Soils: Understanding the Foundations of an Onsite Wastewater System


04.41

Soils: Understanding the Foundations of an Onsite Wastewater System

- Texture
- Clay Minerology
- Structure
- Soil Wetness Conditions

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Factors That Impact Water Movement in Soil

- Soil texture
- Soil mineralogy
- Soil structure
- Soil wetness
- Organic matter and vegetation
- Land use
- Landscape position
- Parent material

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Soil Texture

What is Soil Texture

- Soil texture is the relative proportion of
  - Sand
  - Silt
  - Clay

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Soil Texture

- Use texture to make inferences into pore size
- From pore size begin to estimate water movement and treatment
  - Finer texture means slower water movement
  - Finer texture means greater treatment
- Texture by itself is not enough information to determine site suitability

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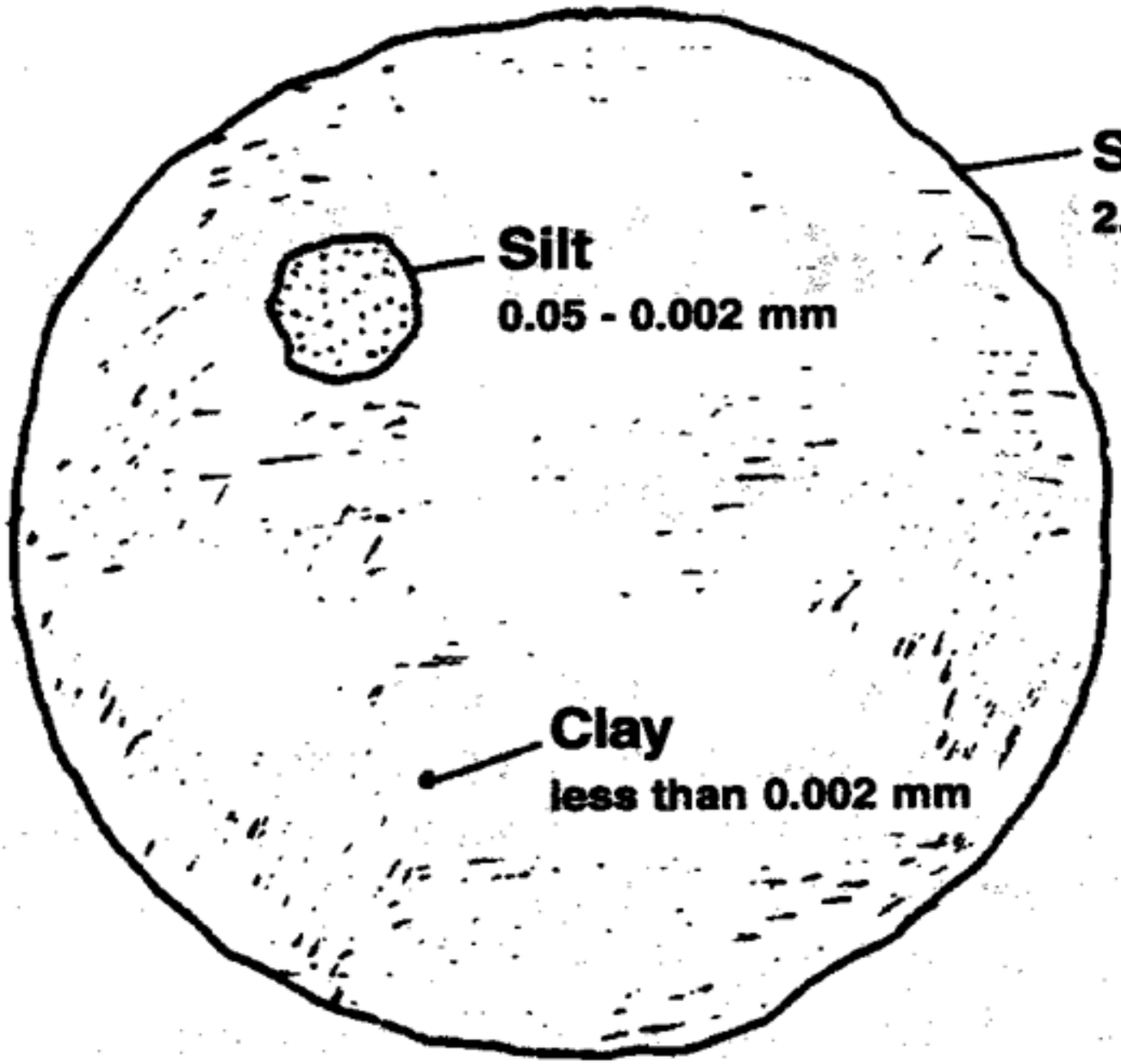

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Soil Texture (Mineral Material Only)

- Sand – gritty

- Silt - smooth, velvety

- Clay - slick, sticky

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USDA Textural Classes (12)

- Sand
- Loamy Sand
- Sandy Loam
- Loam
- Silt Loam
- Silt
- Sandy Clay Loam
- Silty Clay Loam
- Clay Loam
- Sandy Clay
- Silty Clay
- Clay

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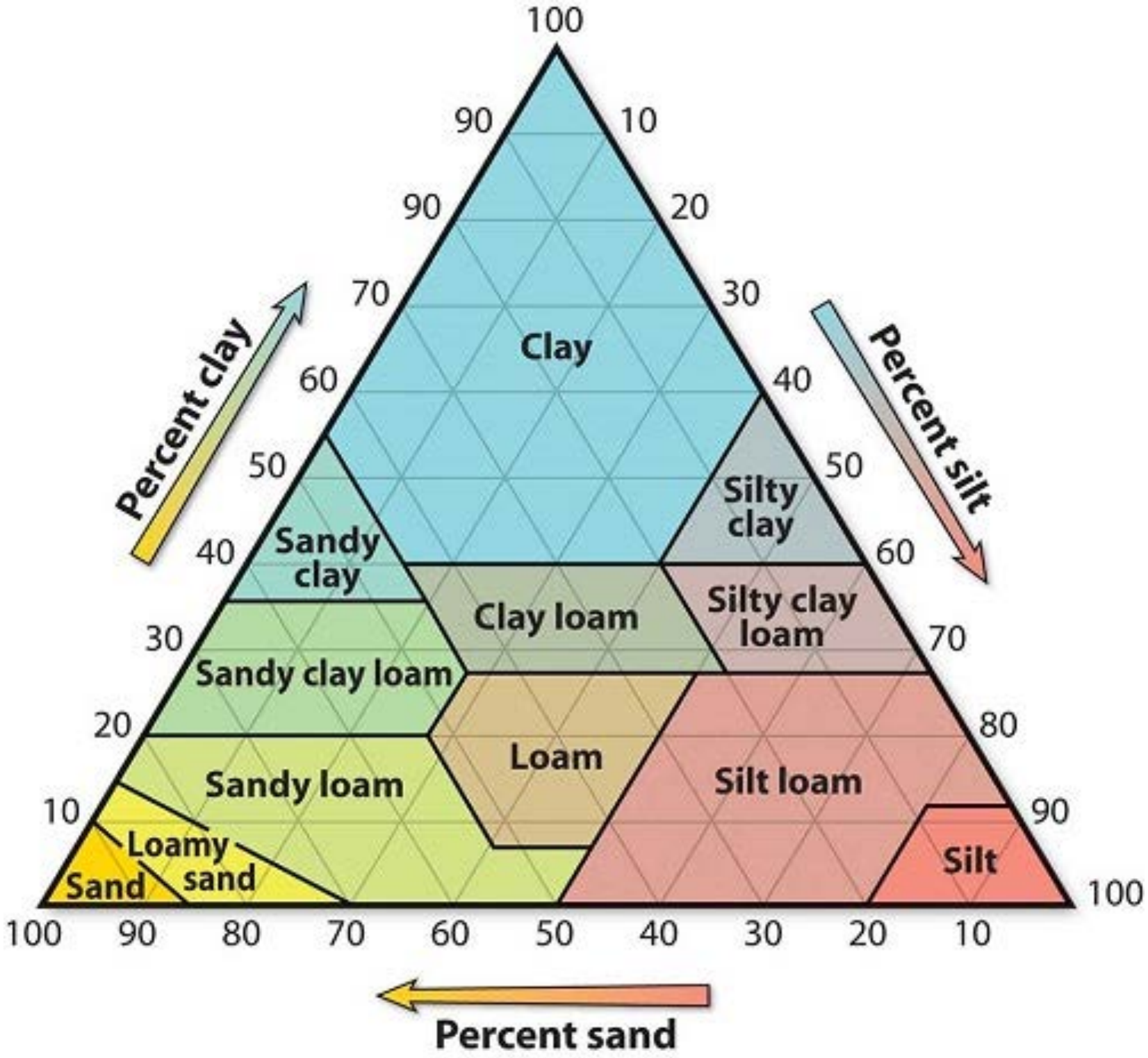
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Percent silt
Percent sand
Clay
Silty clay
Sandy clay
Clay loam
Silty clay loam
Sandy clay loam
Loam
Silt loam
Sandy loam
Loamy sand
Sand
Silt
100 90 80 70 60 50 40 30 20 10

