

Soil Colors, Texture & Structure

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Regional Public Health Agency

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Application

- ⇒ Limiting conditions
 - Soil color – type/depth of system
 - Bedrock – type/depth of system
- ⇒ Soil texture, structure, percolation rate – size and type of system

Color helps identify the water table

- ⇒ Gray = water table
- ⇒ Water table = saturation
- ⇒ Poor treatment in saturated soil
- ⇒ Keep infiltrative surface above water table
- ⇒ Treatment is ensured by proper separation distance

Soil Color

- Is determined by:
 - Soil moisture,
 - Organic matter content,
 - Coatings of Iron, Manganese, or other substances, and
 - Color of the mineral soil grains in absence of coatings.

Soil Color - Organic Coatings

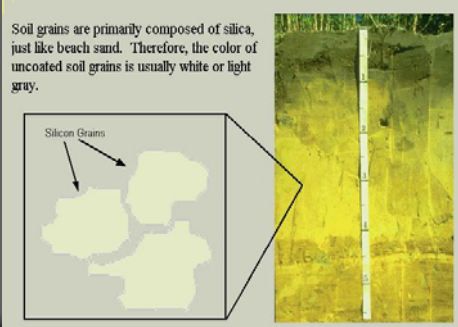
Decomposed organic matter (humus) is dark colored. As the organic matter content of the mineral soil increases, the soil usually becomes darker and eventually black.

Soil Color - Iron Coatings

Iron oxides form thin coatings on mineral soil grains. So even though the iron content of most soils is relatively low, iron plays a very large role in determining soil color.

Soil Color - No Coatings

Soil grains are primarily composed of silica, just like beach sand. Therefore, the color of uncoated soil grains is usually white or light gray.



The diagram shows several irregular, light-colored shapes representing soil grains. Two arrows point to them with the label "Silicon Grains". To the right is a vertical soil profile with a white measuring tape, showing a yellowish soil color.

Soil Formation

- Other factors that influence soil formation and thus color include:
 - Organisms (Vegetation and bugs)
 - Parent materials (till, outwash, lacustrine, loess, bedrock)
 - Relief (position in surrounding landscape)
 - Time
 - Climate

Soil Formation - Organisms

Grasslands



The image shows a grassland landscape with a blue sky and green hills. In the foreground, there is a sign that says "Beware of Bison" with a picture of a bison. To the right is a vertical soil profile with a measuring tape, showing a dark, black soil color.

Soil Formation - Organisms

Deciduous Forests



The image shows a deciduous forest with trees in vibrant autumn colors (orange, yellow, red). A dirt road winds through the trees. To the right is a vertical soil profile with a measuring tape, showing a reddish-brown soil color.

Soil Formation - Organisms

Coniferous Forest




The image shows a coniferous forest with tall, thin trees. To the right is a vertical soil profile with a measuring tape, showing a yellowish-brown soil color.

Soil Formation - Parent Materials

Glacial Till

+ Color of parent material indicates origin (i.e. red, buff, grey, etc.)



Two vertical soil profiles are shown side-by-side, each with a measuring tape. The left profile shows a light-colored, buff soil, and the right profile shows a reddish soil.

Soil Formation - Parent Materials

Outwash
+ Lack of colors due to sandy textures



Soil Formation - Relief

Summit Lower Sideslope Footslope Toeslope



Soil Formation - Time & Climate

Time of soil formation
•Varies by parent material
Climate is similar with
•drier conditions as you move west
•colder conditions as you move north

Topsoil colors

- Do not mean anything by themselves
 - In ND it is common to have thick and dark top soils (indicates organic matter accumulation)
 - Does not indicate wetness
- Usually found on the 10YR page



Subsoil colors - "Bright" colors

- Brownish/Reddish/Yellowish
 - Typically indicate better drained subsoils prevalent across most of
- But** many times this "bright" color may be misleading due to...
 - resistant materials (i.e. red soils) or
 - perched watertable above the subsoil



Subsoil colors - Gray & "light"

- Grayish and "light" colors
 - Much of ND has gray subsoils due to differences in parent materials
 - E layer (forested conditions strip organic matter and iron)
 - Outwash/alluvial sands (no soil paint)
 - Salt accumulations Depleted of iron subsoil (wet conditions)



General Soil Color Trends

On upland (dry) soils...

