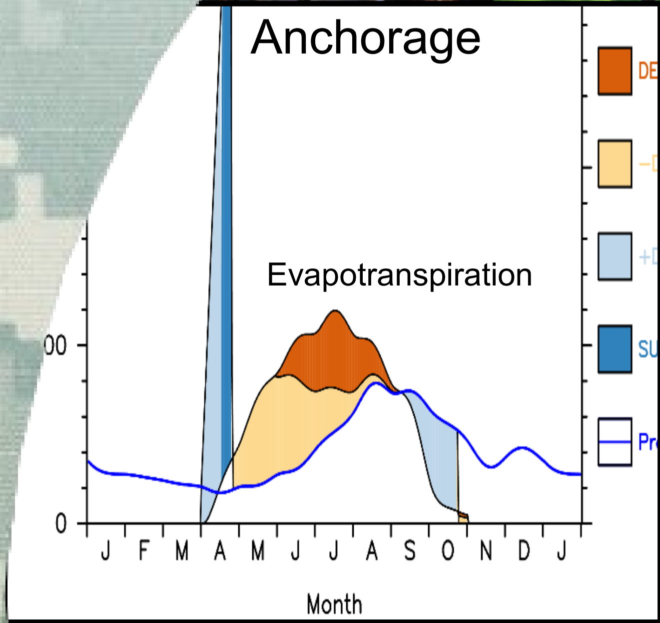
Alaska Region – REG IV
Wetland Delineation

Soils Background



Objectives

The purpose of this presentation is to:

- ► discuss soil properties related to hydric soil development
- ► describe what information is required to be recorded on the soils data form
- ► provide guidance on describing these features.

This includes identifying soil layers, soil color, soil matrix, soil texture (organic vs mineral), redox features, determining percent of redox, where to begin observations, and understanding the concepts of reduced matrix and depleted matrix.

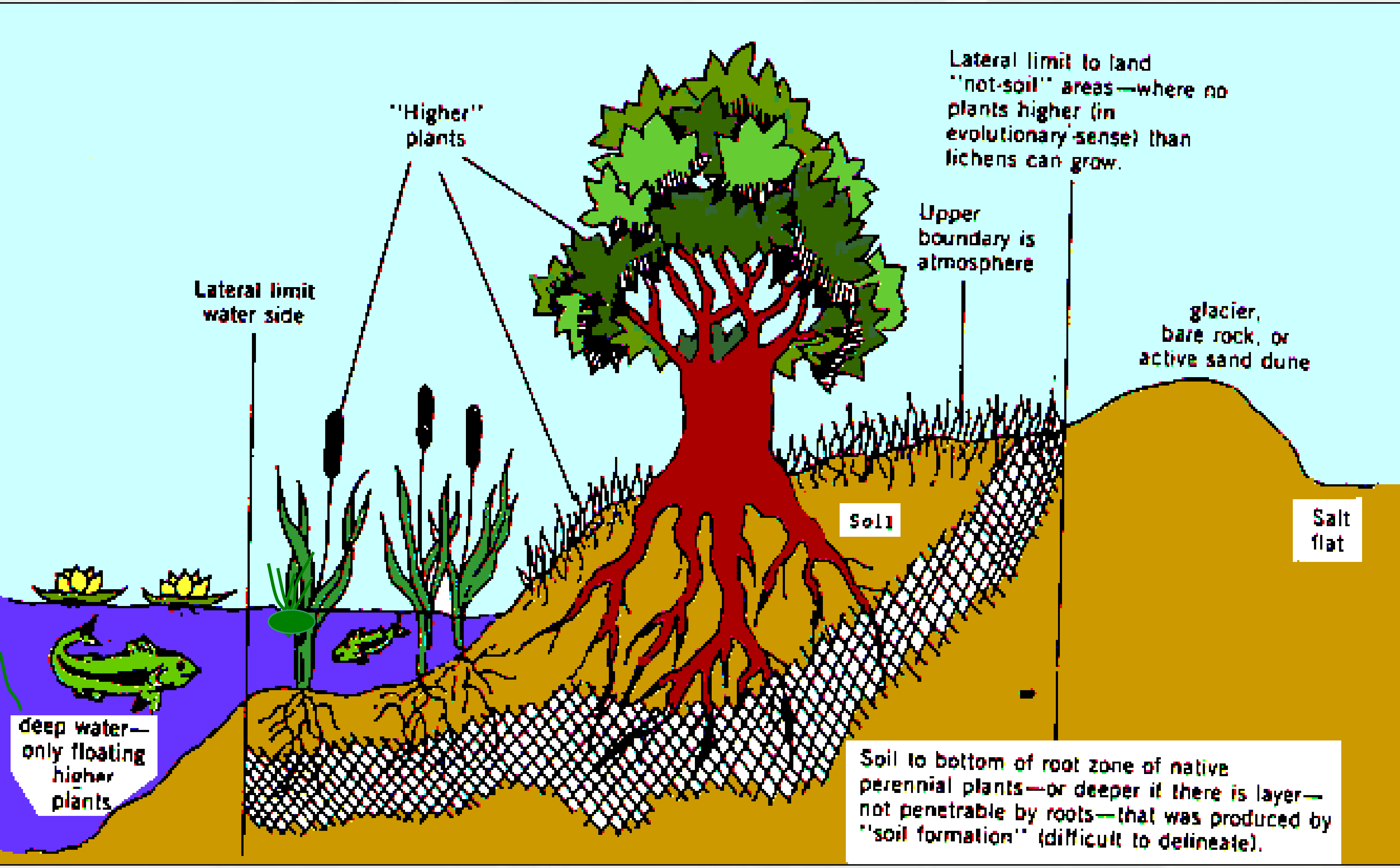
Definition of a Hydric Soil

A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

What is Soil?

Natural body that occurs on the land surface, occupies space, and is characterized by one or both of the following:

- Horizons or layers
- The ability to support rooted plants in a natural environment
  - Upper limit is air or shallow (>2.5 m) water
  - Lower limit is either bedrock or the limit of biological activity
  - Lower limit for classification set at an arbitrary 2 m



"Higher" plants
Lateral limit to land "not-soil" areas—where no plants higher (in evolutionary sense) than lichens can grow.
Upper boundary is atmosphere
Lateral limit water side
glacier, bare rock, or active sand dune
Soil
Salt flat
deep water—only floating higher plants
Soil to bottom of root zone of native perennial plants—or deeper if there is layer—not penetrable by roots—that was produced by "soil formation" (difficult to delineate).

Non-soil

- Badlands
- Beaches
- Chutes
- Cinder land
- Dams
- Dumps
- Dune land
- Glaciers
- Gullied land
- Lava flows
- Mined land
- Oil-waste land
- Pits
- Playas
- Riverwash
- Rock outcrop
- Rubble lands
- Slickens
- Urban land
- Water

Defined in section 627 of the National Soil Survey Handbook

Factors That Influence Soil Development

- **Parent material**: soil derived from weathered sandstone is likely to have different drainage properties compared to clayey lacustrine sediments formed in glacial lakes.
- **Topography**: convex vs concave landscapes will drain and collect water respectively. Long term presence of water may result in formation of hydric soils.
- **Organisms**: Bioturbation from earthworms, animal burrows, and crawfish can influence development of macropores and soil structure.
- **Climate**: different climates allow for varying influences of weather on soil formation (a few months in Alaska vs year-round growing season in Florida).
- **Time**: Older soils tend to be thicker and have more layers or horizons than younger soils.

Parent Material

The material from which soil is formed

Derived from physical and chemical weathering of rocks

Produced by geologic or biologic process

- *Glacial materials*
- *Volcanic flows and ejecta*
- *Organic matter*
- *Tidal Sediments*

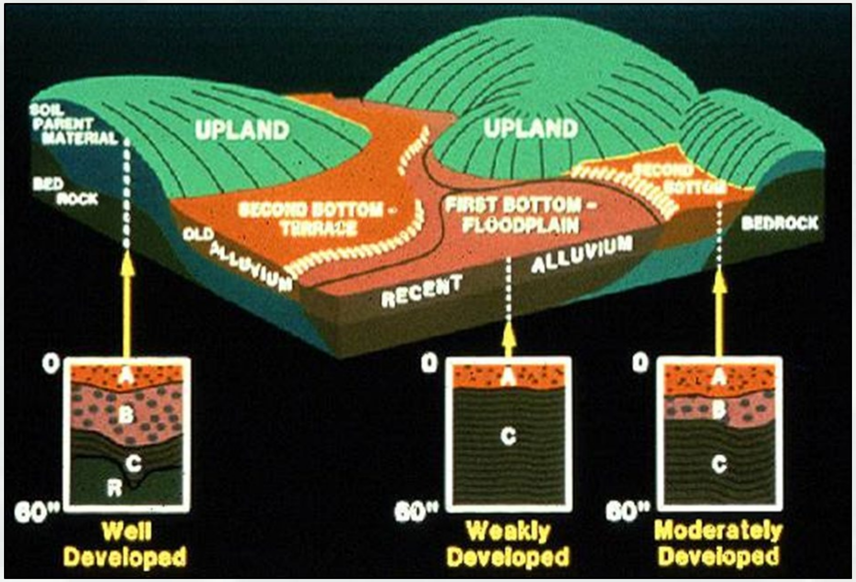
- *In place – residuum*
- *Moved by gravity - colluvium*
- *Moved by wind – loess*
- *Moved by water - alluvium*