Soil Texture

Examples

LOAM

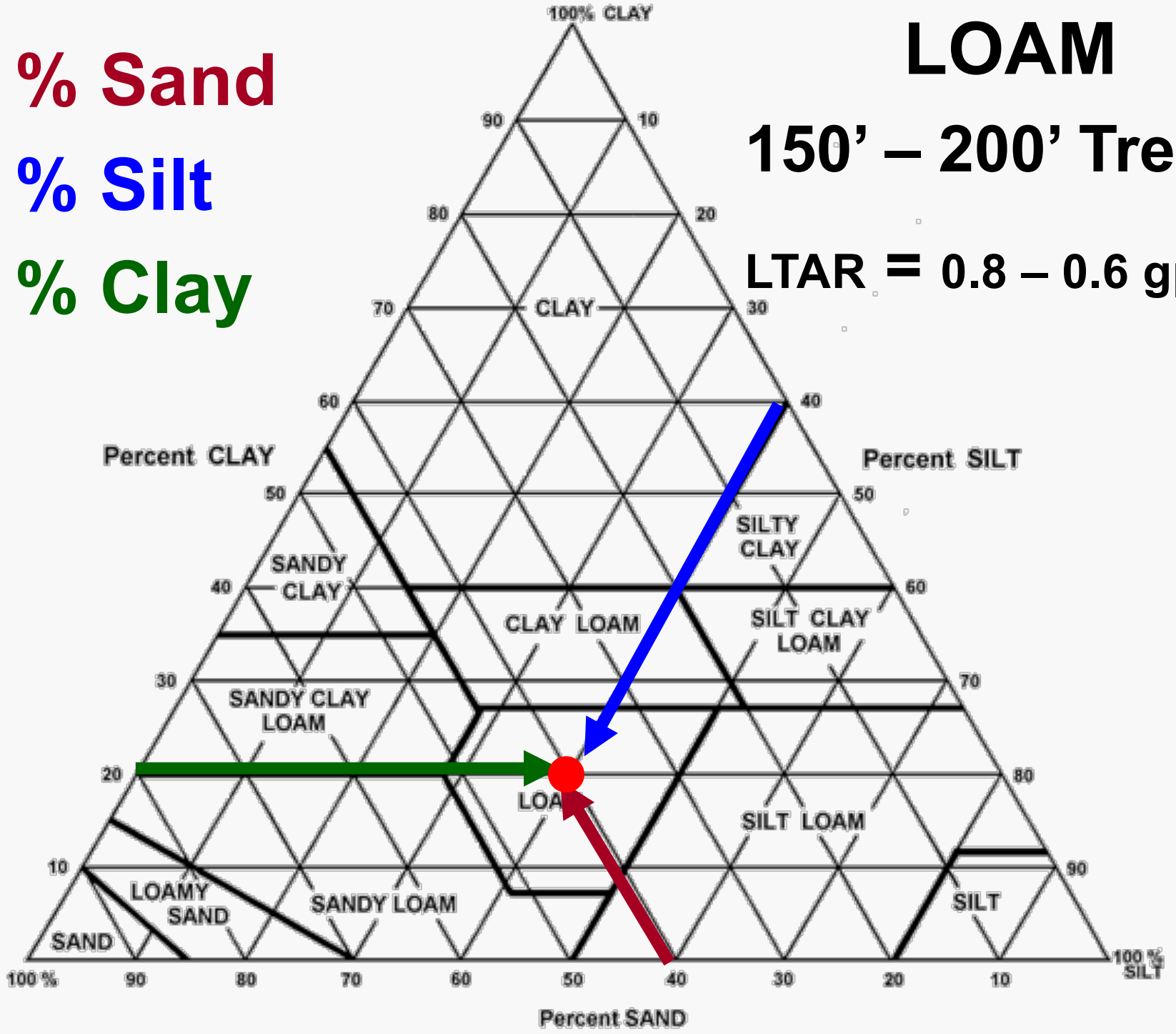
150’ – 200’ Trench

LTAR = 0.8 – 0.6 gpd/ft^2

40 % Sand

40 % Silt

20 % Clay



25 % Sand

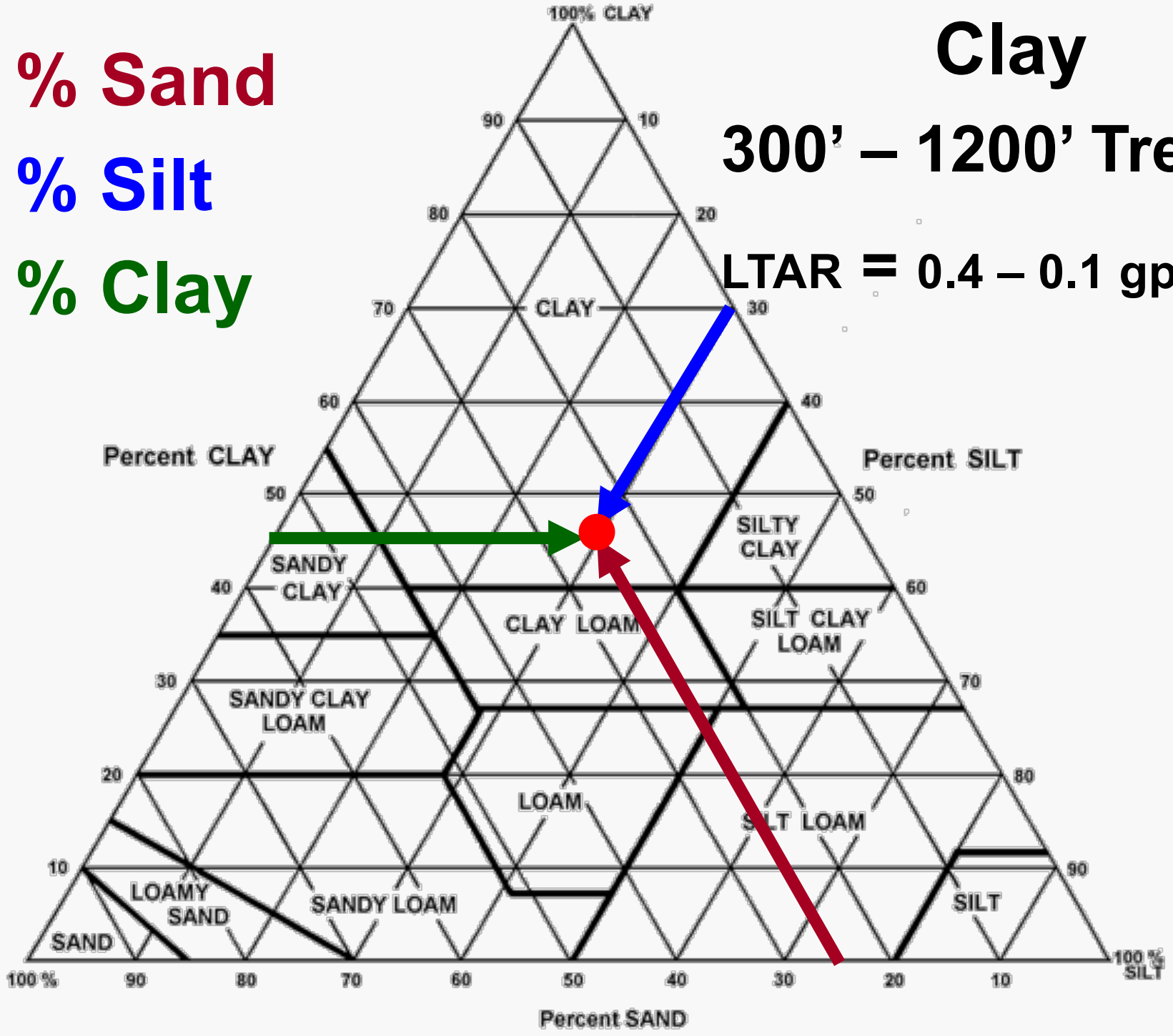
30 % Silt

45 % Clay

Clay

300’ – 1200’ Trench

LTAR = 0.4 – 0.1 gpd/ft^2

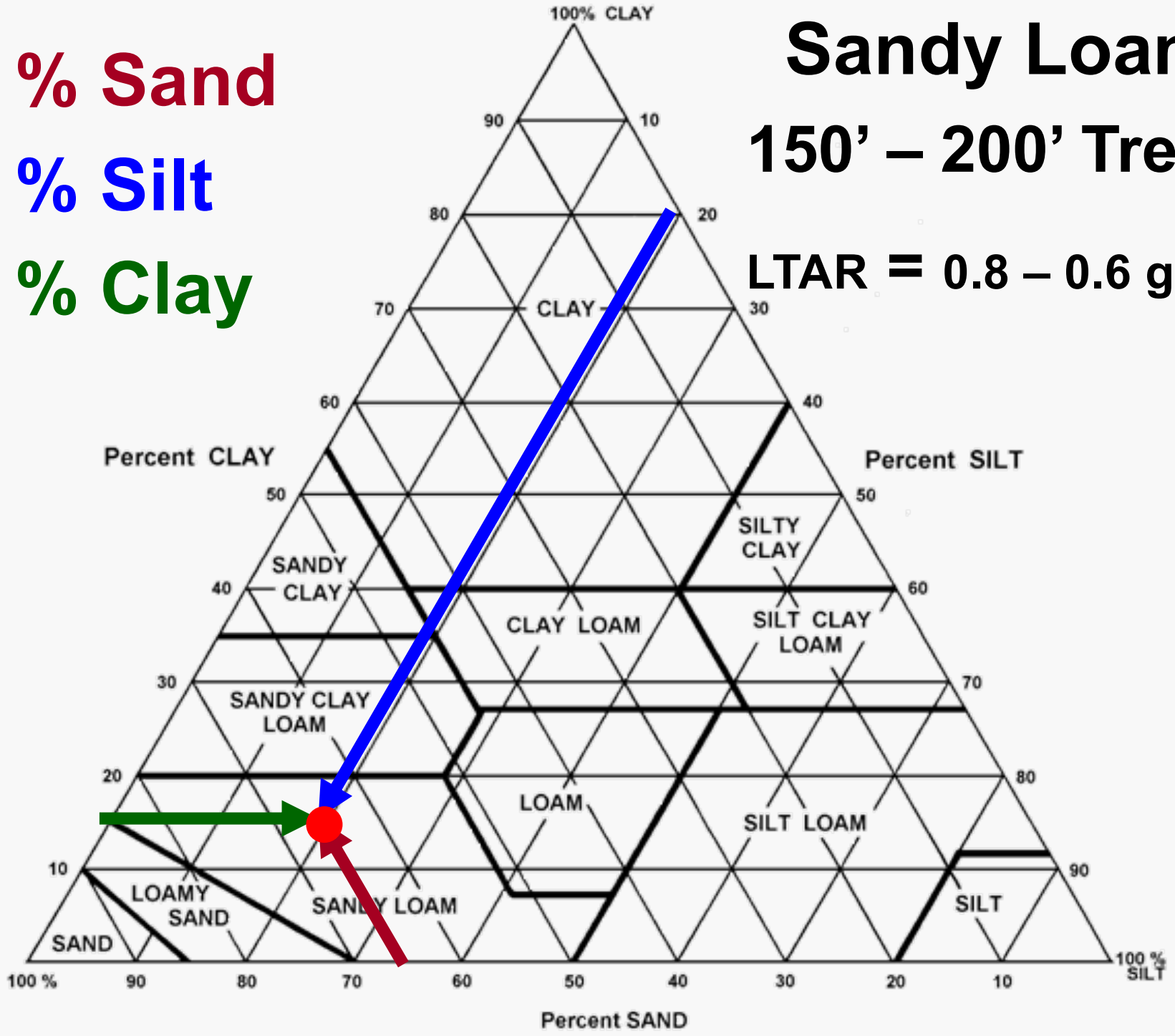


65 % Sand
20 % Silt
15 % Clay

Sandy Loam

150’ – 200’ Trench

LTAR = 0.8 – 0.6 gpd/ft^2



Textural Groups for OSWW

- Group I:
  - Sand, Loamy sand
- Group II:
  - Sandy loam, Loam,
- Group III:
  - Sandy clay loam, Silt loam, Clay loam, Silty clay loam, Silt
- Group IV:
  - Sandy clay, Silty clay, Clay

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Soil Texture

Determining Texture

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Determination of Texture

- Field procedure
- Laboratory procedure
  - Hydrometer
  - Pipette

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Field Determination Of Texture

- Soil must be moist, not saturated; moist enough to mold like putty when you try to form a ball in your hand.
- **Soil Texture Class Key***
- Does soil form a ball or cast?
- No - the texture is ***SAND***

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START

Place approximately 25g soil in palm. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty.

Add dry soil to soak up water

Does soil remain in a ball when squeezeed?

NO

Is soil too dry?

NO

Is soil too wet?

NO

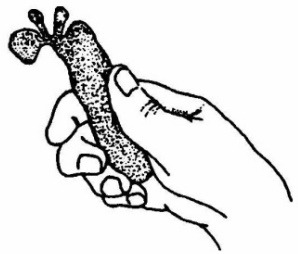
SAND

YES

YES

YES

Place a ball of soil between thumb and forefinger gently pushing the soil with the thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.

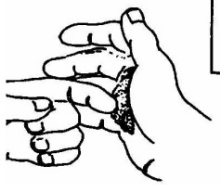


Does soil form a ribbon?

NO

LOAMY SAND

YES



Does soil make a weak ribbon less than 2.5 cm long before breaking?

NO

Does soil make a medium ribbon 2.5-5 cm long before breaking?