Topsoil colors -
vegetation differences

Subsoil colors -
parent material differences

Cannot infer subsoil color from topsoil color and vice versa

Munsell Color Soil Color Charts

- Hue
- Value
- Chroma



Hue

- ⇒ The major rainbow color
- ⇒ Blue- Gray
- ⇒ Red- R
- ⇒ Yellow- Y




Mixing of hues

- ⇒ Yellow + Red = Brown
- ⇒ Y + R = YR



Value

- ⇒ Lightness
- ⇒ Darkness




Low

High

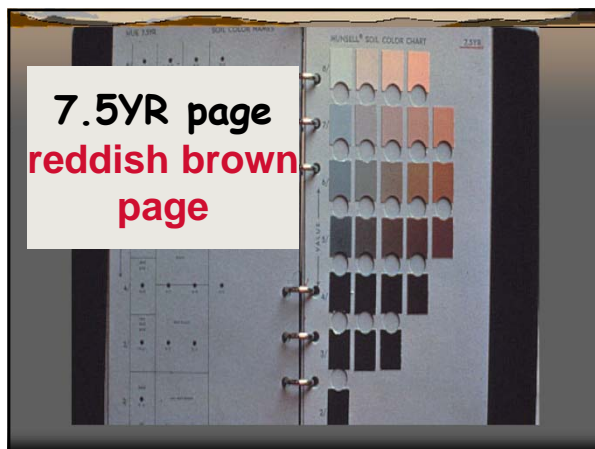
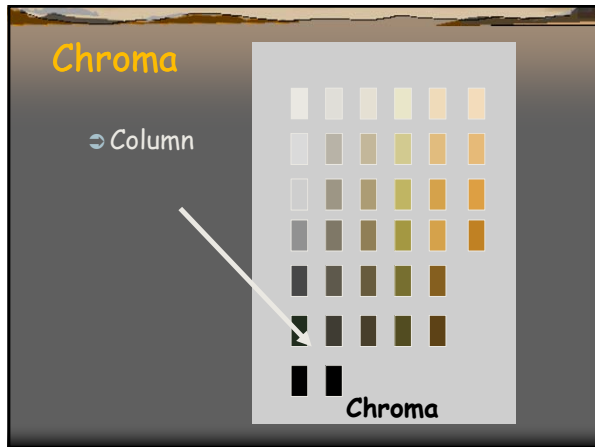
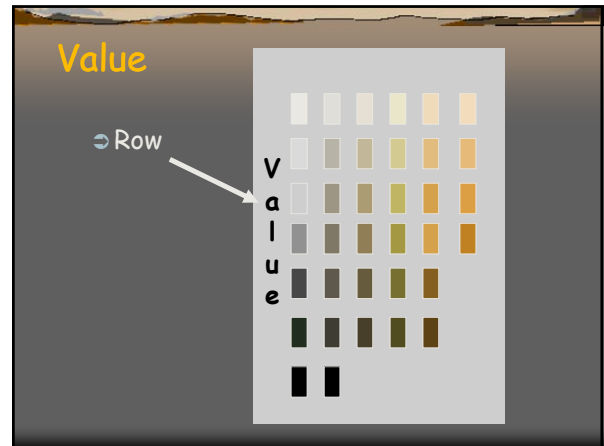
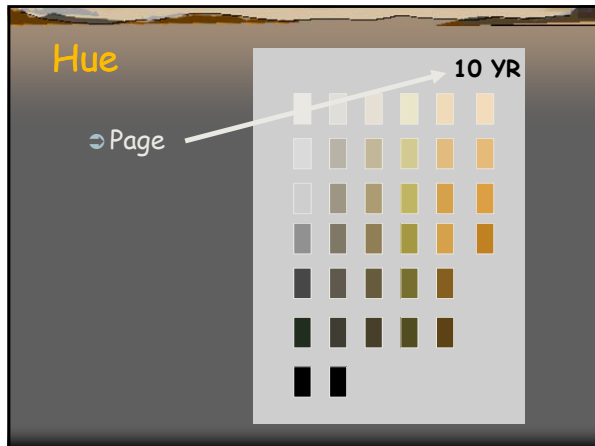
Chroma