Residuum/Colluvium

Glacial Materials

Topography

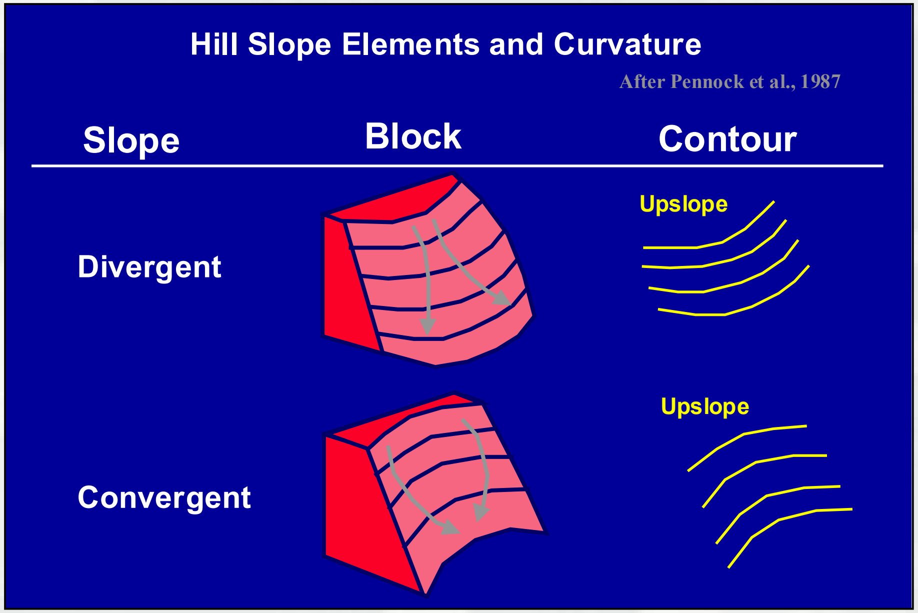
- **Landscape Position**
  - *Where are you?*
    - ***Hill***
    - ***Stream Terrace***
- **Landform**
  - ***Glacial*** *– esker, kame, drumlin, moraine, outwash plain*
  - ***Residual*** *– Bedrock cored Hill, Mountain*
  - ***Wind*** *– dunes, loess hill*
  - ***Water*** *– alluvial fan, floodplain, stream terrace, tidal flat*
  - ***Permafrost*** *– thermokarst ponds, ice wedge polygons*
  - ***Volcanic*** *– cinder cone, lava flow, volcanic cone*

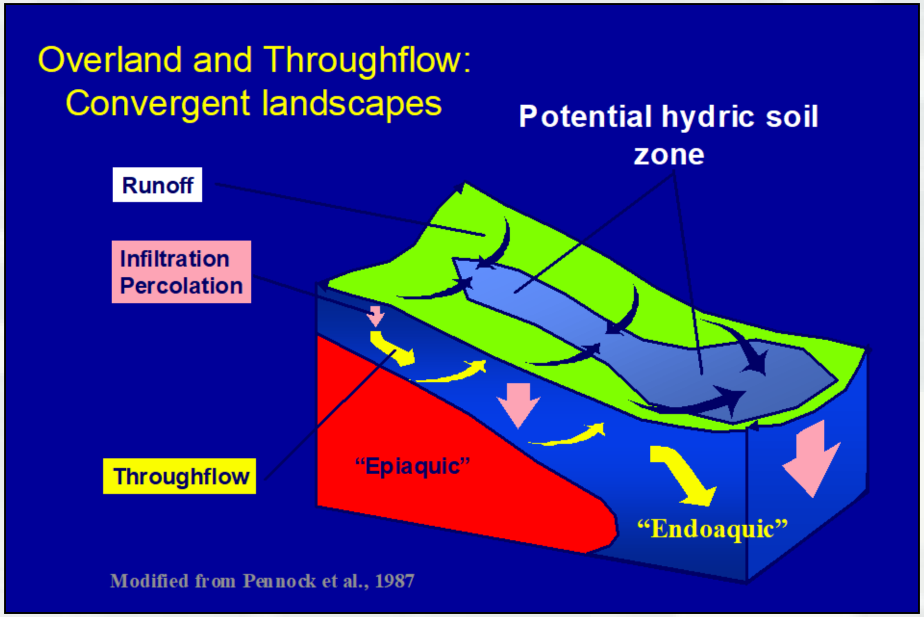


- **Shape**
  - ***Concave***
  - ***Convex***
  - ***Plane***
- **Slope**
- **Aspect**

Effects of Landscape Position

- Critically influences water flow and soil formation
- Most wetlands are on some sort of concave surface
- Aspect: North vs. South





Organisms

- **Plants**
  - Trees
  - Shrubs
  - Herbs
  - Mosses
  - Lichens
- **Microorganisms**
  - Fungi
  - Bacteria
- **Animals/Humans**
  - Excavations
  - Organic Matter Decomposition
  - Organic Matter Additions

Lichens on Rocks

Squirrel Midden

Climate

Climate is the major factor determining the kind of plant and animal life on and in the soil

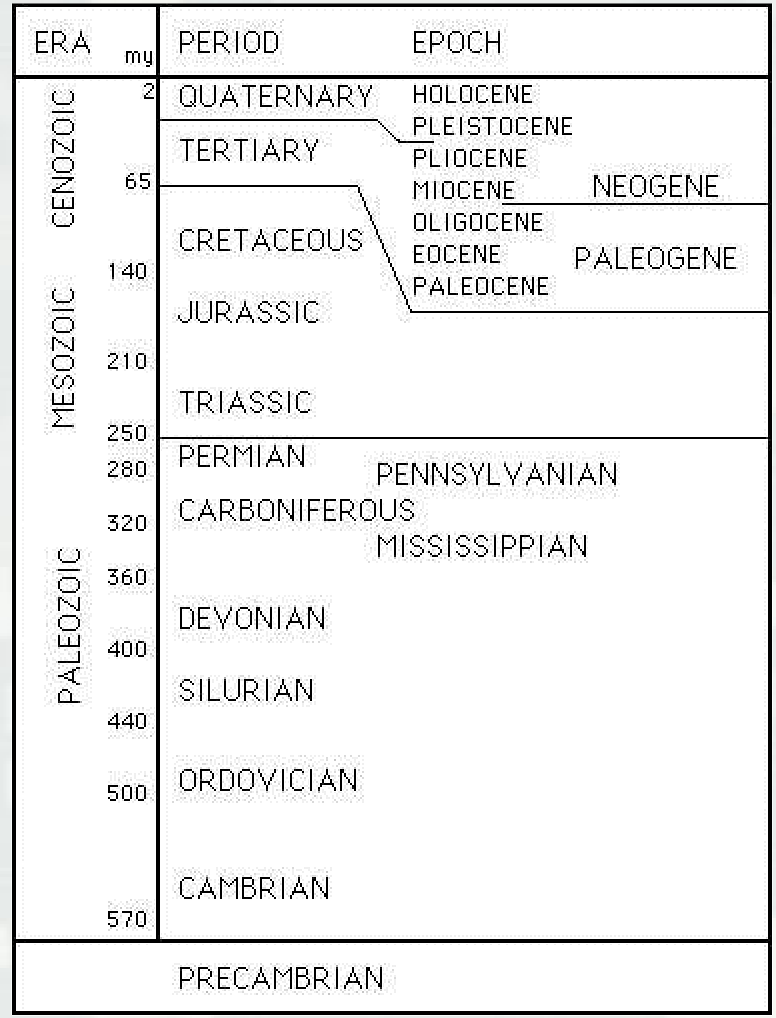
- **Temperature**
  - Freezing and thawing
  - Rate of chemical activity
- **Precipitation**
  - Wetting and drying
  - Amount of chemical activity

Temperature and Precipitation fluctuations control the rate of physical and chemical weathering and the break down of parent materials in the soil

Time

Required for horizon formation

- Horizon formation is a slow process
- Long-term changes happen over hundreds, thousands, or millions of years
- Short-term changes can be caused by human activity and fire



Soil Horizons

- Soils have different layers; these layers are called “horizons”. Major soil horizons are often discerned based upon soil color, organic matter content, and texture.
- A generalized soil profile might consist of the following horizons:
  - A horizon -- the surface layer in a mineral soil characterized by accumulation of organic matter and/or loss of materials (e.g., clays) to deeper layers.
  - B horizon -- the subsoil, characterized by accumulation of clays or other materials and greater structural development.
  - C horizon -- the underlying material, unconsolidated parent material little influenced by soil-forming processes.
  - R horizon – bedrock

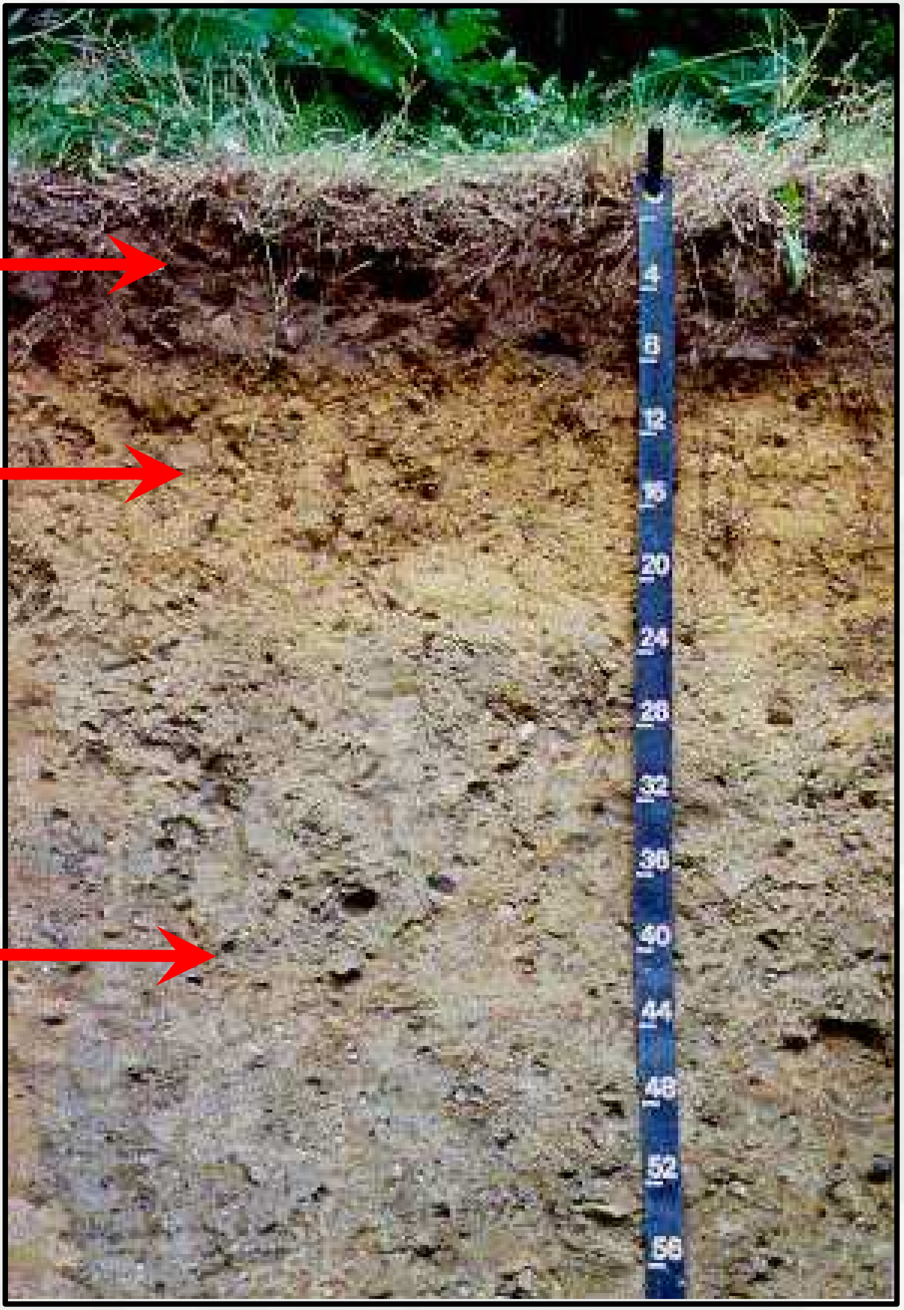
Major Horizon Designations

Layer 1	Surface Organic Layer	O Horizon
Layer 2	Surface Mineral Layer	A Horizon
Layer 3	Subsoil	B Horizon
Layer 4	Underlying Material	C Horizon
Layer 5	Bedrock	R Horizon