NO

Does soil make a strong ribbon 5 cm or longer before breaking?

YES

YES

YES

Excessively wet a small pinch of soil in palm and rub with forefinger.

Does soil feel very gritty?

YES

SANDY LOAM

NO

Does soil feel very smooth?

YES

SILT LOAM

NO

Neither grittiness nor smoothnes predominates

YES

LOAM

Does soil feel very gritty?

YES

SANDY CLAY LOAM

NO

Does soil feel very smooth?

YES

SILTY CLAY LOAM

NO

Neither grittiness nor smoothnes predominates

YES

CLAY LOAM

Does soil feel very gritty?

YES

SANDY CLAY

NO

Does soil feel very smooth?

YES

SILTY CLAY

NO

Neither grittiness nor smoothness predominates

YES

CLAY


Soil does not form a cast:
Textural class is SAND

Field Determination Of Texture

- Can the ball be handled?
- No - the texture is ***LOAMY SAND.***
- OR
- When pressing the soil between thumb and forefinger does the soil form a ribbon that extends beyond your forefinger?
- No - the texture is ***LOAMY SAND.***

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Forms a cast of moist soil material.
Textural class is LOAMY SAND

START

Place approximately 25g soil in palm. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty.

Add dry soil to soak up water

Does soil remain in a ball when squeezeed?

NO

Is soil too dry?

NO

Is soil too wet?

NO

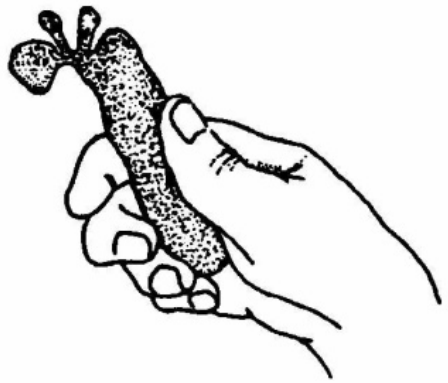
SAND

YES

YES

YES

Place a ball of soil between thumb and forefinger gently pushing the soil with the thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.



Does soil form a ribbon?

NO

LOAMY SAND

YES

Does soil make a weak ribbon less than 2.5 cm long before breaking?

NO

Does soil make a medium ribbon 2.5-5 cm long before breaking?

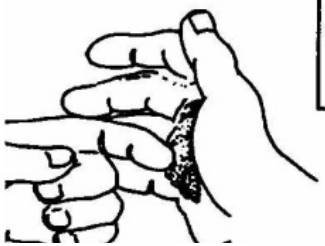
NO

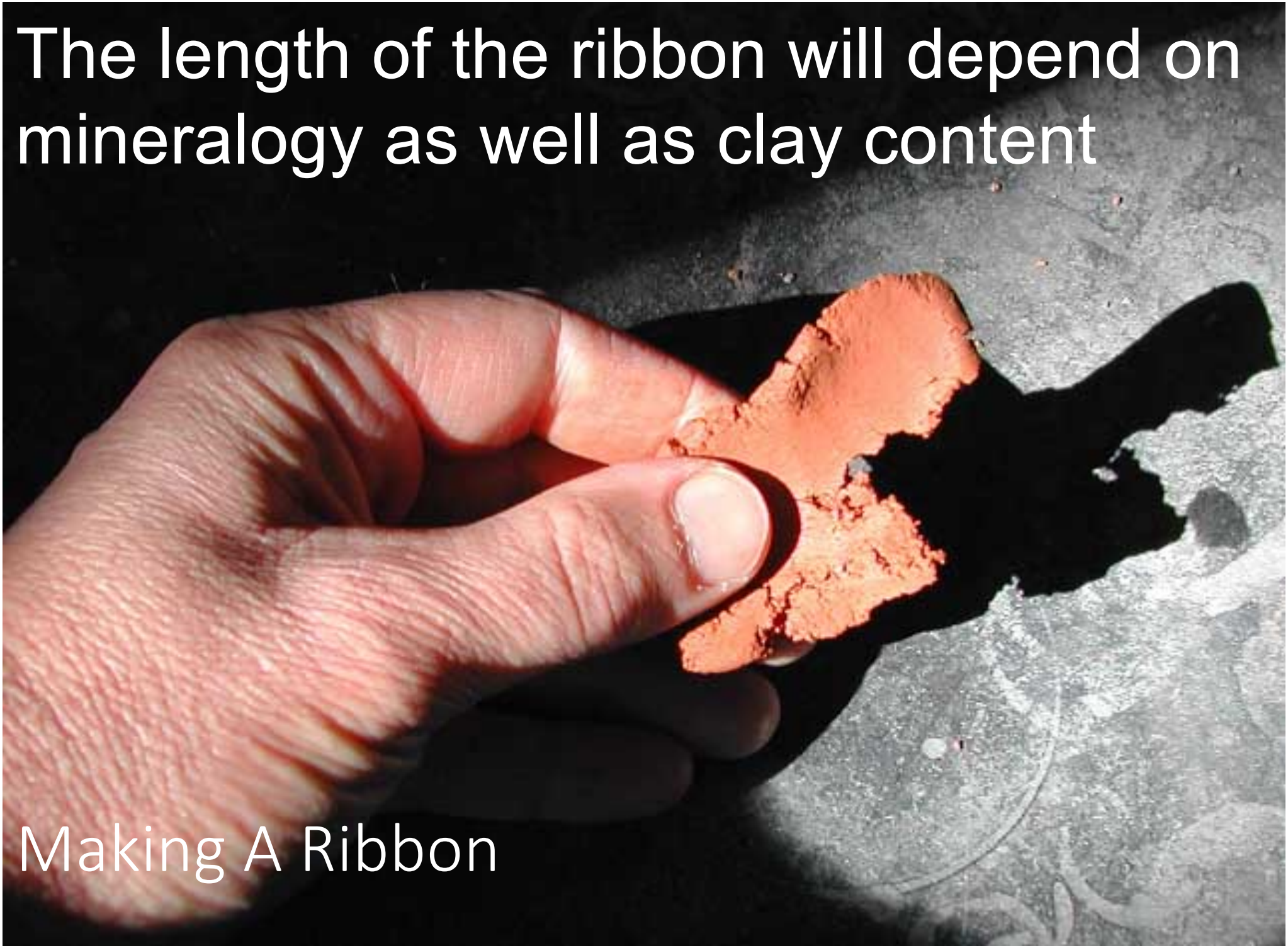
Does soil make a strong ribbon 5 cm or longer before breaking?

