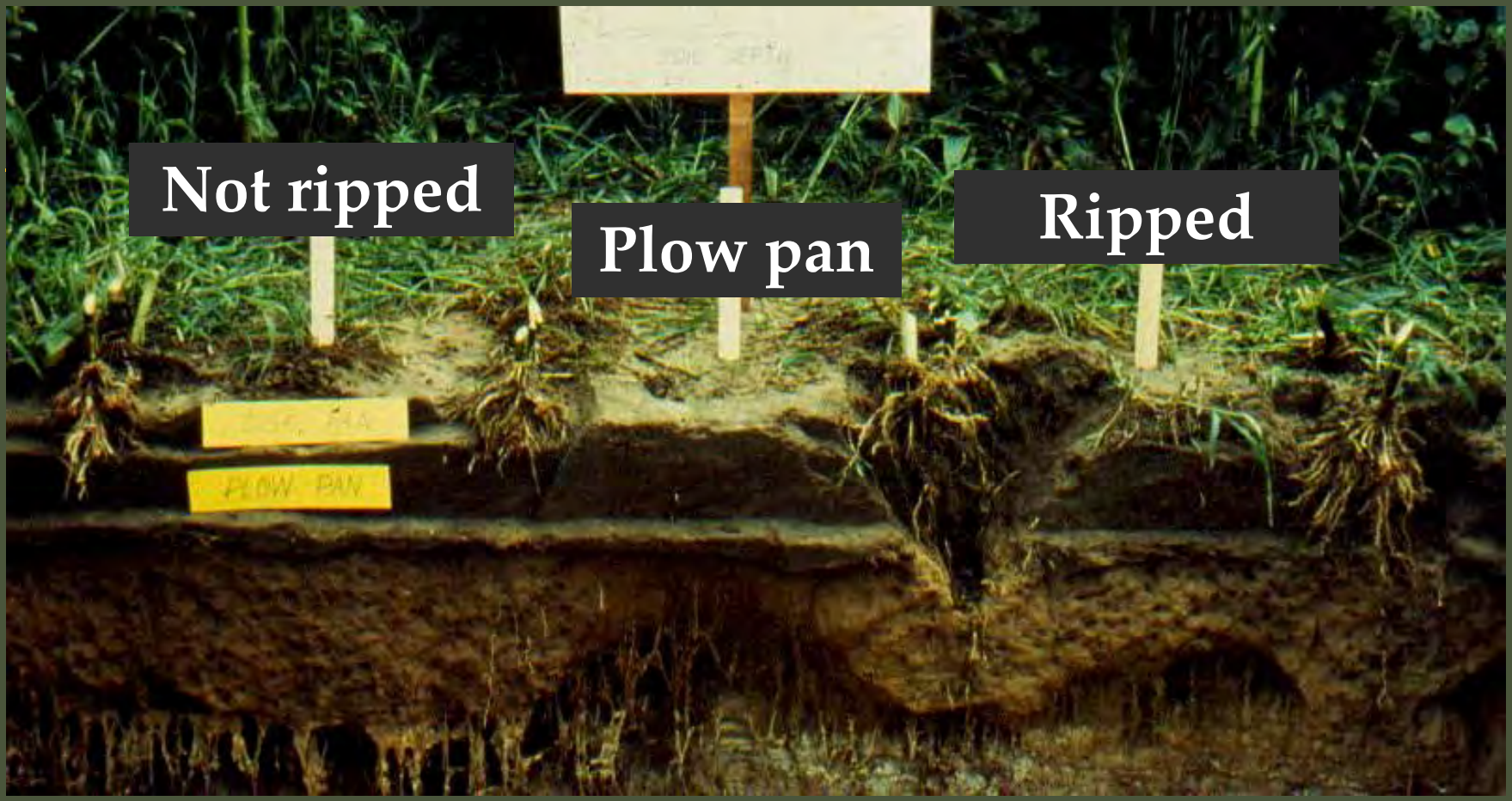


- Bulk Density = 1.38
- 52% Solids
- 48% Pore Space

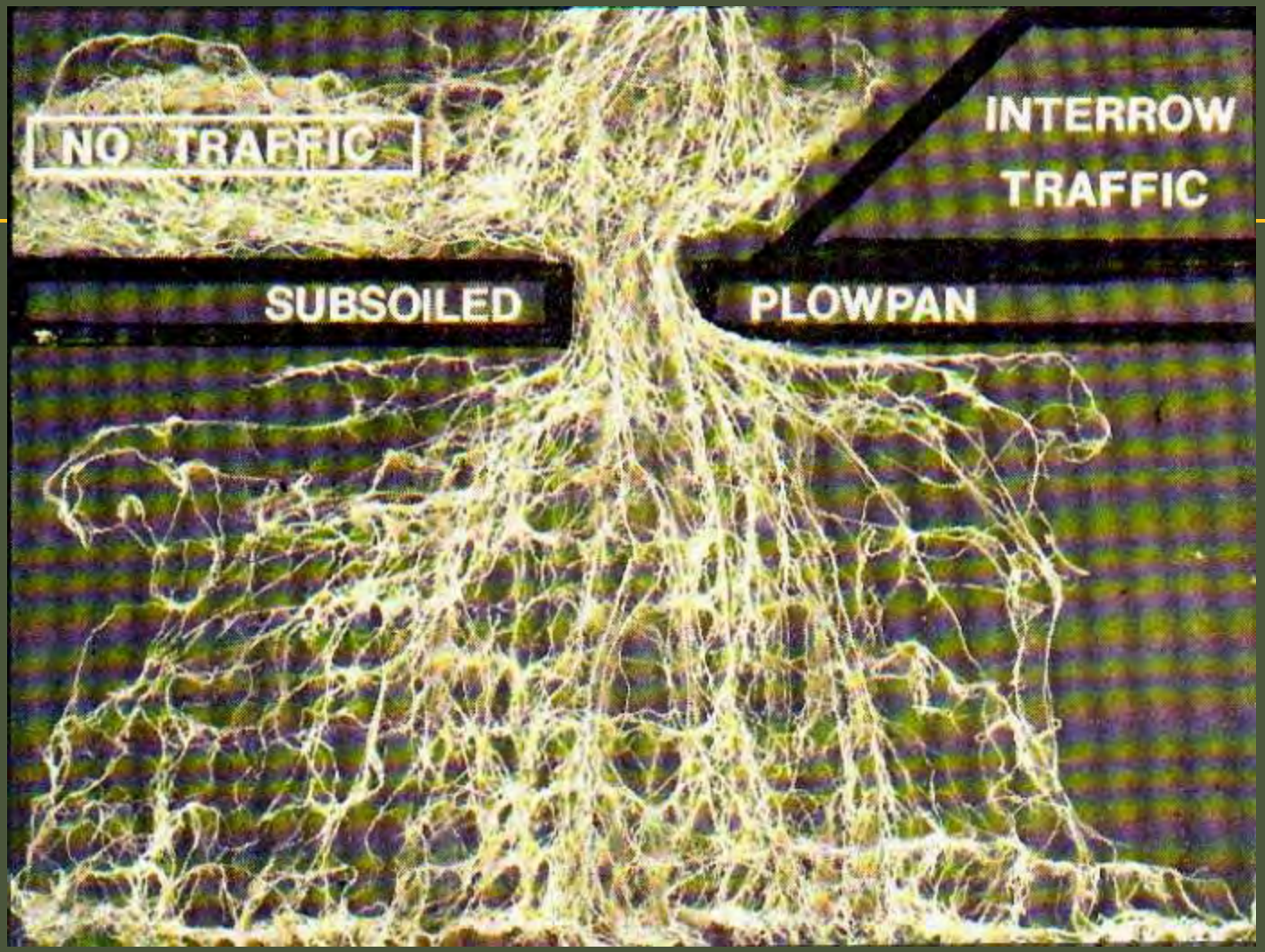
- Bulk Density = 1.96
- 74% Solids
- 26% Pore Space



- Tillage and heavy equipment compacted a zone just below the plow layer of this profile.
- Cotton roots would not penetrate layers with bulk densities of more than 1.8.



- Effect of “Ripping” on the compacted traffic pan.



- This “Root Mass” represents “in place” root distribution on a soil with a plow pan.

- This “Compacted” area is due to foot traffic resulting in a poor rooting environment.

- The edge of this compacted sample shows horizontal fractures.
- This was caused by heavy equipment traffic on a lawn.

- The light colored area (20″ to 48″) is a naturally occurring “Fragipan.”
- Commonly the Bulk Density in such horizons is >1.8

- “Expansive Clays”
- This shows cracking due to expansive clays that change volume on wetting and drying.