Layer 1 A Horizon

Layer 2 B Horizon

Layer 3 C Horizon



Aspects of Soil Color

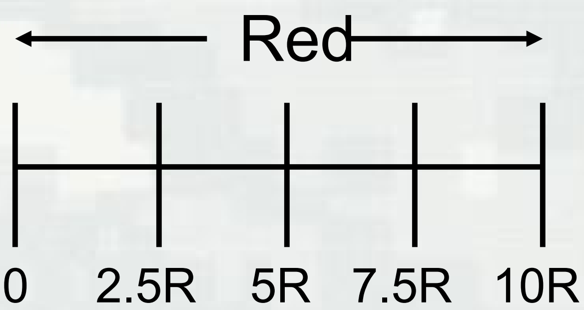
Munsell Soil Color System

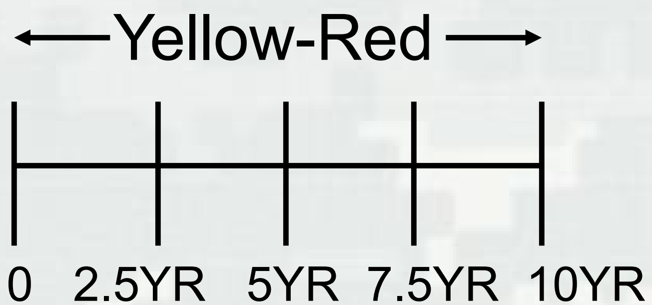
10R 5/8

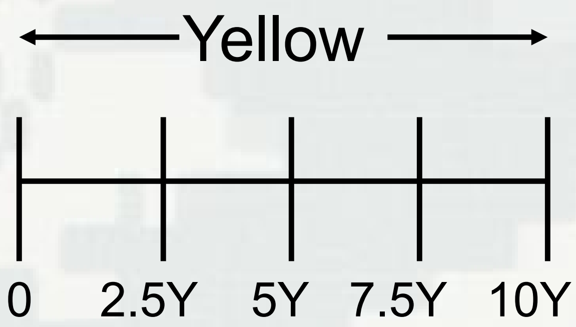
- Hue
- Value
- Chroma

Hue

Spectral color in relation to red, yellow, green, blue, and purple.



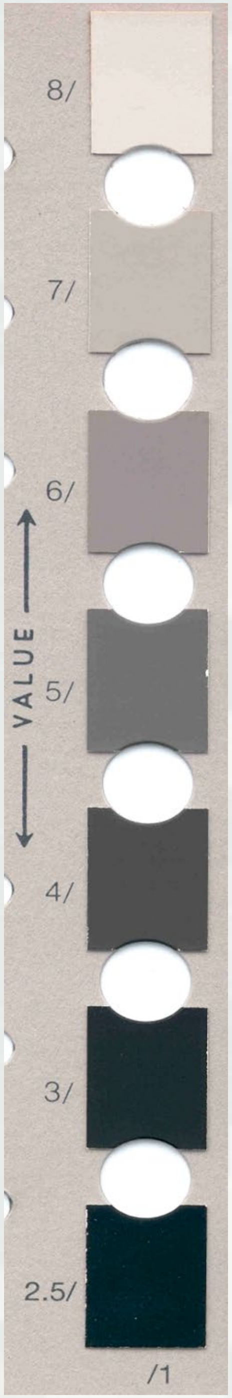




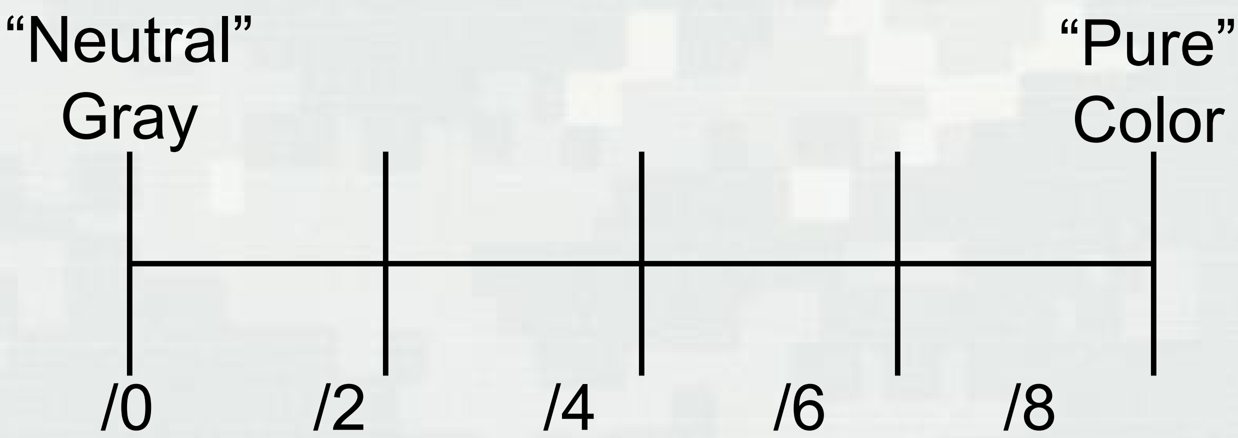
Value

The Lightness or **Darkness** of Color

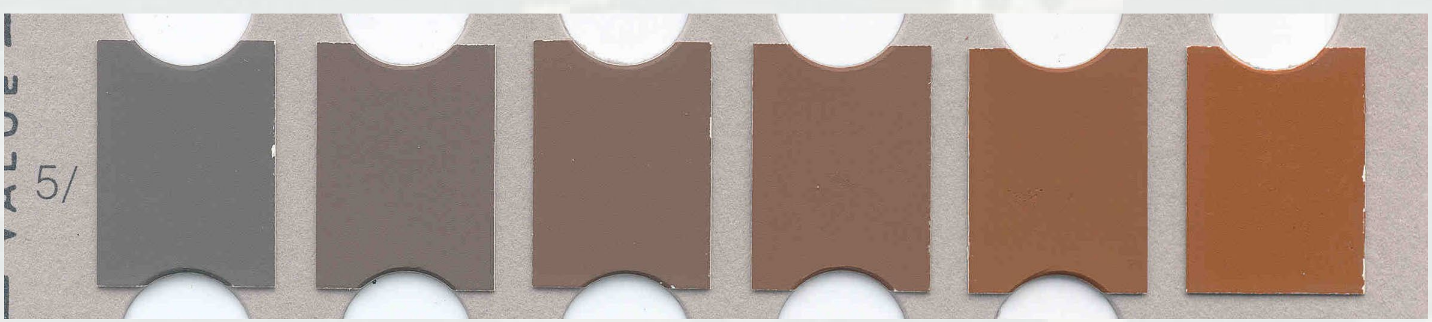
- 10/0 - Pure White
- 5/0 - "Gray"
- 0/0 - Pure Black