YES

YES

YES




The length of the ribbon will depend on mineralogy as well as clay content
Making A Ribbon

Field Determination Of Texture

- If the soil forms a ribbon that that extends past the forefinger, note the length of the ribbon.
- Next excessively wet a small sample in the palm and rub with the forefinger.

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Field Determination Of Texture

- If the ribbon was < 1 inch long when it broke and the excessively wet sample feels:
  - gritty, the texture is ***SANDY LOAM;***
  - smooth, the texture is ***SILT LOAM;***
  - neither gritty nor smooth, the texture is ***LOAM.***

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Field Determination Of Texture

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Field Determination Of Texture

- If the ribbon was between 1 and 2 inches long when it broke and the excessively wet sample feels:
  - gritty, the texture is ***SANDY CLAY LOAM;*** smooth,
  - the texture is ***SILTY CLAY LOAM;***
  - neither gritty nor smooth, the texture is ***CLAY LOAM.***

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Field Determination Of Texture

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Field Determination Of Texture

- If the ribbon > 2 inches long when it broke and the excessively wet sample feels:
  - gritty, the texture is ***SANDY CLAY;***
  - smooth, the texture is **SILTY *CLAY;***
  - neither gritty nor smooth, the texture is ***CLAY.***

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Field Determination Of Texture

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Tricks For Determining Texture

- How much water does it take to moisten the sample?
  - The more clay in the sample the more water it will take
- Does the sample leave hands with dusting
  - Silt
- Does your thumb leave a finger print in the sample?
  - Fingerprints = Clay

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Tricks For Determining Texture

What do your hands look like after drying?

Avoid Texture Mistakes

- Don’t overestimate silt content
  - Mica in the soil will feel like silt but is actually sand sized
  - Organic material will make a sample feel more silty than it really is
- Don’t overestimate clay content
  - Expansive clays will make a sample feel like it is higher in clay than it really is

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Clay Mineralogy

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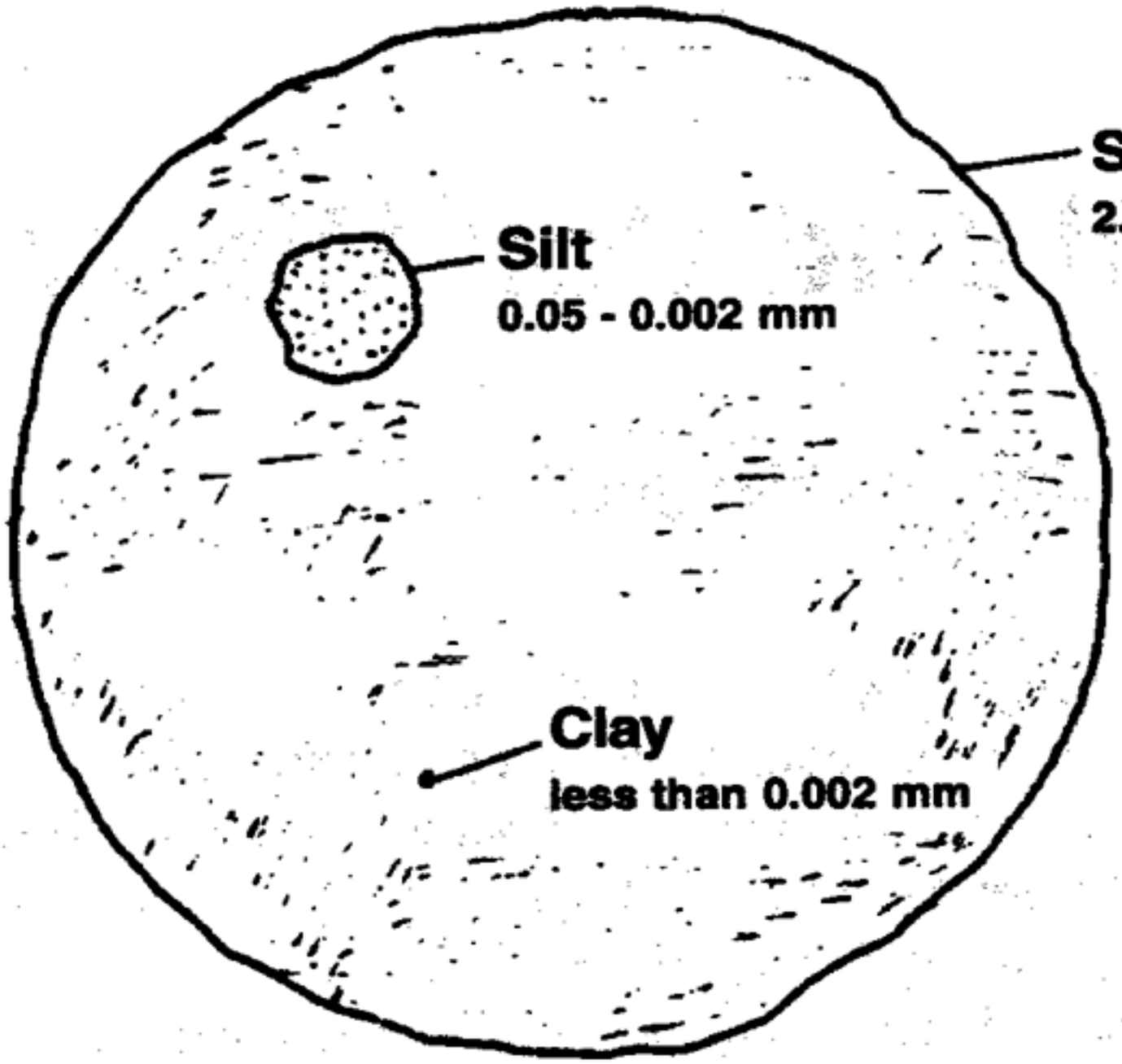
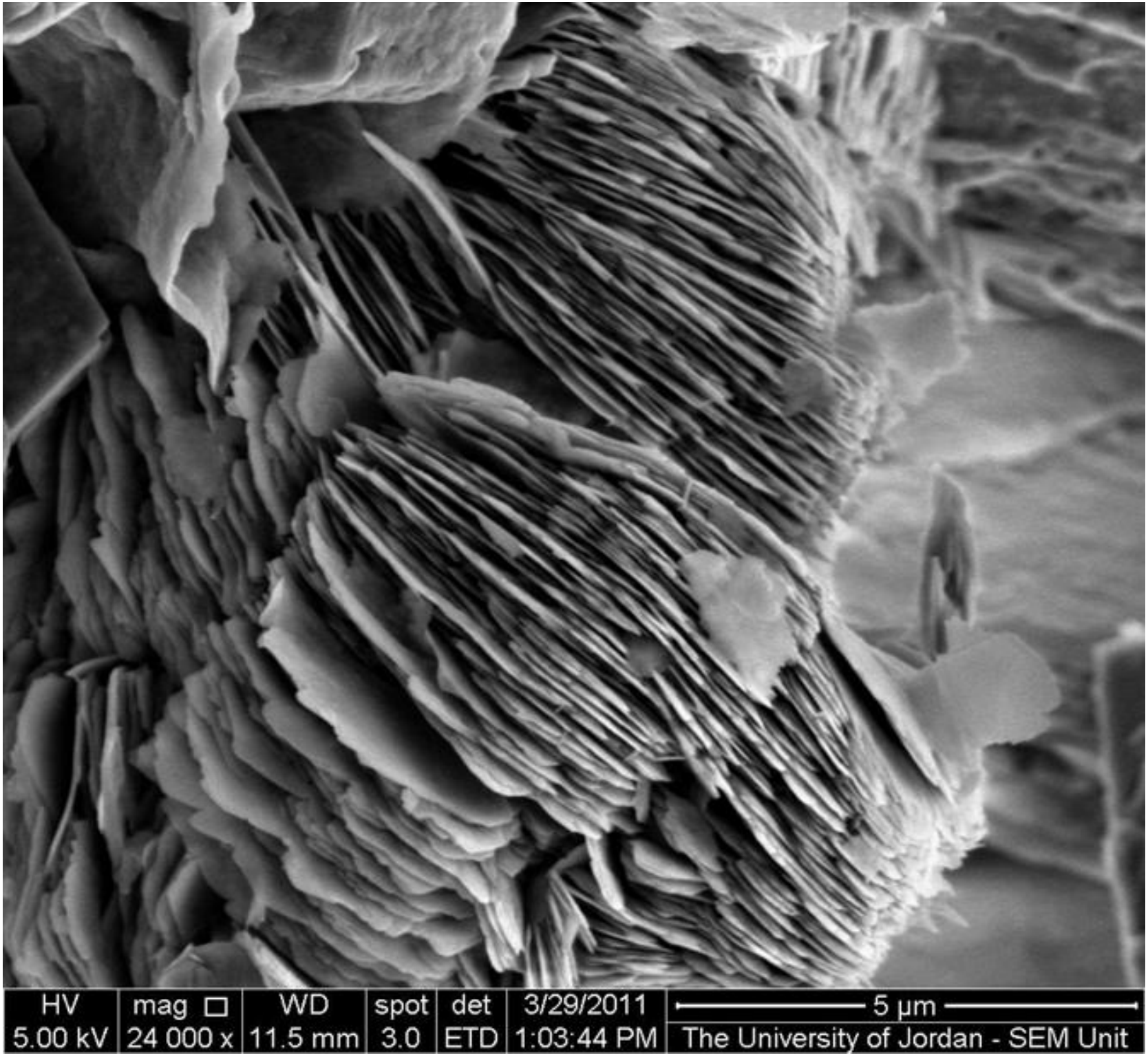


Clay Mineralogy

- Clay mineralogy affects:
  - The degree to which some soils swell when wetted
  - Thereby affecting the number of pores
  - Thereby affecting wastewater movement through soil
- Therefore …
- Clay mineralogy affects site suitability

