Introduction to Forest Soils

Making forest soil observation and interpretation valuable to your management

Learning Objectives:

By the end of this session participants should be able to:

- Identify relevant soil attributes in photographs provided (but ideally in a field setting).
- Read an NRCS soil series description with sufficient comprehension to identify the relevant soil attributes of interest.
- Describe how soil series or soil attributes might change across the landscape if provided a soil map, topographic map, or aerial image.

Hierarchy of Soils Information

Soil characteristics (covered today)

↘

Soil profile description (covered today)

↘

Soil classification/mapping (covered tomorrow)

↘

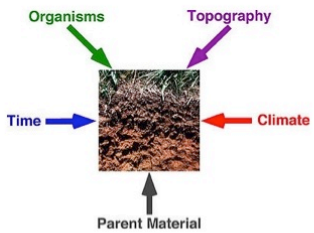
Soil management decisions (covered Friday)

Soil and soil forming factors (A quick review)

- Soil is the naturally occurring, unconsolidated, outer layer of the earth's crust. It is composed of both organic and mineral materials and is capable of supporting plant growth
- Forest soils are soils which have developed under the influence of and are capable of supporting a forest ecosystem.

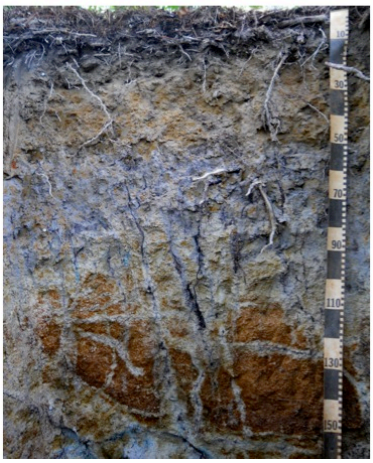
Soil Forming Factors

- **Cl**imate
- **O**rganisms
- **R**elief
- **P**arent Material
- **T**ime



- And now we include humans as a critical organism

Forest Soils

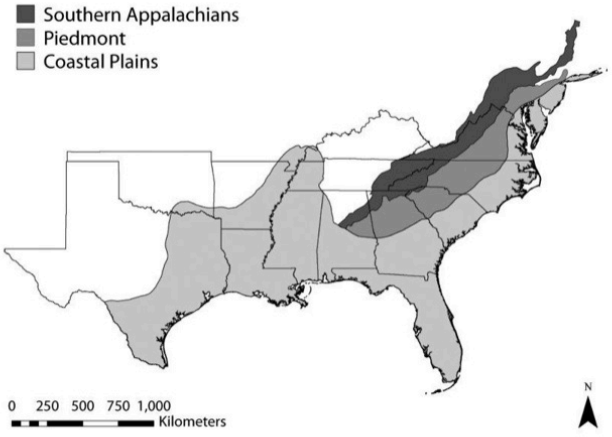


Recognizing key soil characteristics in the field

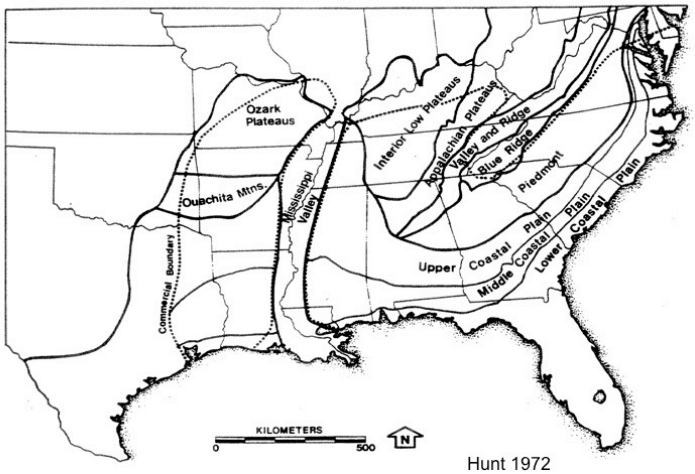
- Parent material
- Horizonation
- Physical Characteristics
  - Color
  - Texture
  - Drainage (and redoximorphic features)
  - Slope

Quick Quiz 1

- What is the predominate physiographic region that you work in?
  - A) Ridge and Valley/Appalachian Plateau
  - B) Piedmont
  - C) Atlantic Coastal Plain/Flatwoods
  - D) Central Gulf or Loess capped Gulf
  - E) Ozarks or Western Gulf