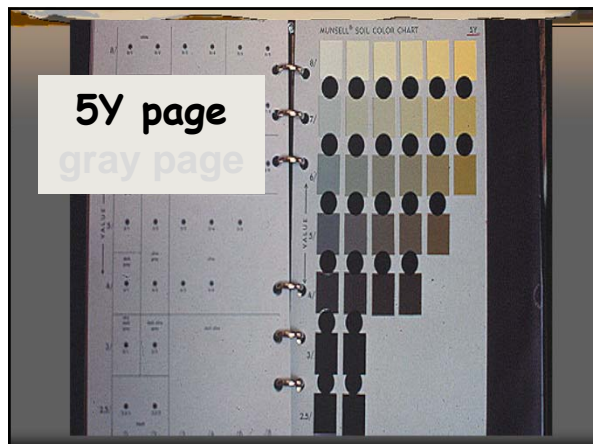
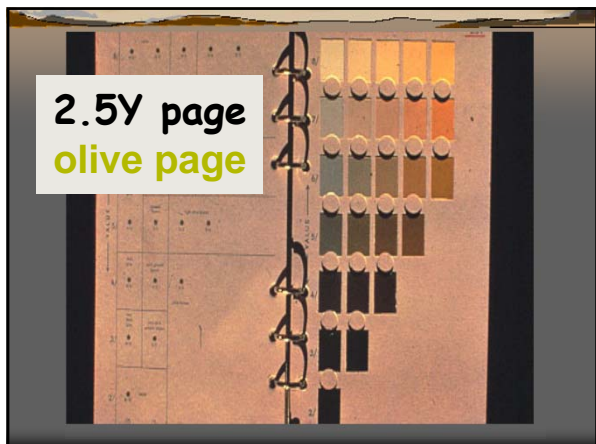
- ⇒ Deviation from Gray
- ⇒ Lower number- More gray



High chroma

Low chroma





Gley Page(s)

- ⇒ First or Last page(s)
- ⇒ Neutral hues
- ⇒ Bluish Hues
- ⇒ Pure White or Black
- ⇒ Page associated with prolonged saturation and non-moving water

A photograph of a Munsell Soil Color Chart page. The chart shows a grid of color swatches. A white box with black text is overlaid on the left side of the chart, containing the text 'Gley Page(s)'. Below the text are several color swatches: a green square, a blue square, a white square, and a black square. A small grid of color swatches is also visible in the bottom right corner of the chart.

Recording Colors

10YR 5/3

Hue Value Chroma

A photograph of a Munsell Soil Color Chart page. The chart shows a grid of color swatches. A white box with black text is overlaid on the left side of the chart, containing the text 'Recording Colors'. Below the text is a diagram showing the Munsell color notation '10YR 5/3'. The '10YR' is labeled 'Hue', the '5' is labeled 'Value', and the '3' is labeled 'Chroma'.

Soil Color

10 YR

⇒ 10 YR 5/3

Value

Chroma

A photograph of a Munsell Soil Color Chart page. The chart shows a grid of color swatches. A white box with black text is overlaid on the left side of the chart, containing the text 'Soil Color' and '10 YR'. Below the text is a diagram showing the Munsell color notation '10 YR 5/3'. The '10 YR' is labeled 'Hue', the '5' is labeled 'Value', and the '3' is labeled 'Chroma'. A red circle is drawn around the color swatch corresponding to '10 YR 5/3'.