Types of clay

- 1:1 Clays (such as kaolinite)
  - Do not expand extensively on wetting
- 2:1 Clays, including mixed mineralogy clays (e.g. mix of kaolinite and montmorillonite or other clay minerals)
  - May shrink and swell extensively when dried and wetted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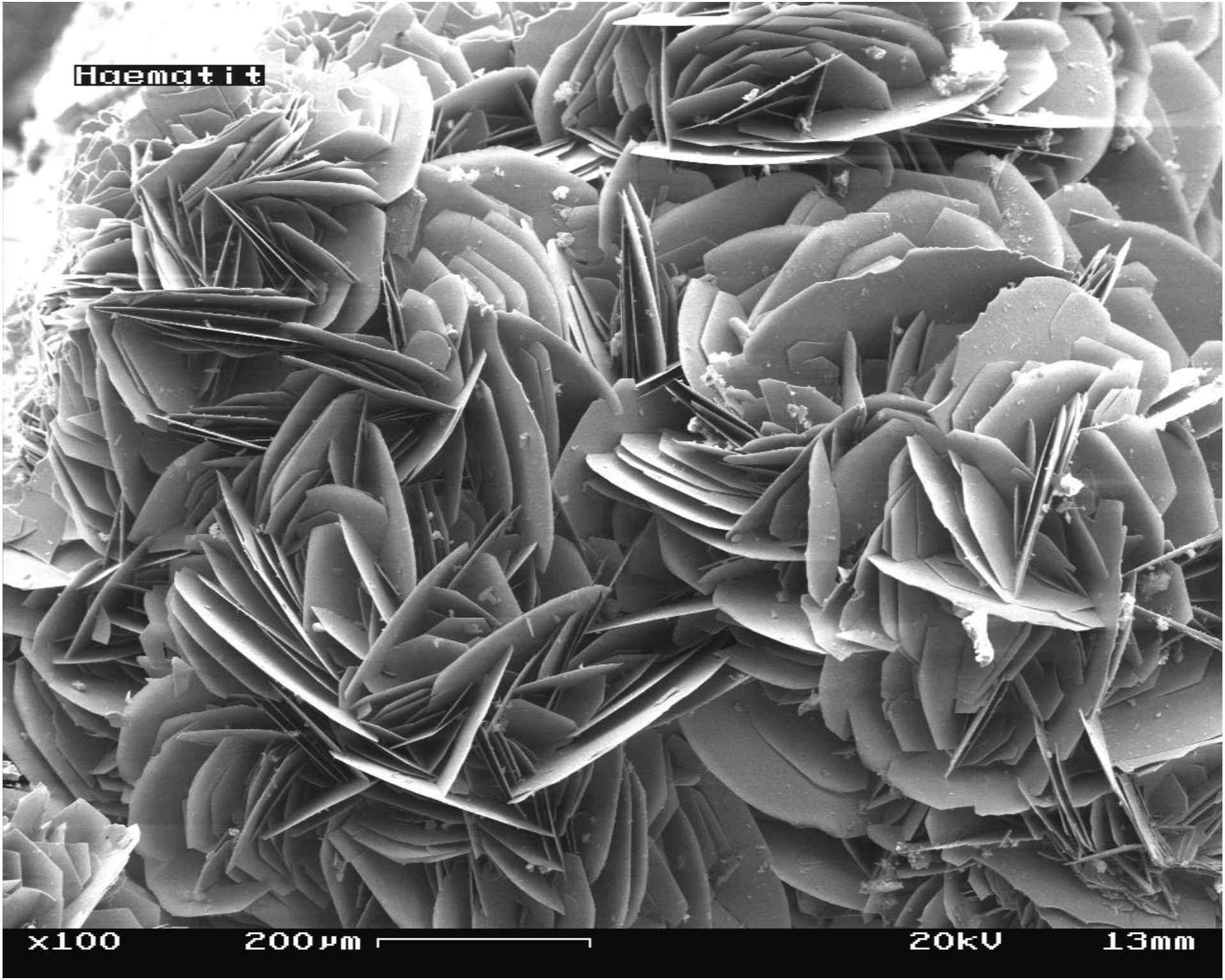
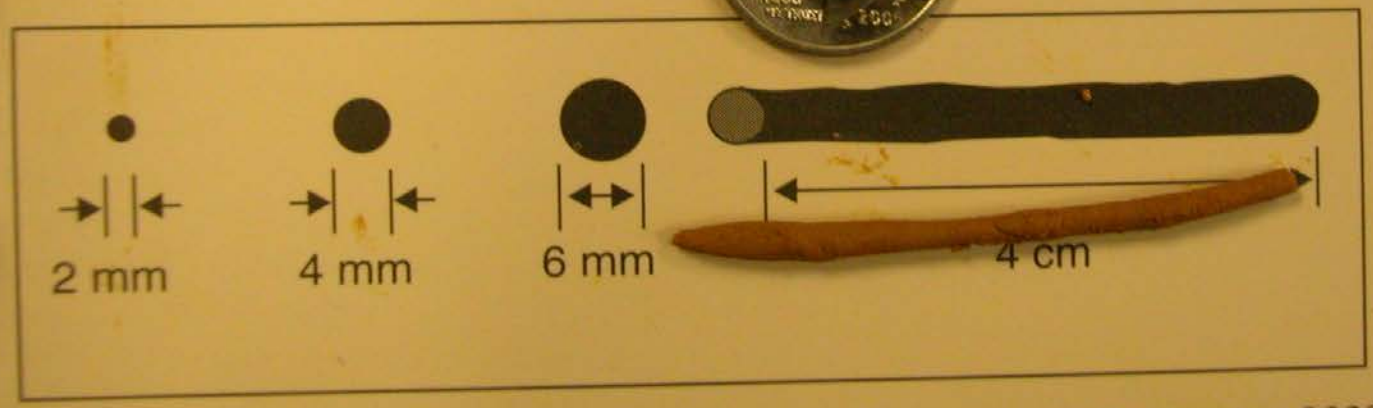

Haematit
x100
200µm
20kV
13mm

roll (wire) of soil at a water content where the maximum plasticity is expressed.

Plasticity Class	Code			Criteria: Make a roll of soil 4 cm long
	Conv	PDP	NASIS	
Non-Plastic	(w) po	PO	PO	Will not form a 6 mm diameter roll, or if formed, can't support itself if held on end.
Slightly Plastic	(w) ps	SP	SP	6 mm diameter roll supports itself; 4 mm diameter roll does not.
Moderately Plastic [1]	(w) p	P	MP	4 mm diameter roll supports itself, 2 mm diameter roll does not.
Very Plastic	(w) vp	VP	VP	2 mm diameter roll supports its weight.

[1] Historically, the *Moderately Plastic* cl… …mply called *Plastic*.



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Sticky.

PLASTICITY - The degree to which "puddled" or reworked soil can be permanently deformed without rupturing. The evaluation is made by forming a roll (wire) of soil at a water content where the maximum plasticity is expressed.

Plasticity Class	Code			Criteria: Make a roll of soil 4 cm long
	Conv	PDP	NASIS	
Non-Plastic	(w) po	PO	PO	Will not form a 6 mm diameter roll, or if formed, can't support itself if held on end.
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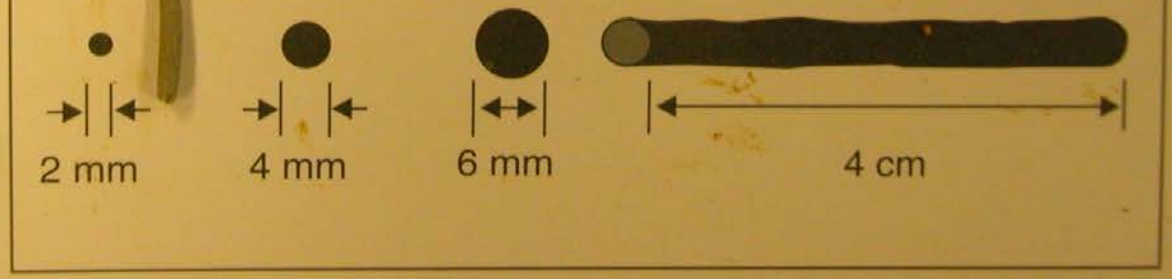
Very Plastic	(w) vp	V		2 mm diameter roll supports its weight.

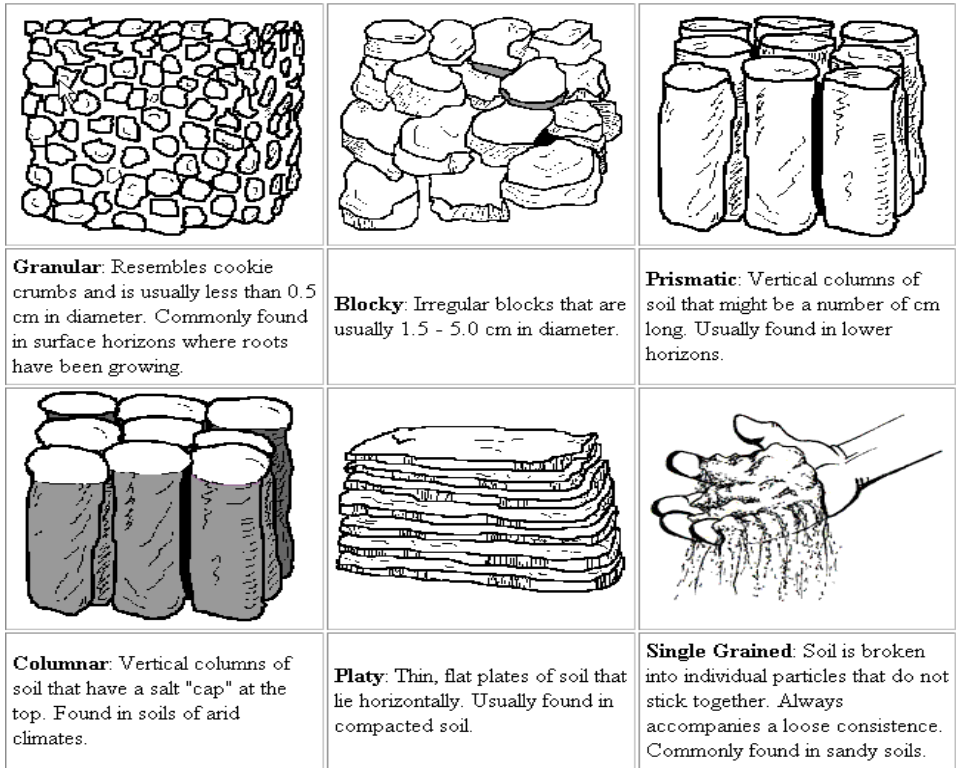
[1] Historically, the *Moderately Plastic* class was simply called *Plastic.*



Special / Perm. / Chem. Resp.