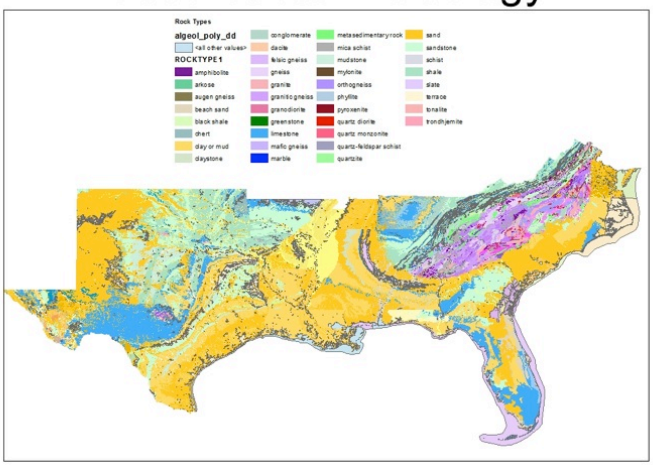


SE Physiographic Regions



Hunt 1972

Southeastern Geology



Quick Quiz #2

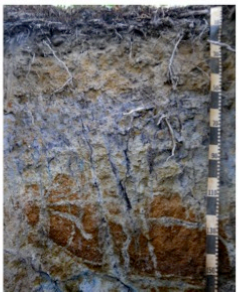
- What are the dominant parent materials in your region?
  - A) Acid igneous rocks
  - B) Basic igneous rocks
  - C) Sedimentray rocks
  - D) Marine sediments
  - E) Wind derived sediments

Parent material

- Bedrock vs Marine vs Loess
- In place vs Transported (Alluvial, Colluvial, Wind)

Derived from Marine Deposit

Derived from Bedrock



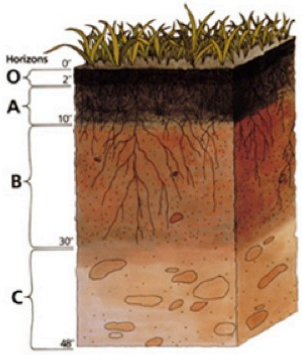
Parent Material

- Strong influence on
  - Chemistry (pH, base saturation)
  - Particle Size (Sand, silt, clay)

Horizonation

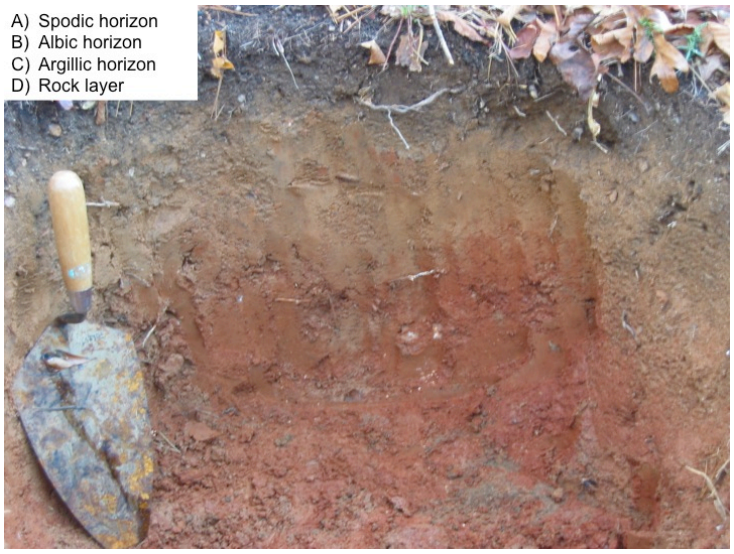
Patterns of horizons are repeating and recognizable

- The depth and arrangement of soil horizons can provide insight to site quality
  - Thickness of A
  - Depth to B
  - Depth to restricting layer



Quick Quiz #3

- What horizons are recognizable in these forest soil profiles?



Soil Physical Characteristics

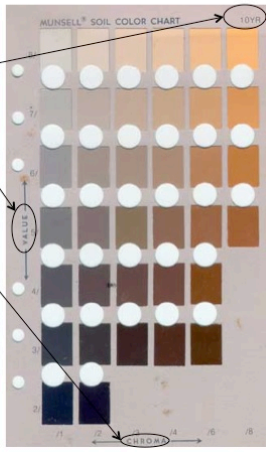
- Soil physical characteristics recognizable in the field (as opposed to chemical attributes) may provide insight to site quality
  - Soil color
  - Texture
  - Drainage class (redoximorphic features)

Soil Color

- Distinctive property caused by compositional differences, varying redox chemistry
  - Humus (topsoils: brown, black)
  - Oxidized iron (red/yellow/brown)
  - Reduced iron (greys/greens)
  - Uncoated minerals (light grey/whitish in E horz)