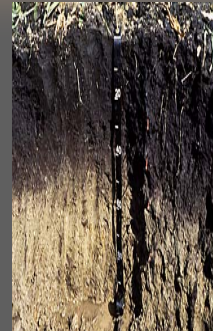
Transitions

- ⇒ Between horizons is a difficult place to make a determination



Soil Color

- ⇒ Always start at the top and work down the soil horizons looking for wetness indicators



Reading Soil Colors

- ⇒ Moist
- ⇒ Unsmear
- ⇒ Break open the Peds
- ⇒ Read all colors
- ⇒ Adequate light midday
- ⇒ Natural light
- ⇒ Take off the sunglasses!

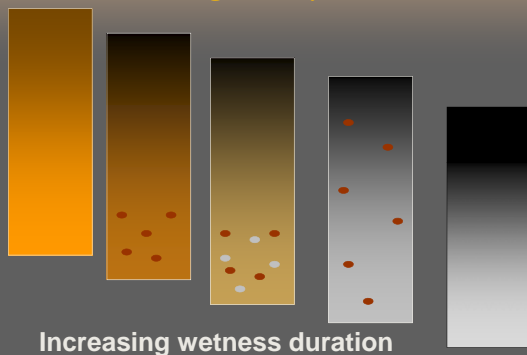


Adequate light

- ⇒ Overcast days are OK
- ⇒ Full Shade is difficult
- ⇒ Winter- Only mid day

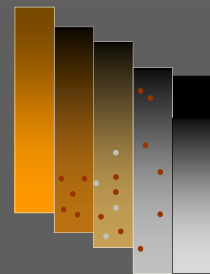


Soil Drainage Sequence



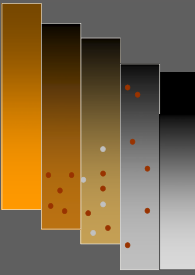
Soil Oxidation Reduction (redox)

- As soils become saturated...
- Soil microbes consume all Oxygen,
 - Organic matter is needed for microbial activity, and
 - Suitable soil temperatures (>42F) for microbial activity are required.



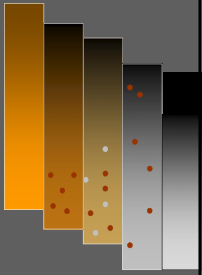
Soil Oxidation Reduction (redox)

- Assuming that these conditions are met in the soil then:
 - A series of reduction reactions take place in soil.
 - These reactions alter the state of soil color components, namely iron.
 - Once iron has been altered by a reduction reaction it is: a different color; soluble in water; and mobile



Soil Oxidation Reduction (redox)

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Soil Oxidation Reduction (redox)

- This type of soil color alteration is known as REDOXIMORPHIC FEATURES
 - These are features formed in the soil by the processes of saturation and reduction of iron
 - **Accumulations** of iron are bright red (**concentrations**)
 - Areas where iron is **removed** are gray or light colored (**depletions**)
 - Where iron is just **reduced** but has not moved, there are blue-gray colors (**gley**)

Redox Feature Formation

The mobile nature of iron usually results in different redoximorphic features forming including areas of

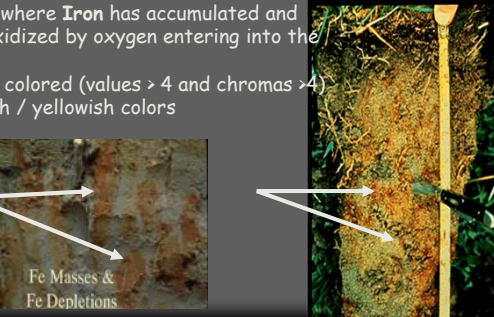
- Concentrations,
- Depletions, and
- Gleying