Soil Structure

Impacts on Water Movement



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.

What Is Soil Structure?

- The natural aggregation of basic soil particles into identifiable masses, or structural *units*
- These units are identified by:
  - Type- based on the shape
  - Size – based on the relative size
  - Grade- based on how well the structure is developed

Definition

- *Soil Structure*
  - the arrangement of primary soil particles into compound particles, peds, or clusters
  - that separate by natural planes of weakness from adjoining aggregates.

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How Soils Get Structure

- Excretions from soil microbes bind soil particles together
- Filaments from soil fungi tie soil particles together
- Plant roots excrete sugars and waste products that bind soil mineral particles
- Movement of clay and organic materials helps bind soil particles
- Electrostatic forces

Granular (crumb)

Blocky

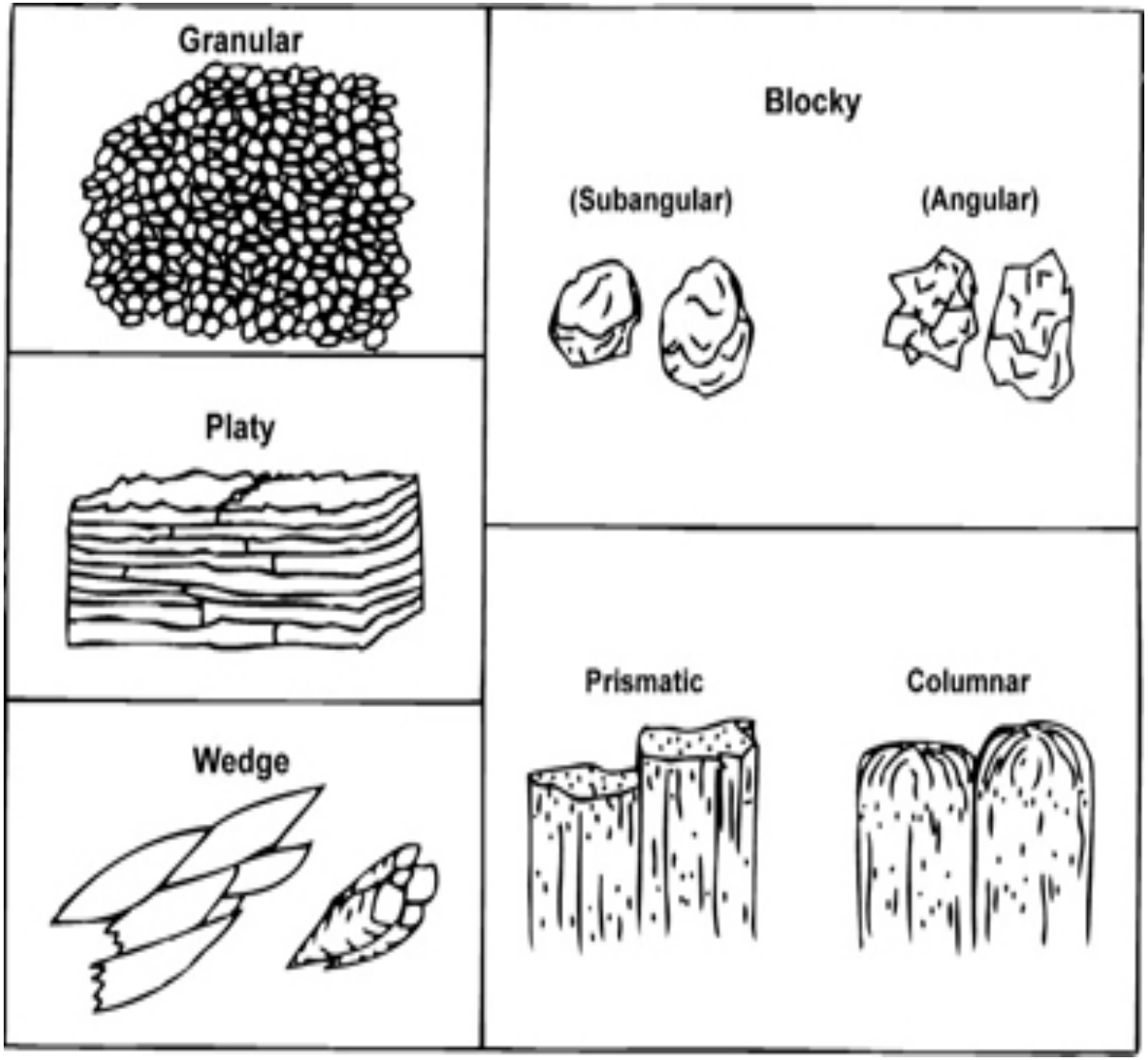
Platy

Prismatic

Columnar

Wedge

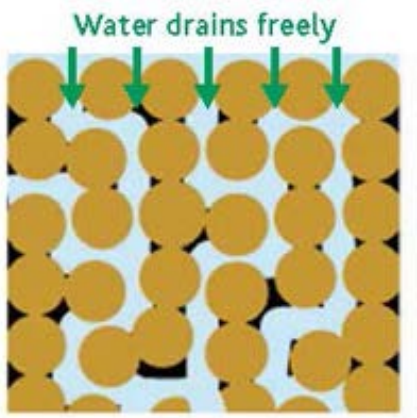
Single Grained

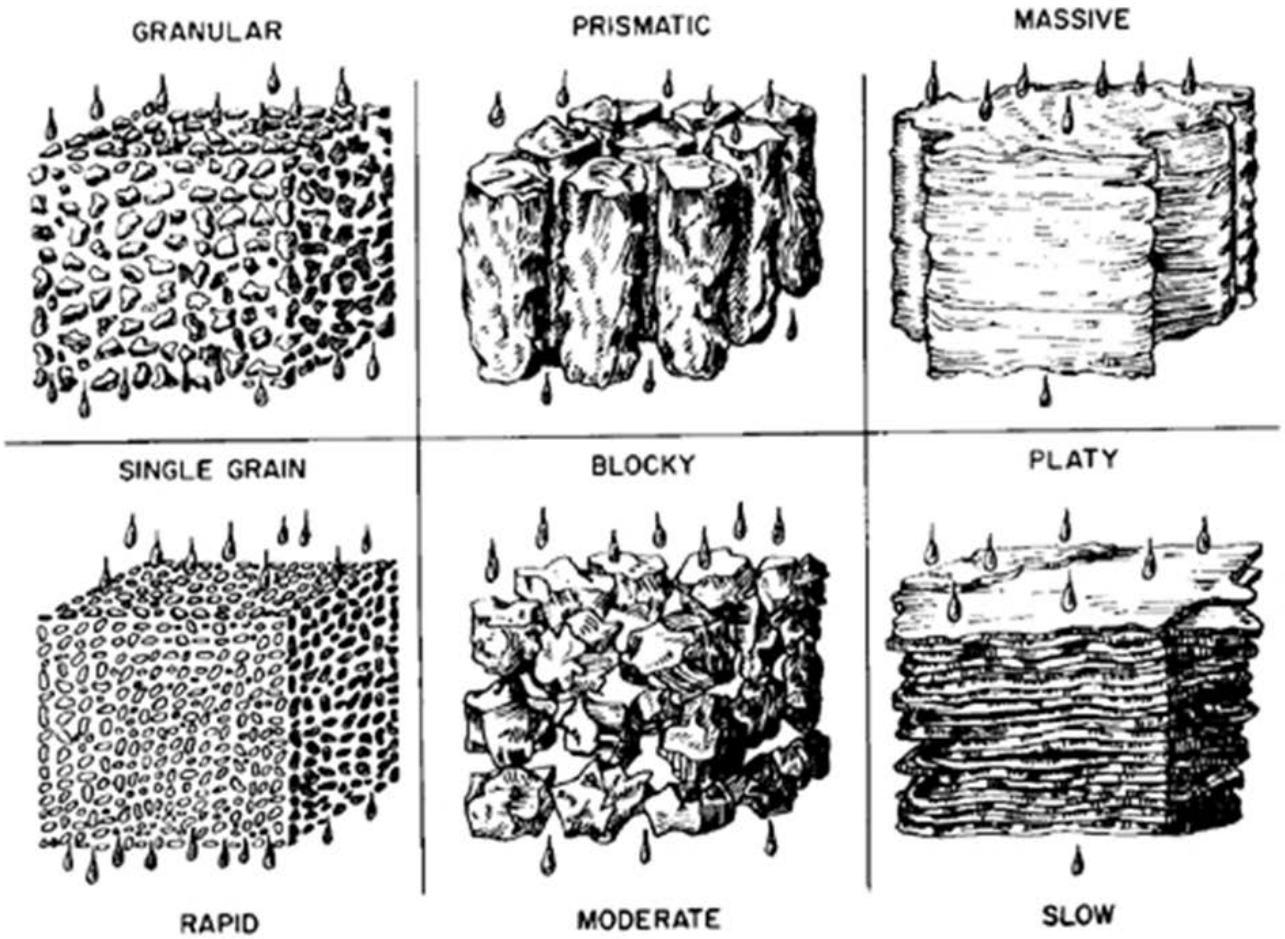


Types Of Soil Structure

Water Movement

- Predominantly around structural units versus through structural units





Soil Structure

- Crumb And Granular Soil Structure = Suitable

Block-like Soil Structure

Blocky

Sub-Angular Blocky

Soil Structure

- PLATY SOIL STRUCTURE = Problematic

Soil Structure

- PRISMATIC SOIL STRUCTURE = Problematic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Soil Structure

- ABSENCE OF SOIL STRUCTURE –
  - Soils which are single grained and exhibit no structural aggregates = SUITABLE
  - Soils which are massive and exhibit no structural peds = UNSUITABLE.