Chroma



Increasing strength of color →



← Increasing grayness

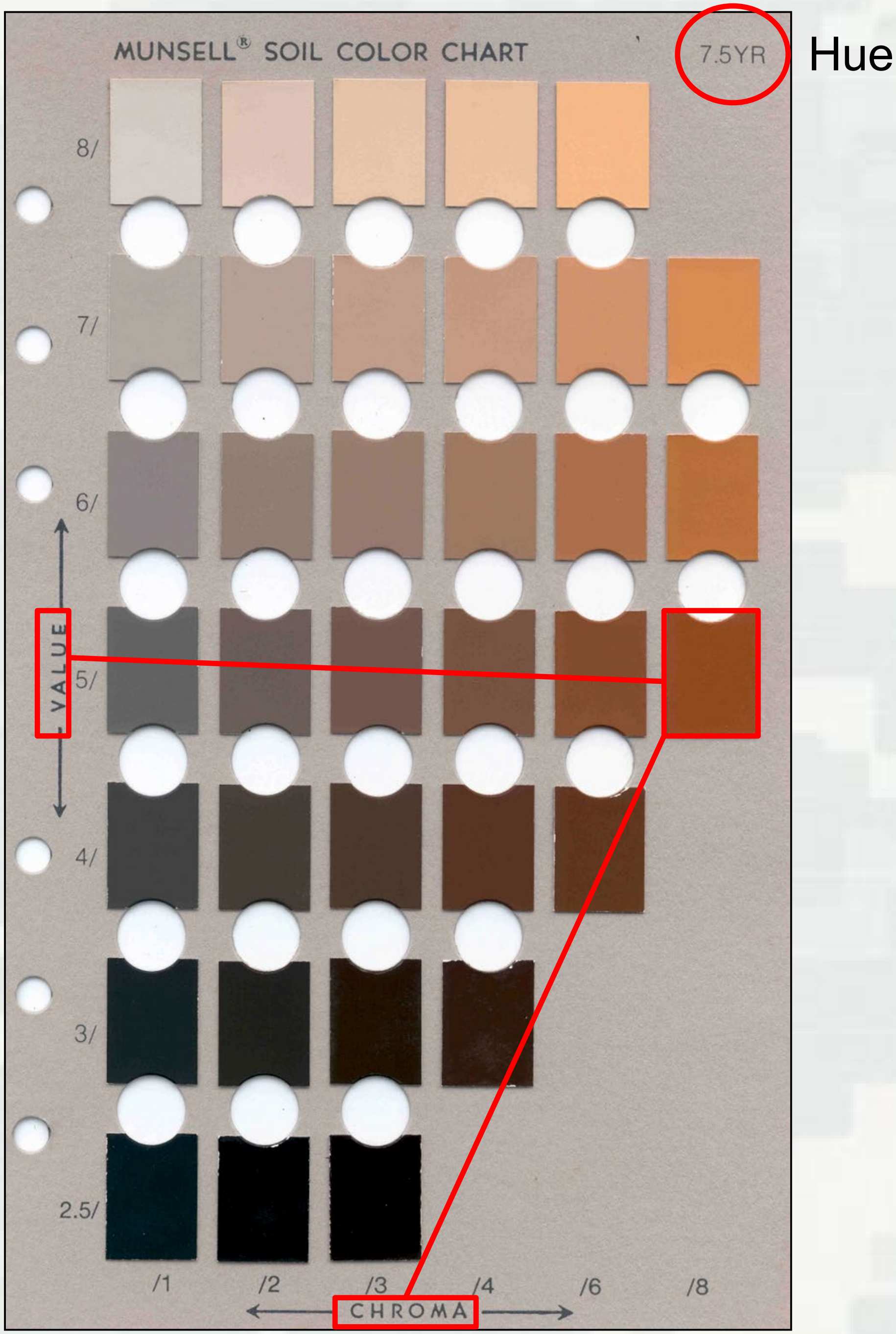
From: 10YR page

Soil Color

Munsell Soil Color Book, 7.5YR page

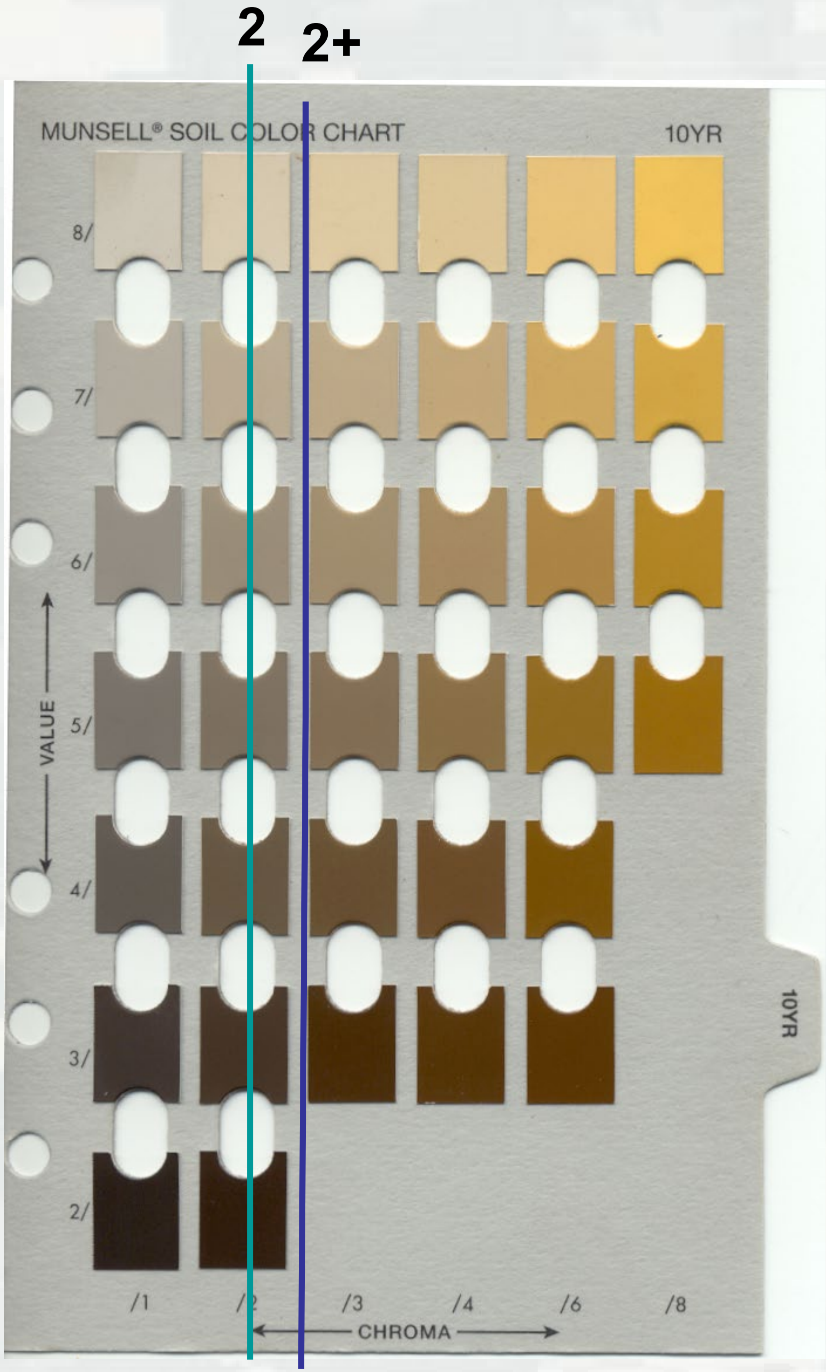
The highlighted color chip is:

7.5YR 5/8



Chroma

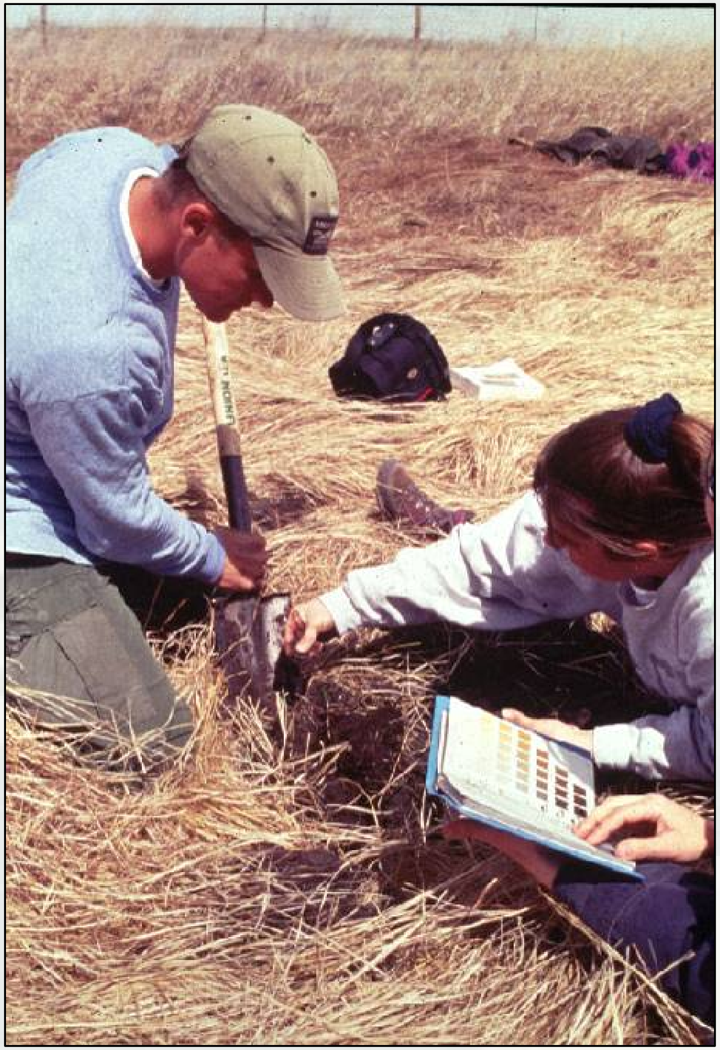
- Colors specified in the indicators do not list decimal points
- However, colors do occur between Munsell chips
- Do not round color to qualify as meeting an indicator



Reading Soil Colors

Optimum conditions for reading soil colors

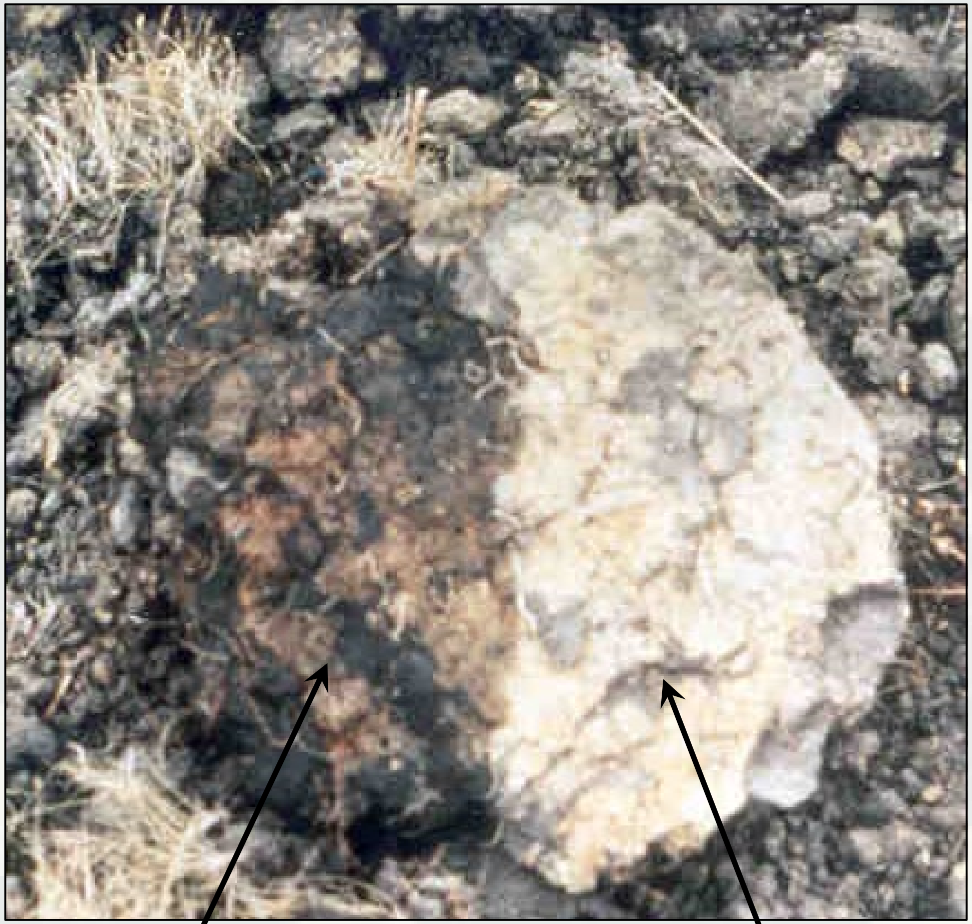
- Natural light
- Clear, sunny day
- Midday
- Light at right angles
- Soil moist