Redox Feature Formation

Concentrations


- Areas where Iron has accumulated and been oxidized by oxygen entering into the soils
- bright colored (values > 4 and chromas > 4)
- reddish / yellowish colors



Redox Feature Formation

Depletions


- Areas where Iron has been removed
- light colored (values > 4 and chromas < 2)
- light gray colors



Redox Feature Formation

Gleyed Soil

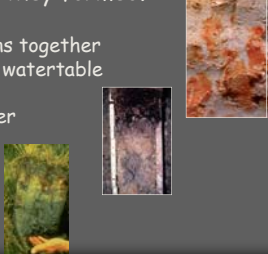
- Areas where **Iron** has been reduced, but still in the soil
- gley pages in Munsell colorbook
- bluish / greenish colors
- turns rust colored after brief exposure to air



Redox Feature Formation

Each redox feature or combinations of redox features indicates the type of hydrology conditions under which they formed.

- Concentrations & Depletions together
 - zone of fluctuating watertable
- Depletions
 - zone of moving water
- Gley
 - stagnant water



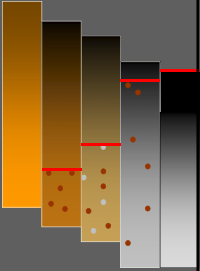
Redox Feature Formation

Persistence of redox features under "drained" conditions:

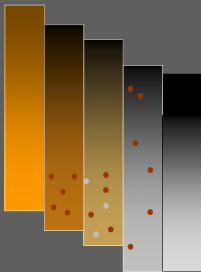
- Concentrations
 - remain evident unless saturation alters state of iron (oxidized iron is not soluble in water)
- Depletions
 - remain evident even with additional saturation (soil paint removed)
- Gley
 - iron will oxidize if oxygen is reintroduced into soil

Subsoil colors indicating significant saturation for Septics

- Clearly visible (distinct) redoximorphic features (either depletions or concentrations)
 - Periodic saturation
- Distinct redoximorphic features (BOTH depletions and concentrations)
 - Frequent saturation
- Distinct redoximorphic features and reduced or depleted matrix
 - Very frequent saturation
- Gley conditions
 - Permanently saturated



Soil Color



These redoximorphic Features used to be called...

MOTTLES

Redox Features versus Mottles

Redox features - specific kind of mottle indicating wetness conditions

For our purposes, we are concerned with redox features.



Soil Color

- ⇒ Always use soil color to verify depth to saturated soil
- ⇒ Other Assistance:
 - Landscape position
 - Vegetation
 - Soil Survey/ County maps
 - Local land owners
 - Licensed Professional Soil Scientists
 - Others...

Soil Color Application

Saturated Subsoil Advice

- If distinct redox concentrations, then,
- Look for Gray matrix colors

Fe Masses & Fe Depletions

Soil Color Application

Color progression with depth

- It is likely that as you dig deeper, soil will get wetter
- Unless water saturating soil is coming from the surface (recharge)

Soil Color Application

Wetness Indicators for Duration of Saturation

- Never Saturated - Oxidized matrix
- Infrequently Saturated - Oxidized matrix with few concentrations
- Frequently Saturated - Oxidized matrix with depletions and concentrations
- Very Frequently Saturated - Depleted (gray) or reduced matrix (gleyed) with concentrations
- Permanently Saturated - Depleted (gray) or reduced (gleyed) matrix

Soil Color Application

Saturated Topsoil Determination

Wet topsoils are difficult to determine due to large amounts of organic matter masking soil grains

Soil Color Application

Saturated Topsoil Determination

If a soil has 12" or more of topsoil, **Step 1**. Determine if upper subsoil is saturated.

Soil Color Application

Saturated Topsoil Determination-Upper subsoil

- Above colors must be dark (3/3 or less)



A photograph of a soil profile showing a dark topsoil layer and a lighter, more textured upper subsoil layer. A white arrow points to the upper subsoil layer.