How Does Structure Affect System Size

- The finer the ped size, the better the drainage
  - Smaller Peds = Smaller Drainfield

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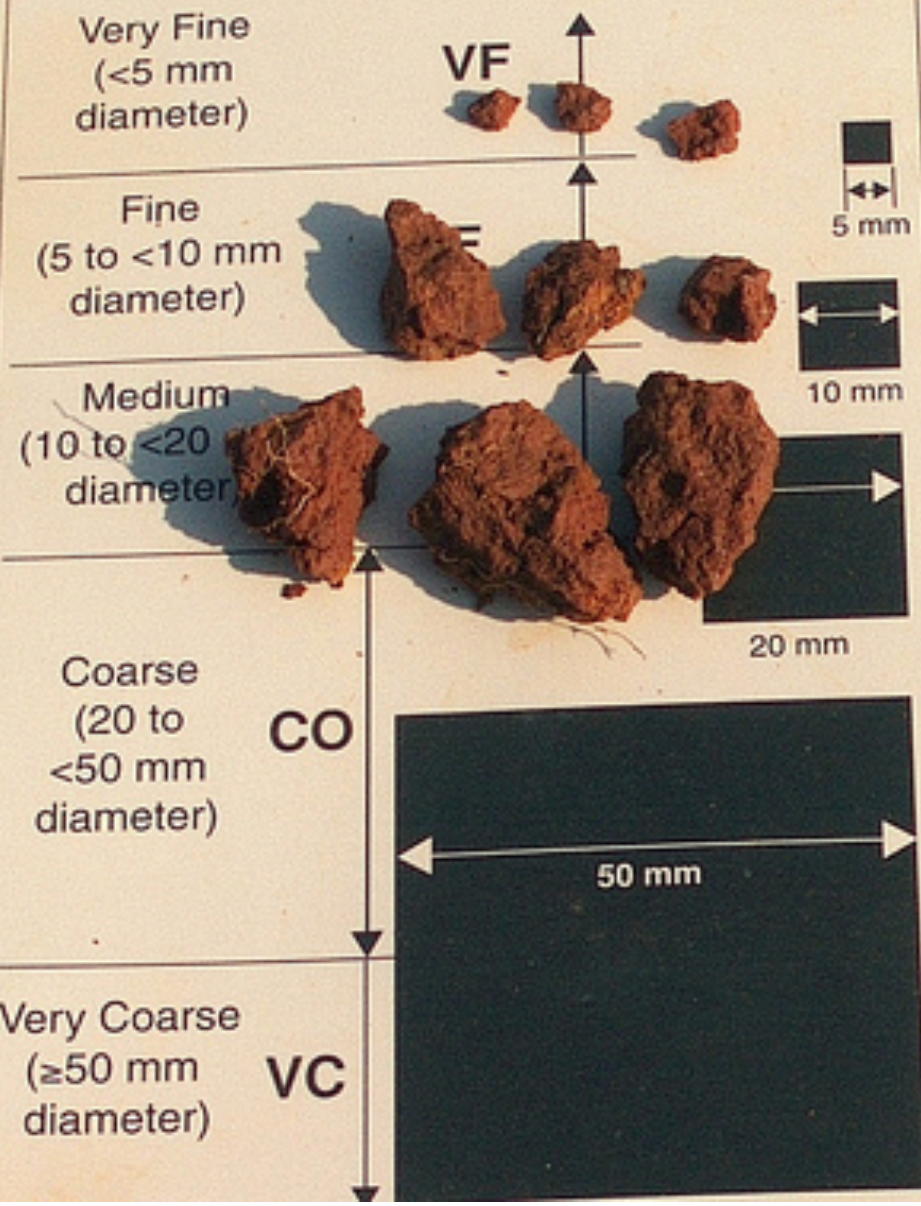
Angular & Subangular Blocky

Codes



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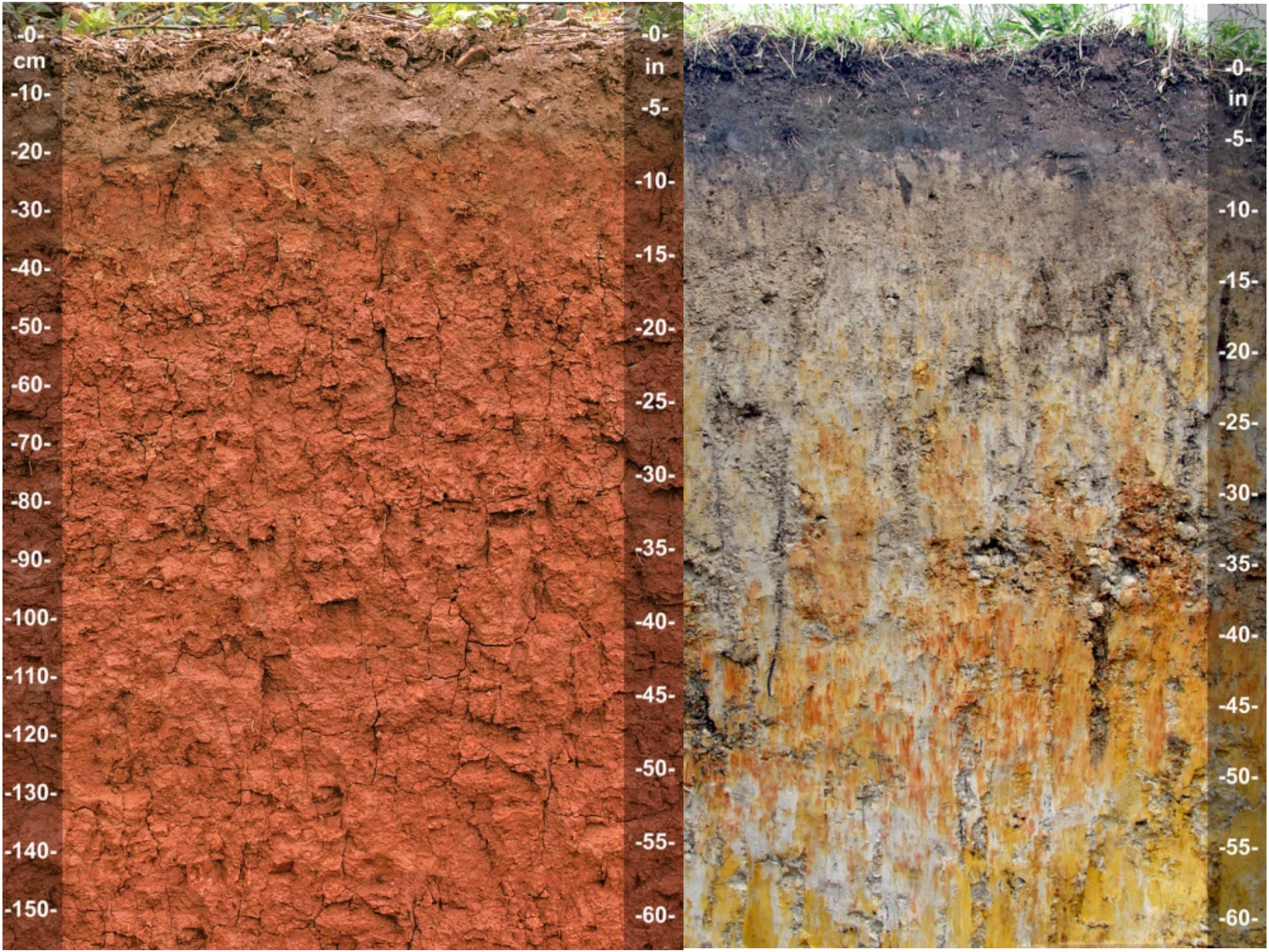
Soil Wetness

Soil Wetness

We do not rely on visual observation of water or wet soils

We use soil colors as an indication of how well-drained or wet a soil is (or was)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Seasonally Waterlogged Soils Will Develop a Mixture of Gray and Brown Colors as Fe is Reduced And Re-Oxidized

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Waterlogged Soils Are Identified By:

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- Colors that form only in anaerobic soils: contain no oxygen (reduced) and are saturated.
- Diagnostic colors are gray with spots of red or brown that form in soils that were reduced.
- Termed Redox Depletions (gray) and Redox Concentrations (red, brown)

How To Make A Soil Gray?

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1. Specific chemical reactions must occur to cause gray colors to form when soils are saturated.
2. These reactions require:

- Bacteria,
- Organic matter,
- Saturated soil, and
- Slowly moving water lacking oxygen.