Moist Colors

All color requirements (hue, value, and chroma) are for *moist* soils

- If dry, moisten to record color
- If wet, allow to dry to a moist state

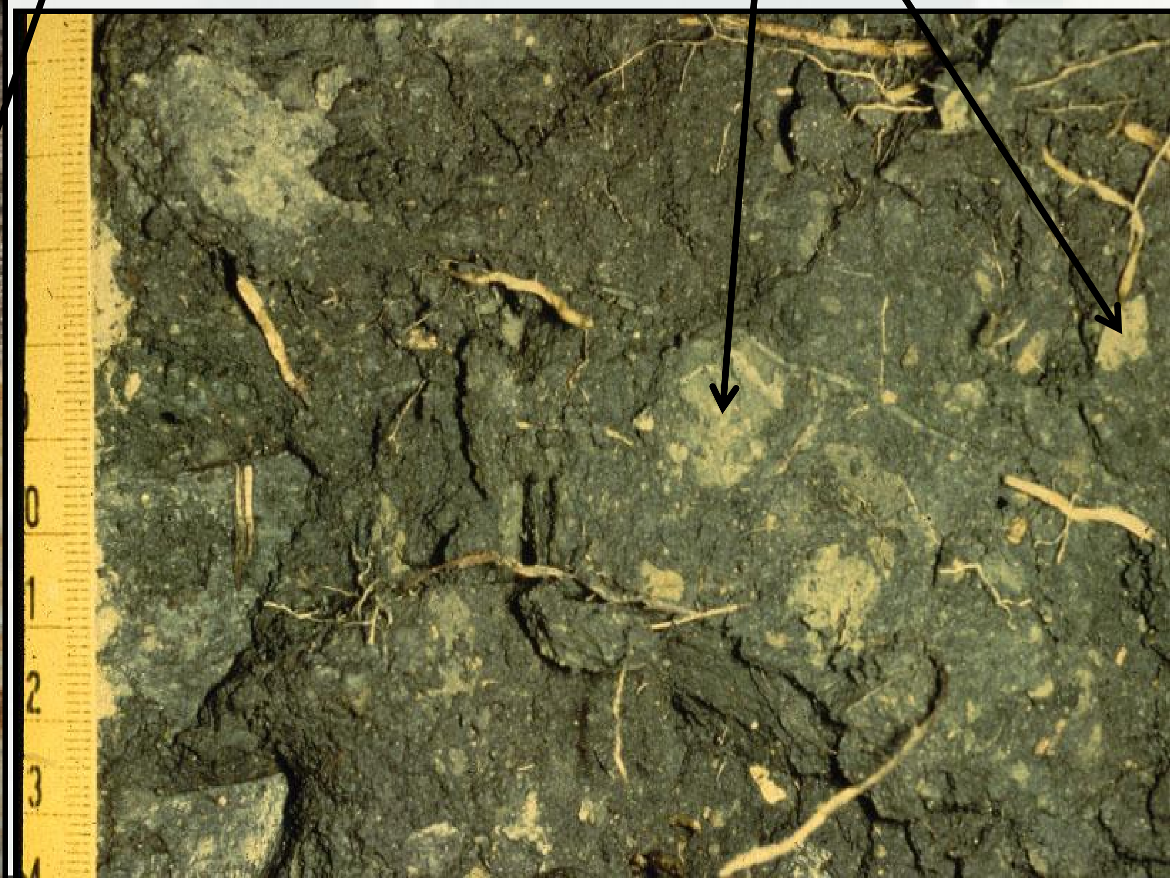


Color Patterns in Soils

- Matrix (predominant) color
- Redoximorphic features
- Feature contrast and abundance

Redox Features Within a Soil Matrix

Concentrations -- Depletions



Contrast of Features

The degree of visual distinction between associated colors

- Faint – evident only on close examination
- Distinct – readily seen
- Prominent – contrast strongly

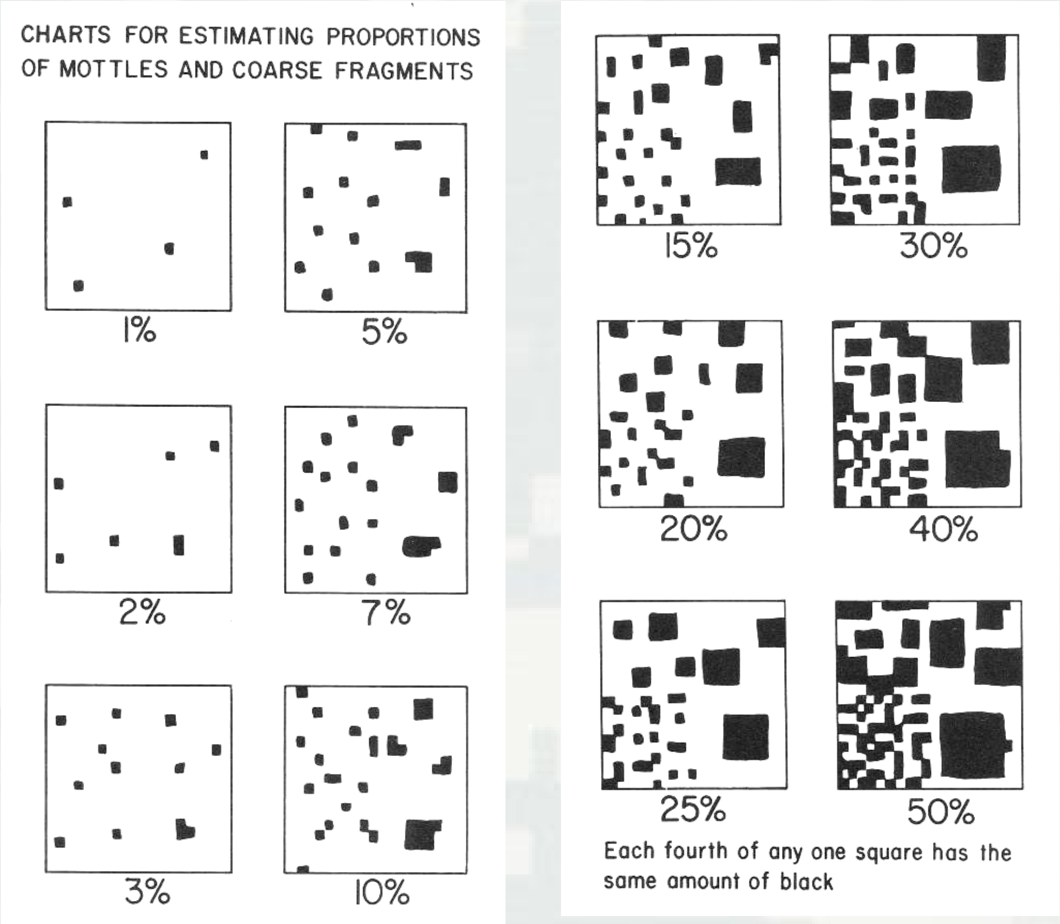
Upper Threshold for Faint

Delta Hue	Delta Value	Delta Chroma
0	≤2	≤1
1	≤1	≤1
2	0	0
Hue	Value	Chroma
Any	≤3	≤2

Abundance of Features

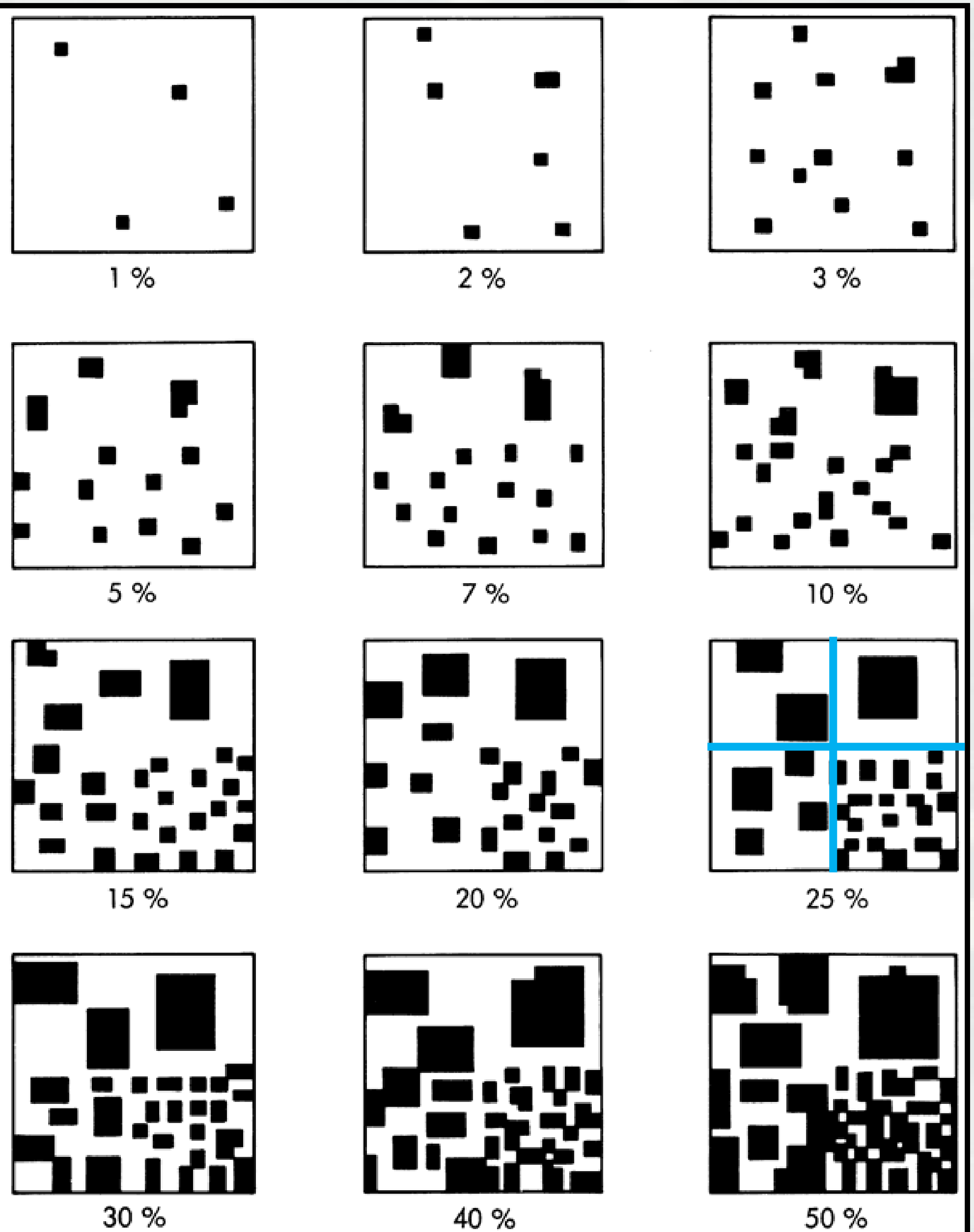
Different indicators require different abundance thresholds.