Soil Color Application

Saturated Topsoil Determination-Upper subsoil

Step 2: If upper subsoil is saturated, then 6 yes/no questions that must be answered to determine whether you have:

- 12" of suitable soil OR
- 0" of suitable soil

■ Why? Organic matter can mask redox features.

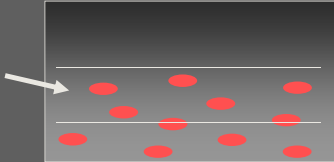


A photograph of a soil profile showing a dark topsoil layer and a lighter, more textured upper subsoil layer. A white arrow points to the upper subsoil layer.

Soil Color Application

Saturated Topsoil Determination

- **Question 1a:** Are there redox features in the lower topsoil (below 12")?

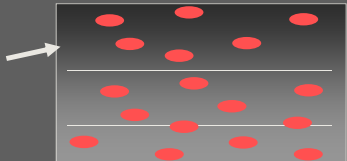


A diagram of a soil profile showing a topsoil layer and a lower topsoil layer. Red dots representing redox features are scattered in the lower topsoil layer. A white arrow points to the lower topsoil layer.

Soil Color Application

Saturated Topsoil Determination

- **Question 1b:** Are there redox features in the upper topsoil (within 12" of surface)?



A diagram of a soil profile showing a topsoil layer and a lower topsoil layer. Red dots representing redox features are scattered in the upper topsoil layer. A white arrow points to the upper topsoil layer.

Soil Color Application

Saturated Topsoil Determination

- **Question 2:** Is any part of the topsoil colored as a N 2.5/0 (pure black)?
- This color is found on Munsell color chart 1 for gley (lowest left hand corner chip).

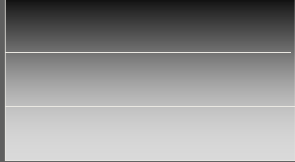


A placeholder for a Munsell color chart, showing a white box with a horizontal line.

Soil Color Application

Saturated Topsoil Determination

- **Question 3:** Is there a peat, mucky, or organic texture to any portion of the topsoil?

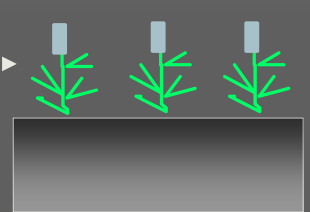


A placeholder for a soil profile diagram, showing a white box with a horizontal line.

Soil Color Application

Saturated Topsoil Determination



- **Question 4:** Is there wetland vegetation at the site of the boring(s)/pit? (e.g. cattails, willows, sedges)



Soil Color Application

Saturated Topsoil Determination

- **Question 5:** Is the site in a wet landscape position?
 - Depression,
 - Floodplain
 - Toeslope
 - Broad flat area (lake bed)
 - Swale, draw, concave.

Soil Color Application

Saturated Topsoil Determination

- **Question 6:** Is the soil meet a hydric soil indicator?
 - Wetland soil
 - SWCD or private wetland delineator

Soil Color Application

Saturated Topsoil Determination

- If you answered NO to *all* 6 questions, then your site has no more than 12" of suitable soil.
- If you answered YES to *any* of the 6 questions, then you have 0" of suitable soil.

Soil Color

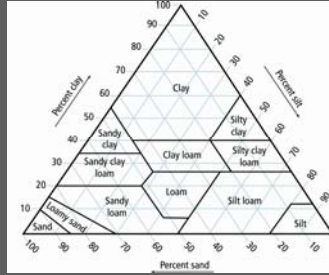
- Other Colors
 - May have other colors and redox features in same horizon
 - Be sure to ID and record all color variations

Puzzled?