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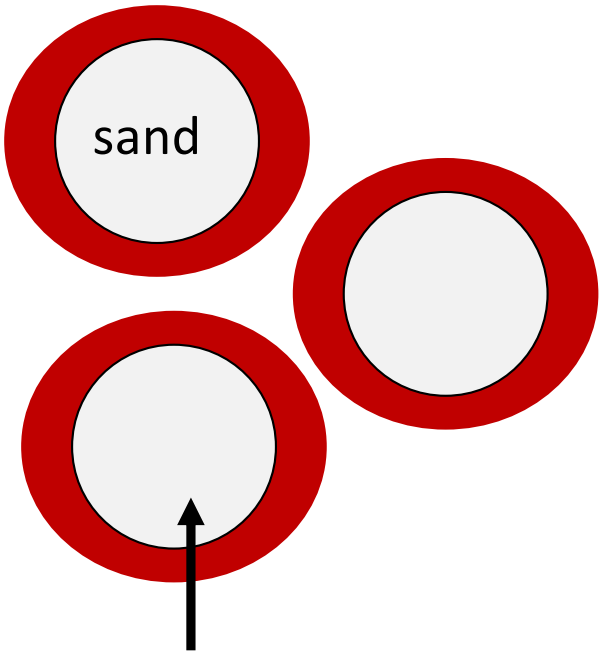
Where does the brown color come from?

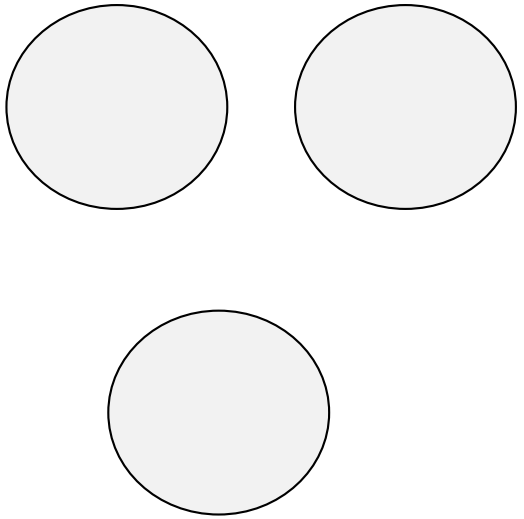
Red Soil

Gray Soil



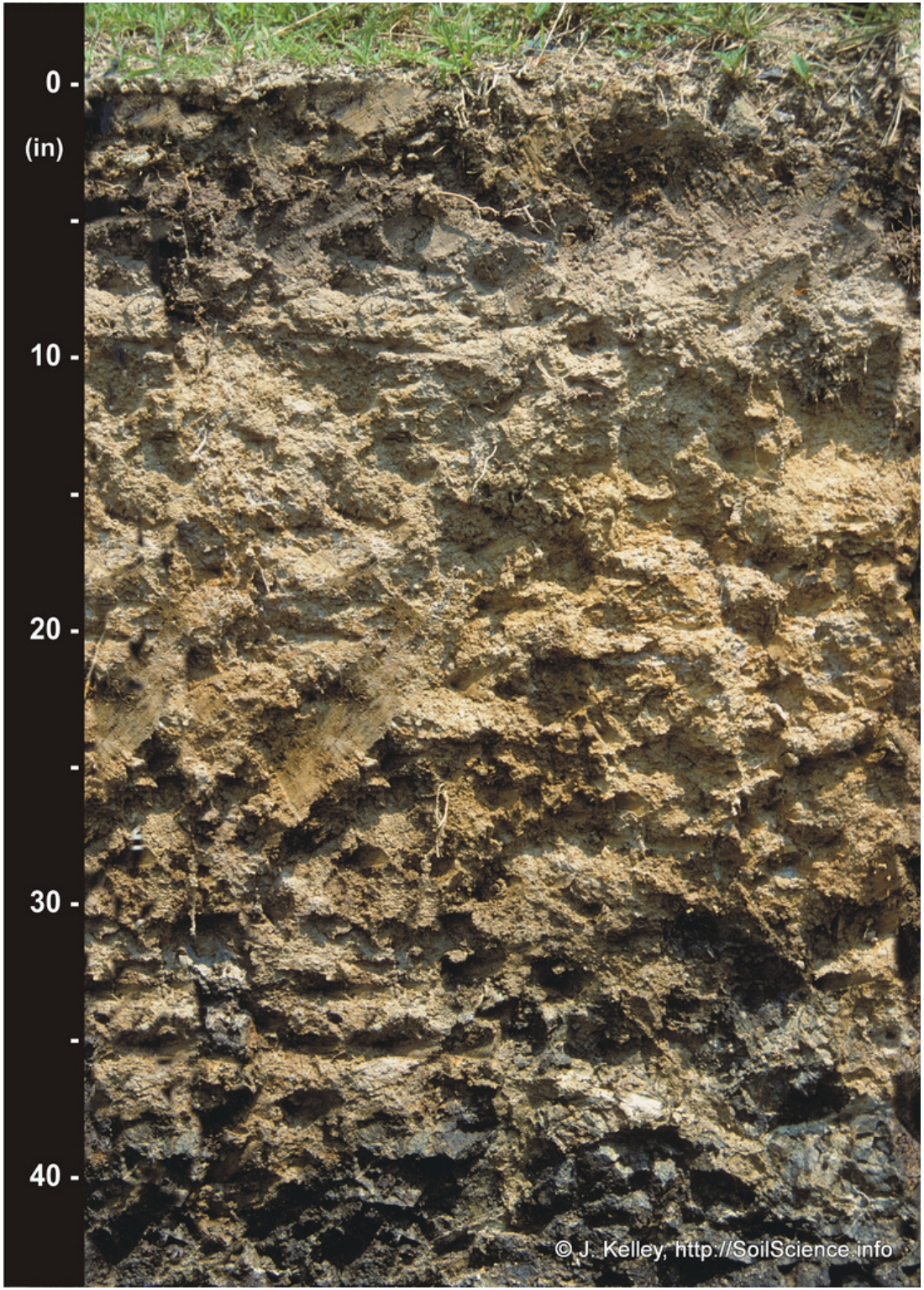
Remove

Fe coats



Gray sand
covered
by red
Fe^{3+} coating

Sand
without
Fe coatings



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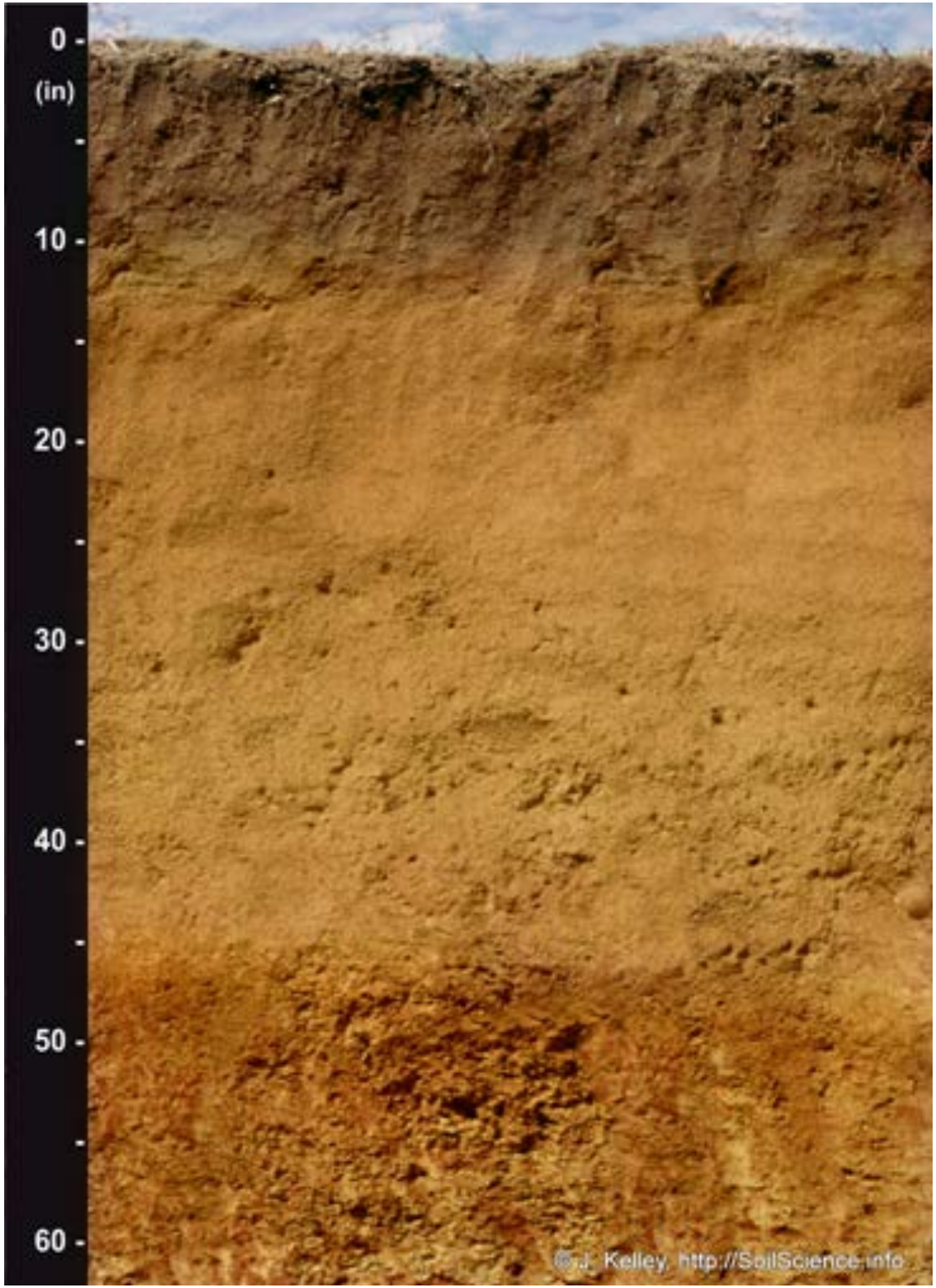

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