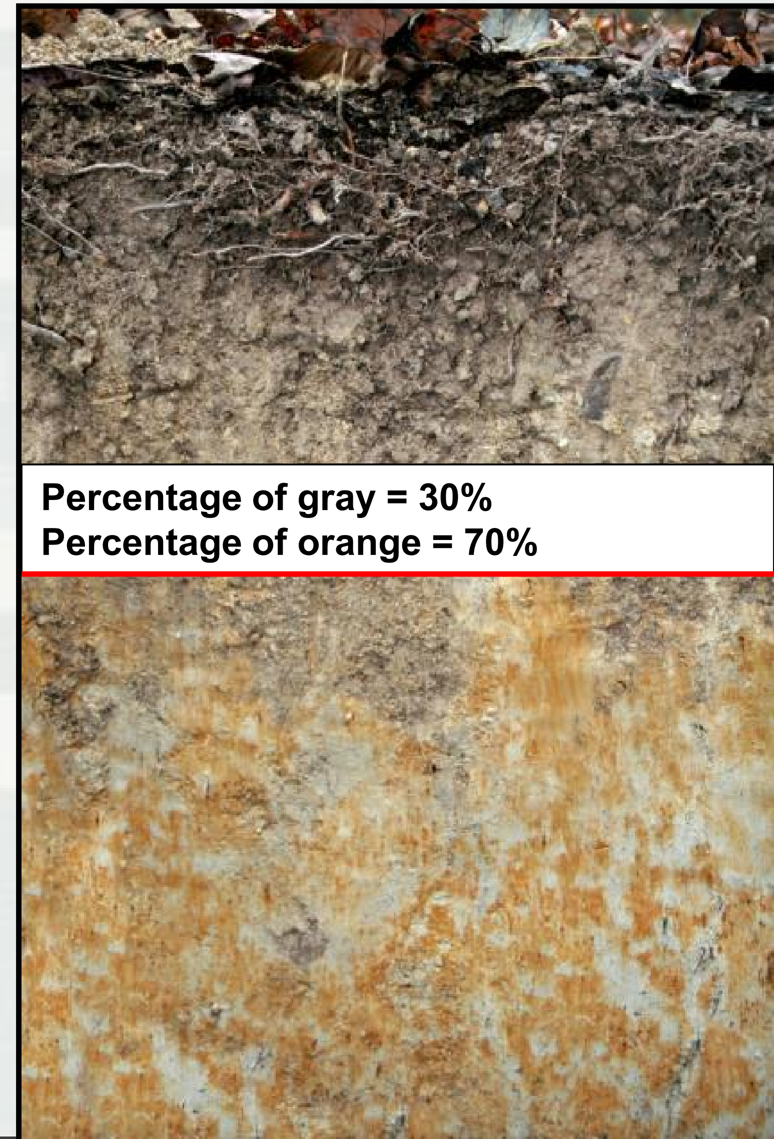
Best to record an estimated percentage.



From: Munsell front pages

Estimating Percent





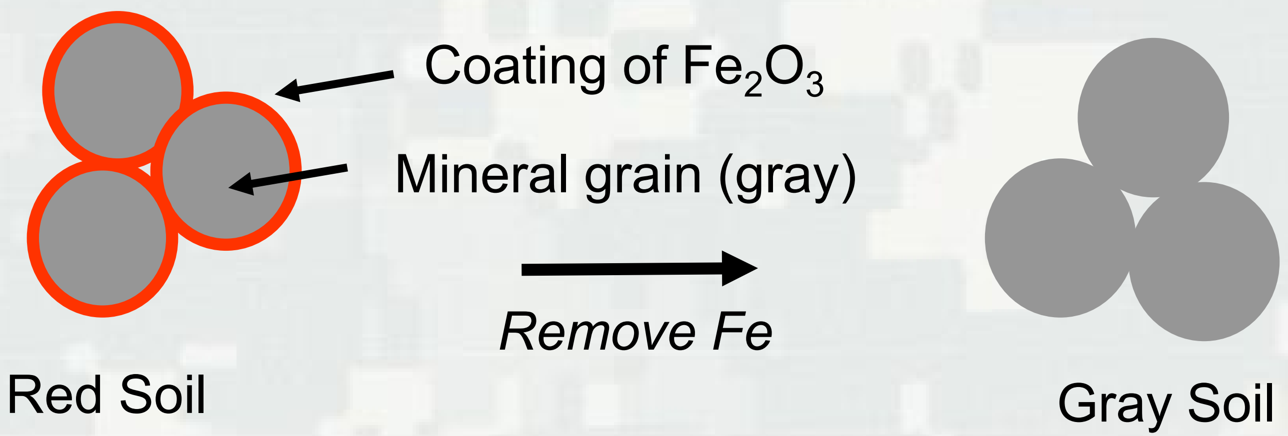
Estimating Percent

- Can all redox concentrations fit on one side?
- Can all redox concentrations fit in one corner?
- Breakdown further if necessary.

Oxidation/Reduction and Soil Color

[or, why concentrations and depletions look the way they do]

- In soil layers, Fe and Mn oxides give soils their characteristic brown, red, and yellow colors.
- When saturated and reduced, Fe and Mn are mobile and can be stripped from soil particles.
- This leaves the characteristic mineral grain color, usually a neutral gray.



Types of Redoximorphic Features

- Redox <u>Concentrations</u>
  - ►Masses
  - ►Pore Linings
  - ►Nodules and Concretions
- Redox <u>Depletions</u>
  - ►Depleted Matrix
- Reduced Matrix
- Coated sand grains

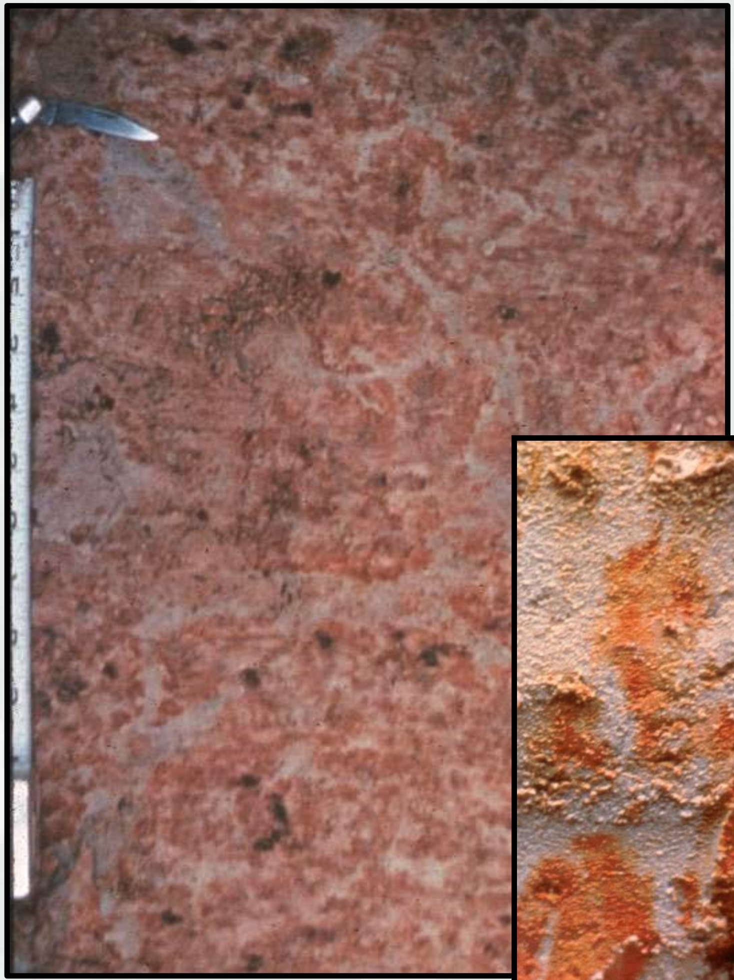
Redox Concentrations

Bodies of apparent accumulation of Fe/Mn oxides

- Masses
- Pore linings
  - on ped faces
  - in root channels
- Nodules and concretions

Masses

- Soft bodies
- Frequently in the soil matrix
- Variable in shape



Pore Linings

- Coatings on a pore surface
- Impregnations of the matrix adjacent to the pore

Nodules and Concretions

- Firm to extremely firm bodies
- Often relict
- Contemporary ones should be irregular in shape
- Diffuse boundary
  - “halo” or “corona”

Fe/Mn nodules washed from the soil

Relict vs Contemporary

Relict Contemporary

Relict features are often firm to extremely firm and have abrupt boundaries with the soil matrix.

On left is a relict pore lining in deoxidized loess from eastern Nebraska. Commonly called pipe stems, these features formed at least 10,000 years ago (Pleistocene). On right, contemporary depletions along root channels and a contemporary Fe/Mn soft mass in lower left.

Age of Features

Redox features do not always indicate current hydrologic conditions

- Can be relicts of past climates
  - relict features can persist for thousands of years (e.g., Pleistocene).
  - relict features may have sharp edges and abrupt boundaries
  - relict nodules and concretions are often rounded
- Contemporary features should have diffuse boundaries and/or be associated with ped faces or root channels

Redox Depletions

Bodies of low chroma where Fe/Mn oxides have been stripped out

- Generally value ≥ 4
- Chroma ≤ 2
- Formerly called "gray mottles"

Depleted or Reduced Matrix

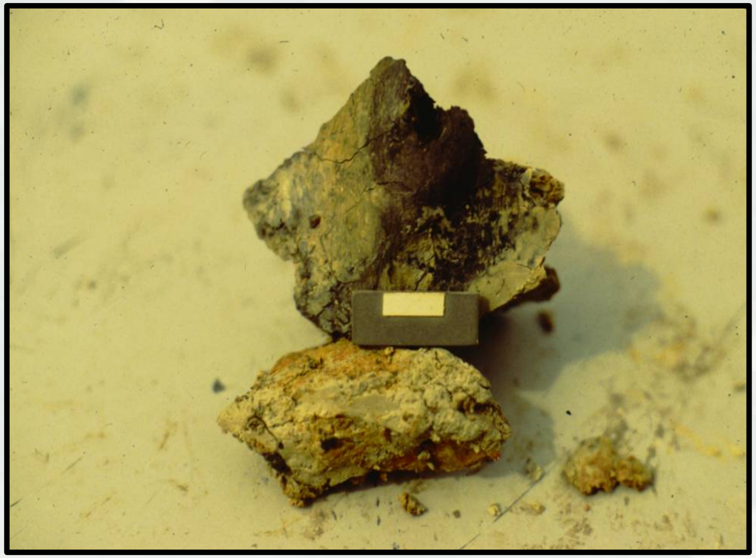
- The concept of a depleted matrix is that due to prolonged saturation, the soil has had significant iron removed, leaving the neutral base gray color as dominant. This is different from a reduced matrix.
- A reduced matrix occurs when soils have high value and low chroma *in situ*, but color changes when exposed to air. Reduced Fe^{2+} is present and oxidized to Fe^{3+} upon exposure to air. Specifics of color change requirements from Chapter 5 are discussed later.