- Soil Survey
- Local Soil & Water Conservation Office
- County Planning & Zoning Office
- Other ISTS Professionals
- Licensed Professional Soil Scientists

Soil Texture
Textural Triangle Example

- 20% Sand
- 40% Silt
- 40% Clay



Soil Texture
Loam Textures

- "equal" parts sand, silt, clay (feels like)
- Can be found at any depth (not just "loam" topsoil)
- Has nothing to do with color or drainage class

Soil Texture
Surface Area

1 gram of sand =



Postage Stamp

1 gram of clay =



11 sheets of paper

Soil Texture
Surface Area & Treatment

- Increasing Clay %
 - More surface area
 - Better Treatment per unit area of soil
 - Larger Sizing due to slow water movement
- Increasing Sand %
 - Less surface area
 - Less Treatment per unit area of soil
 - Sizing smaller due to better water movement

Soil Texture – Field Determination
General

- Sand - gritty
- Fine sand - smooth
- Silt - greasy, floury
- Clay - sticky, cohesive, stains hand

Soil Texture – Field Determination

USDA Classification	Texture Subclasses
• Sand*	→ 1. Coarse Sand
• Loamy sand*	→ 2. Medium Sand
• Sandy loam*	→ 3. Fine Sand
	→ 4. Coarse and medium loamy sand
	→ 5. Fine and very fine loamy sand
	→ 6. Coarse and medium sandy loam
	→ 7. Fine and very fine sandy loam

*Sand
Modifiers
co-coarse
m-medium
f-fine
vf-very fine

Soil Texture – Field Determination

Procedure

- Use feel method
- Large enough sample (golf ball)
- Soil must be moist, not saturated
- Does the soil form a cast?
 - No - sand
 - Yes - go to next question



Soil Texture – Field Determination

Procedure

- Can the cast be handled?
 - No - loamy sand,
 - Yes - go to next question



Soil Texture – Field Determination

Procedure

- Can the soil be ribboned?
 - No - sandy loam
 - Yes - go to next question



Soil Texture – Field Determination

Procedure

- How long is the ribbon?
 - Less than 1" - loam, silt loam, silt
 - Between 1"-2" - silty clay loam, clay loam, or sandy clay loam
 - Greater than 2" - silty clay, clay, or sandy clay



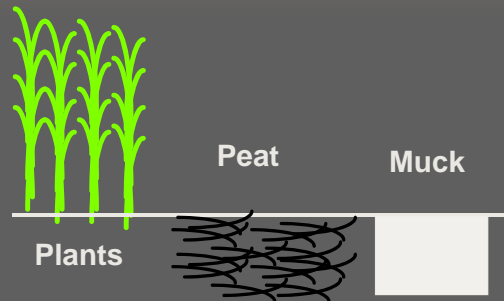
Soil Texture – Field Determination

Non-soil components

- Gravel
 - Anything larger than 2mm
- Organic material
- Peat or Muck (decomposed peat)

Soil Texture – Field Determination

Peat- Muck formation



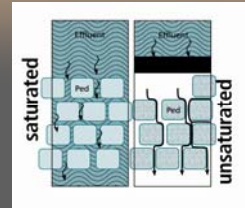
Soil Structure Description

- How the soil is glued together



Soil Structure Benefits

- Increases porosity
 - Increases pore size
 - Connects the pores (interconnection)
 - Increase oxygen transfer into the soil
- Increases perc rate



Soil Structure Identification

- Smallest soil units-Peds
- The clumps of soil particles



Soil Structure Formation

- Forces
 - Freeze/Thaw
 - Wet/Dry
 - Plants/animals/invertebrates
- Glue
 - Circumstances
 - Disturbed



Soil Structure Formation Glue

- Iron
- Clay
- Organic matter
- Calcium Carbonate / Salts



Soil Structure Formation Time

Time is KEY to structure



Soil Structure

Typical Changes with Depth

Topsoil

Subsoil

Soil Structure

Typical Changes with Depth

Subsoil

Parent Material

Soil Structure

Formation Depth

- Root zone
- Weathering
- 3.5- 4 feet

A Soil Profile

Horizons

0

2

A

10

B

30

C

40

Soil Structure

Damage

Soil-water movement unknown if:

- Damage
- Compaction
- Smearing
- Fill Soils

1/8" diameter rolled cylinder

- Plastic limit - to see if soil is too wet to construct

Soil Structure - Identification

Shape

- Granular
- Blocky
- Platy
- Prismatic
- Single Grain
- Massive

Single-grain

Blocky

Platy

Rapid

Moderate

Slow

Granular

Prismatic

Massive

Rapid

Moderate

Slow

Soil Structure - Shape

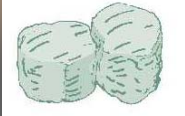
Granular

Granular:

- The peds are spherical or polyhedral.
- These are the small, rounded peds that hang onto roots when soil is turned over.
- Commonly found in the topsoil.


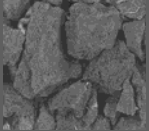

Soil Structure - Shape

Blocky




Blocky:

- The peds are block-like or polyhedral
- Commonly found in the lower topsoil and subsoil



Soil Structure - Shape

Prismatic



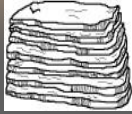
Prismatic:

- Flat or slightly rounded vertical faces bound the individual peds.
- Peds are distinctly long vertical faces.
- Commonly found in lower subsoil.



Soil Structure - Shape

Platy




Platy:

- Peds are flat and plate like.
- They are oriented horizontally and are usually overlapping.
- Common in forested areas just below the top soil, glacial till, and shallow bedrock.

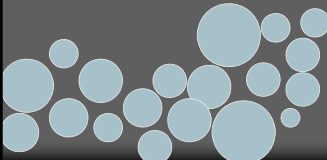

Soil Structure - Shape

Single grain



Single Grain:

- The structure found in sandy soil.
- The individual particles are not held together.





Soil Structure - Shape

Massive

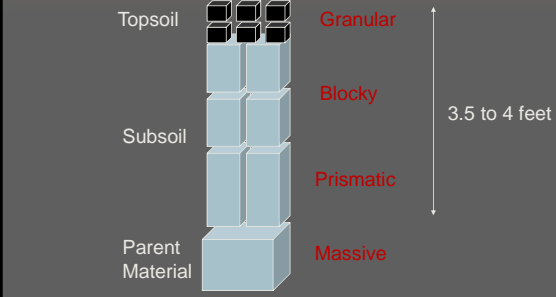
Massive:

- Unweathered parent materials (typically glacial till).
- It does not have to be hard or cemented.
- Commonly found below subsoil and above bedrock.



Soil Structure - Shape

Example



Topsoil

Subsoil

Parent Material

Granular

Blocky

Prismatic

Massive

3.5 to 4 feet



Soil Structure - Shape

Applications

Granular Blocky Prismatic	× Good Structure
Single Grain	
Platy Massive	× Problem Structure

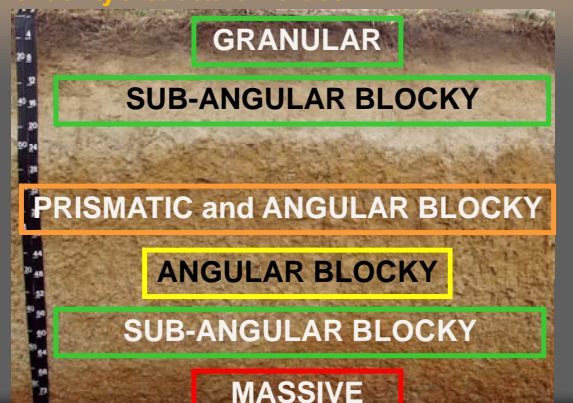
Soil Structure Sampling

- Sampling methods allow for structure identification



- Boring
- Probe
- Pit

Variability of Structure in the Soil



Summary

- Limiting conditions
 - Soil color – type/depth of system
 - Bedrock – type/depth of system
- Soil texture, structure, percolation rate – size and type of system

Questions

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