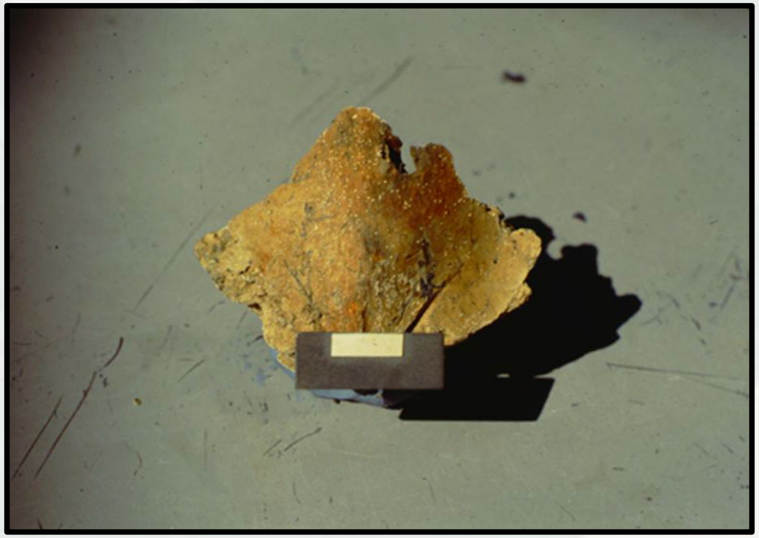
Depleted Matrix

- Dominant color of the soil is "gray" due to removal (depletion) of iron
- Commonly used to identify hydric soils
  - Discussed more in the material on hydric soil indicators

Reduced Matrix

Soils have high value and low chroma *in situ*, but color changes when exposed to air





- Reduced Fe is present
- Fe^{2+} is oxidized to Fe^{3+} upon exposure

Redox Reactions

How do they help identify hydric soils?

Element	Sign that Reduction Occurred
Oxygen	Organic carbon accumulation
Nitrogen	None
Manganese	Redoximorphic Features
Iron	Redoximorphic Features
Sulfur	Rotten egg odor
Carbon	Methane

These reactions make wet soils look or smell distinctive
allowing development of hydric soil indicators

Interpretation Problems

Not all wet soils develop redoximorphic features

- Low amounts of soluble organic carbon
- High pH
- Cold temperatures
- Low amounts of Fe
- Aerated groundwater

Rate of Feature Formation

- Soils in recently constructed wetlands develop visible redox depletions within a couple years if saturation occurs during the growing season

- Redox concentrations (pore linings) begin forming around aerated roots in as little as 7 days in flooded rice paddies, but may take 30 days or more before they start to become visible to the naked eye

Alpha, Alpha-Dipyridyl

A dye used to test for the presence of reduced Fe

- Pink reaction to Fe^{2+}
- Dye is sensitive to light and heat
- Apply to freshly broken soil ped

Alpha, alpha-dipyridyl applied to a fresh slice of soil

Alpha, Alpha-Dipyridyl Test Strips

Describing Redoximorphic Features

- Concentrations and Depletions
  - Describe type, color, abundance and location (i.e., along macropores or within matrix)
    - contrast can be obtained from color charts
    - automatically determined on automated data sheets (i.e., distinct/prominent)
- Reduced Matrix
  - Describe reduced matrix color, oxidized color, and time for color change to occur
- Alpha, Alpha-Dipyridyl
  - Describe % of soil that reacts and location

Two Categories of Soil Material

Differ in organic matter content:

- Organic material
- Mineral material

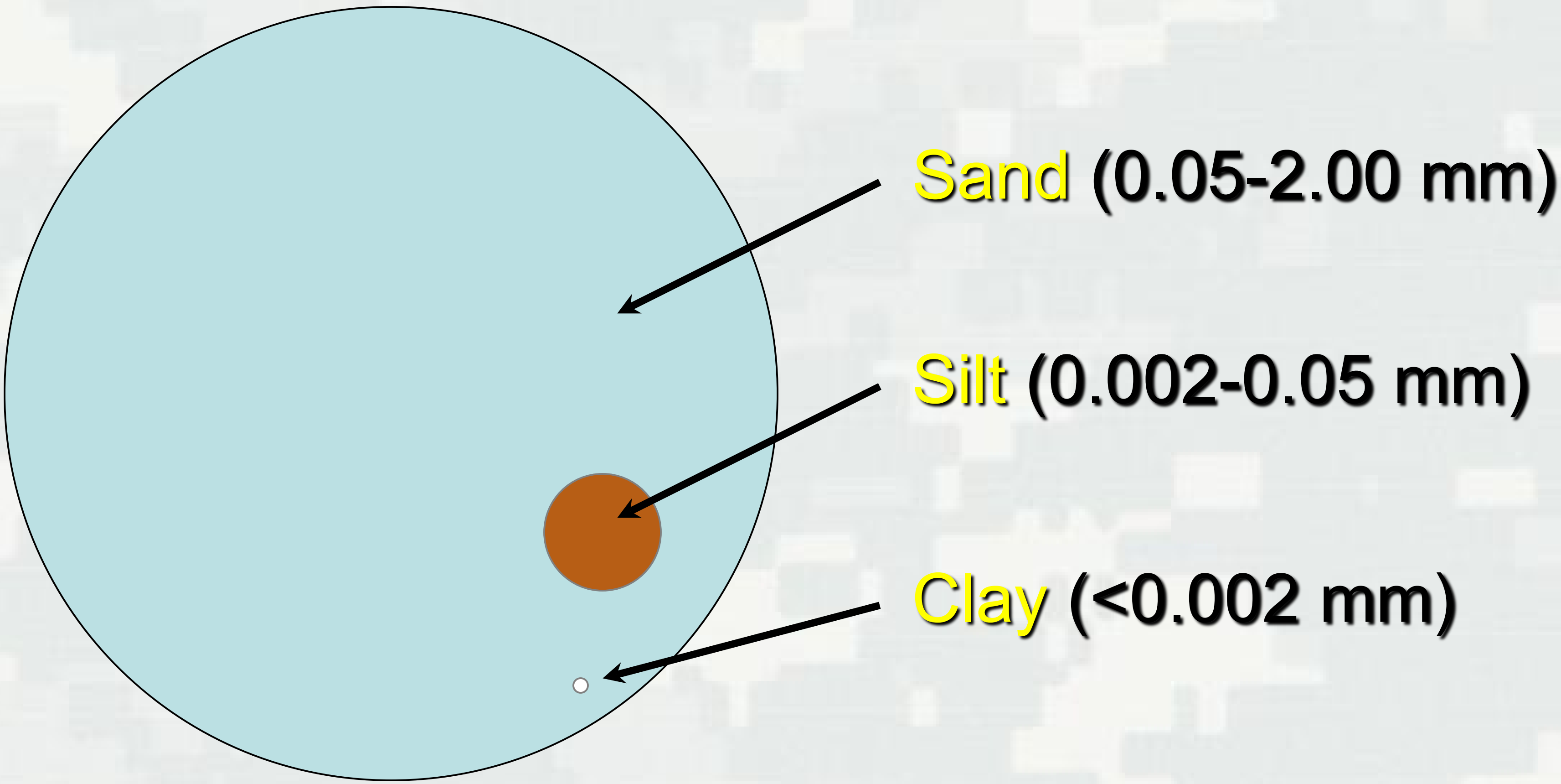
Organic Layers

- Consist of decomposed organic material
  - ▸ Peat (fibric) – least decomposed
  - ▸ Mucky peat (hemic)
  - ▸ Muck (sapric) – most decomposed

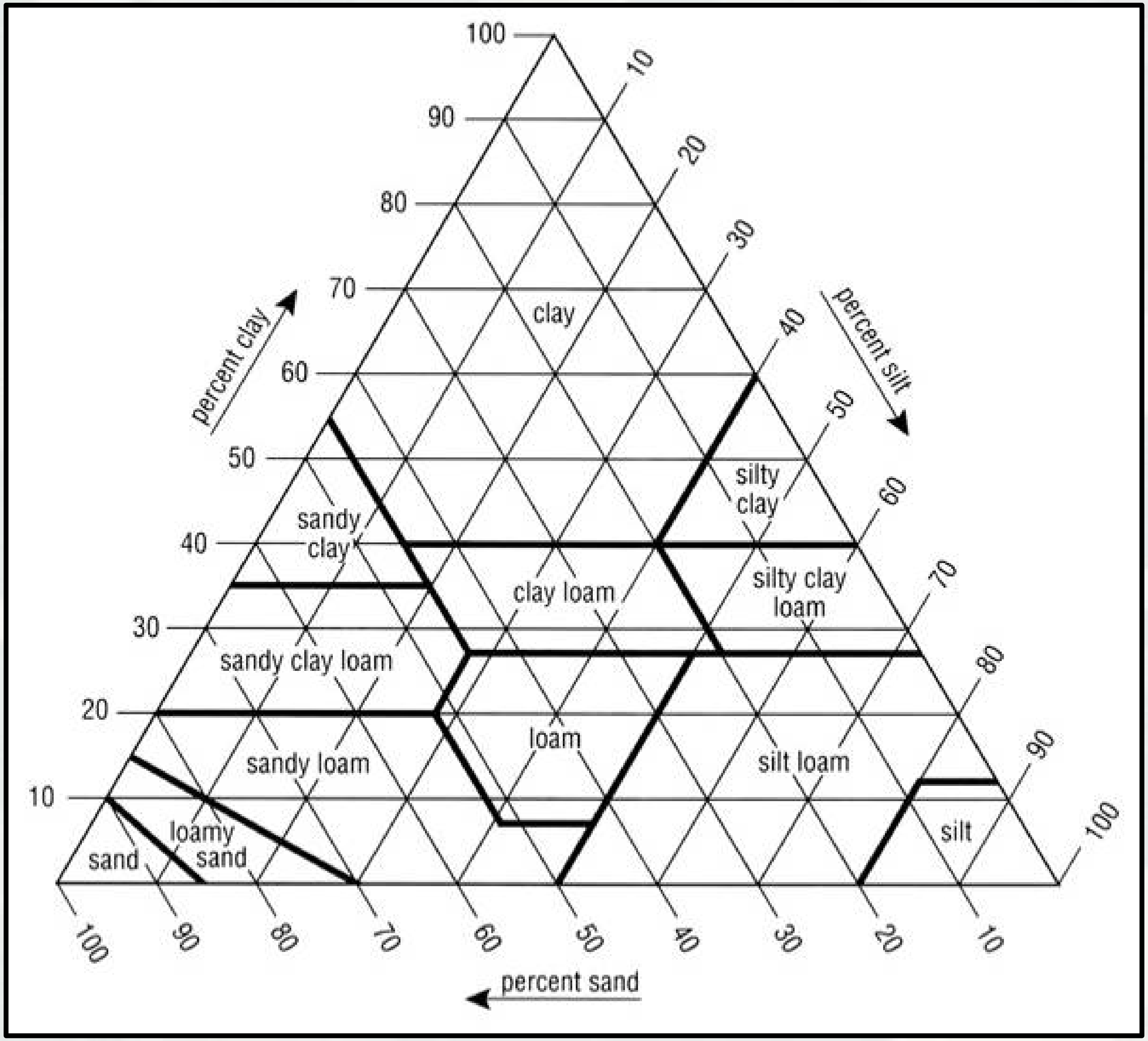
Mineral Layers

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

Relative Sizes of Soil Particles

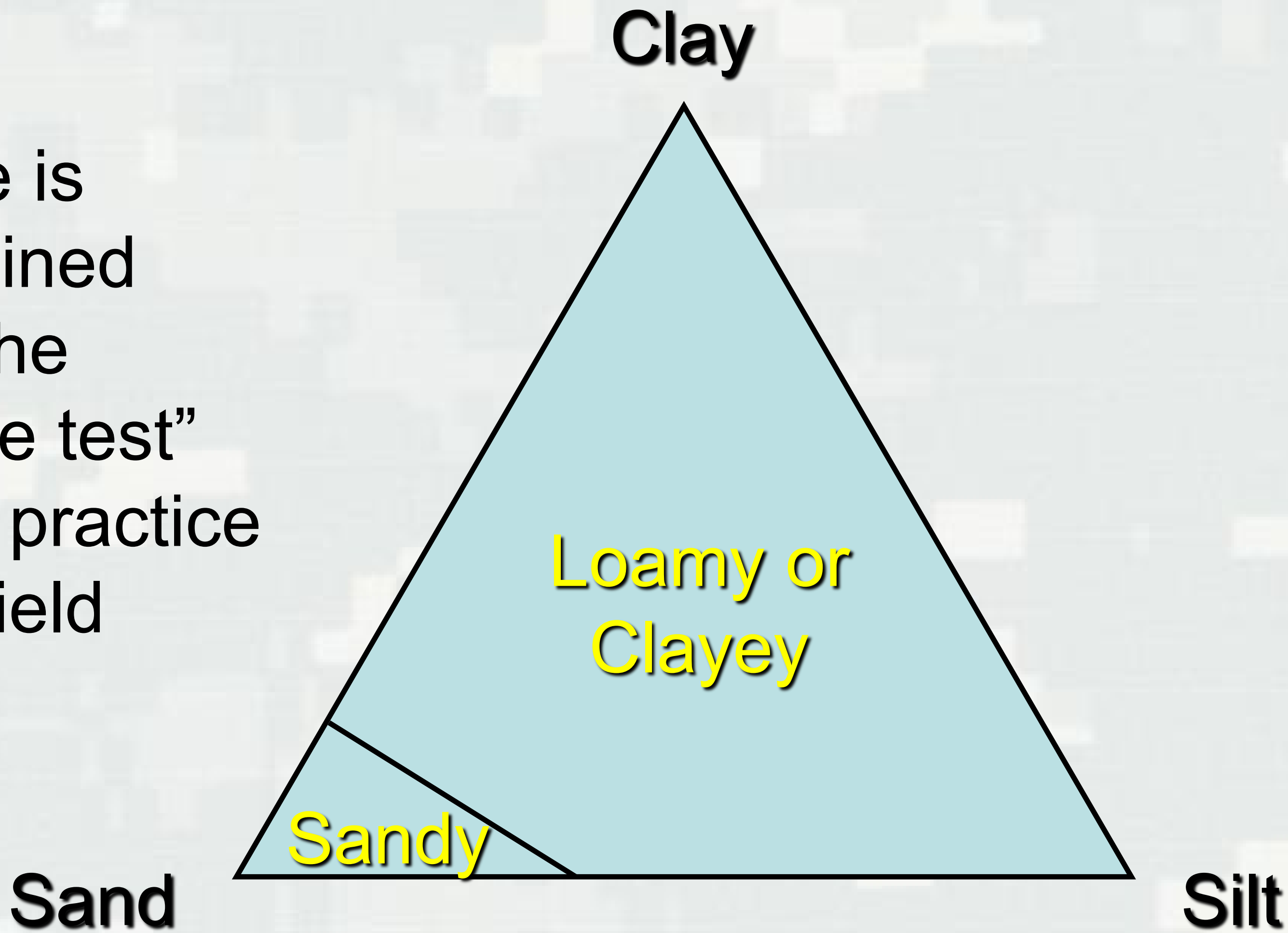


Soil Texture Triangle

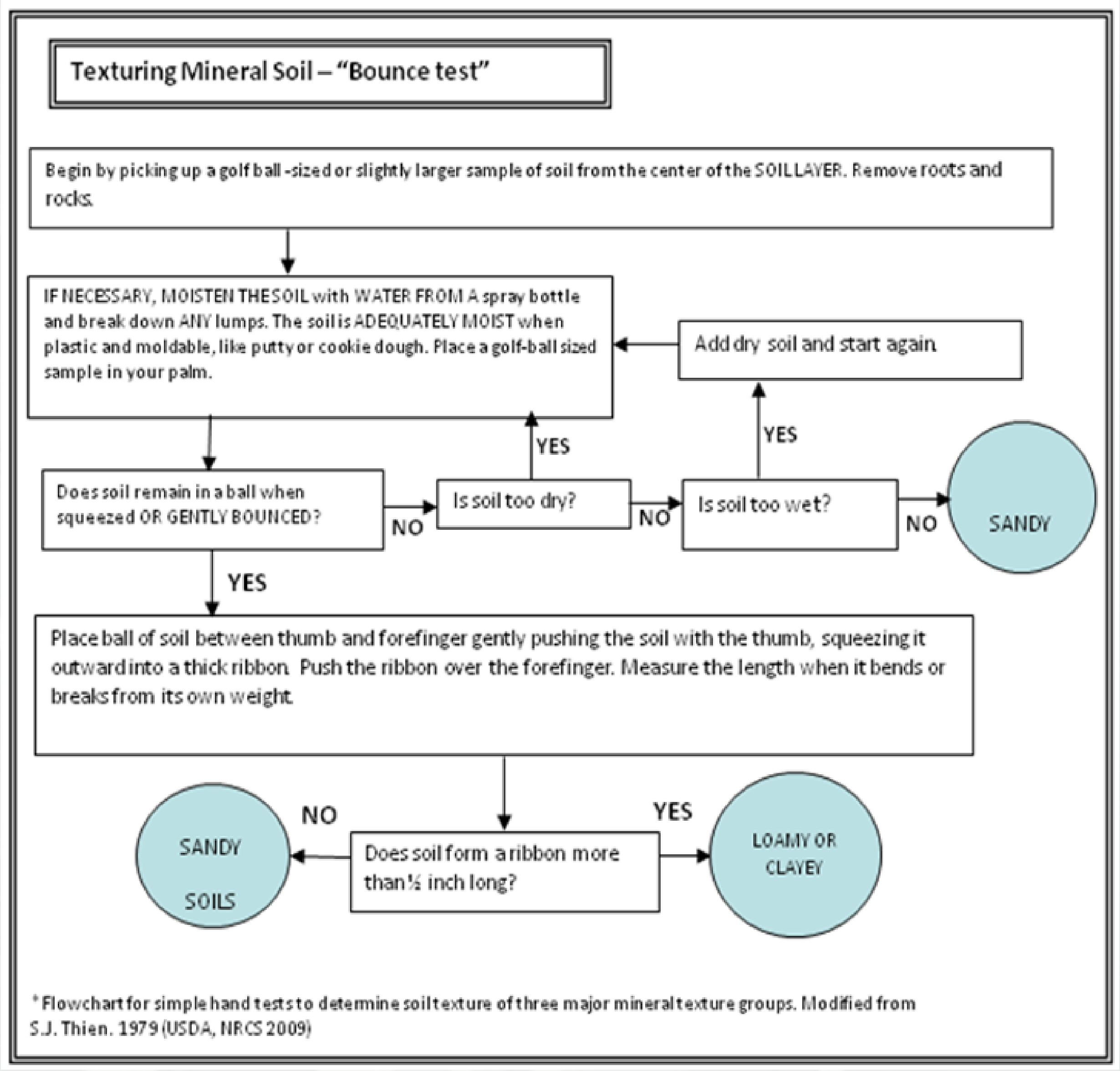


Simplified Soil Texture Triangle

Texture is determined using the "bounce test" we will practice in the field



Bounce Test



Texturing Mineral Soil – "Bounce test"
Begin by picking up a golf ball -sized or slightly larger sample of soil from the center of the SOIL LAYER. Remove roots and rocks.
IF NECESSARY, MOISTEN THE SOIL with WATER FROM A spray bottle and break down ANY lumps. The soil is ADEQUATELY MOIST when plastic and moldable, like putty or cookie dough. Place a golf-ball sized sample in your palm.
Add dry soil and start again.
YES
YES
Does soil remain in a ball when squeezed OR GENTLY BOUNCED?
NO
Is soil too dry?
NO
Is soil too wet?
NO
SANDY
YES
Place ball of soil between thumb and forefinger gently pushing the soil with the thumb, squeezing it outward into a thick ribbon. Push the ribbon over the forefinger. Measure the length when it bends or breaks from its own weight.
SANDY SOILS
NO
Does soil form a ribbon more than ½ inch long?
YES
LOAMY OR CLAYEY
* Flowchart for simple hand tests to determine soil texture of three major mineral texture groups. Modified from S.J. Thien. 1979 (USDA, NRCS 2009)

Where do soil observations begin?

The soil in this example begins:

- beneath the knife blade
- below the fibric and hemic material

Describe the Soil Profile

To select the appropriate indicator(s), it is critical to accurately describe the soil profile on the data sheet.

The soil profile is layered.

Each layer…

…has a thickness (and depth),
…has a color,
…has a texture, and
…may have other features.