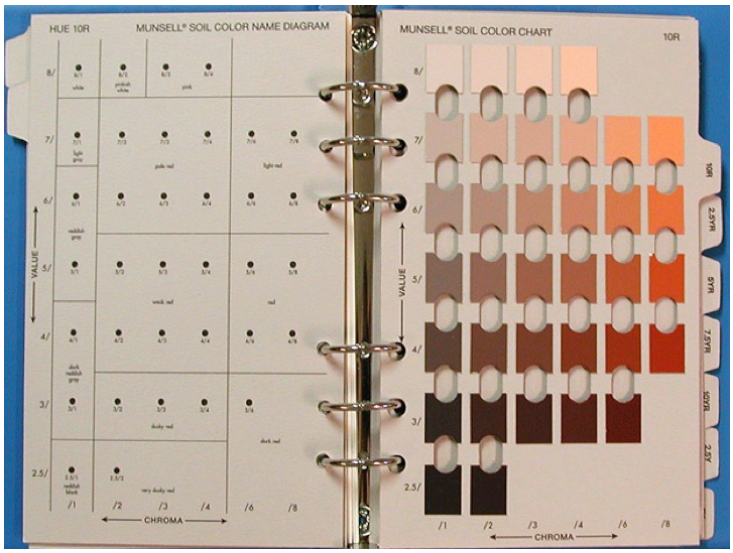
Munsell Color System

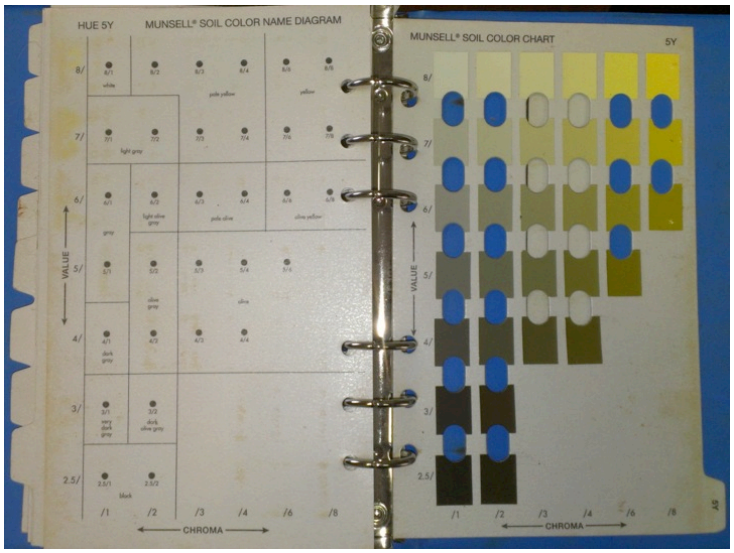
- Hue – chromatic composition
- Value –lightness-darkness
  - Vertical scale
- Chroma –dullness-brightness
  - Horizontal scale

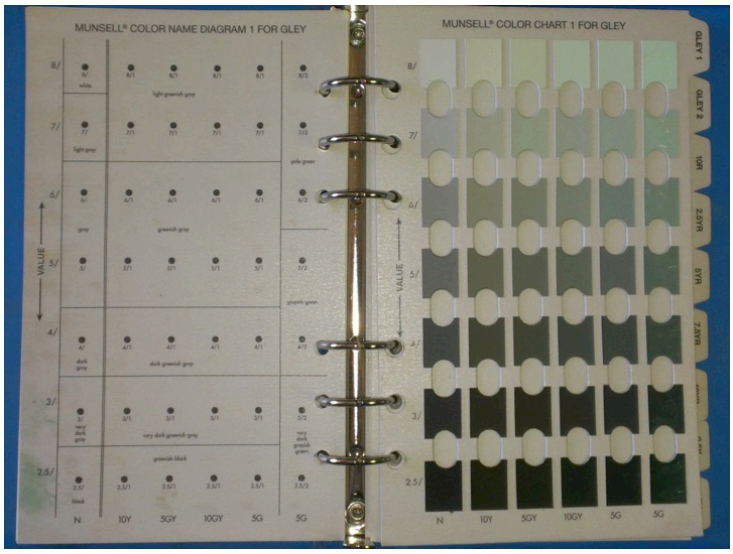


Munsell Soil Chart Colors

- 10R, 2.5YR, 5YR, 7.5YR, 10YR, 2.5Y, 5Y
  - Red to yellow
- Gley1 and Gley 2
  - Reduced soils
  - Olive greens

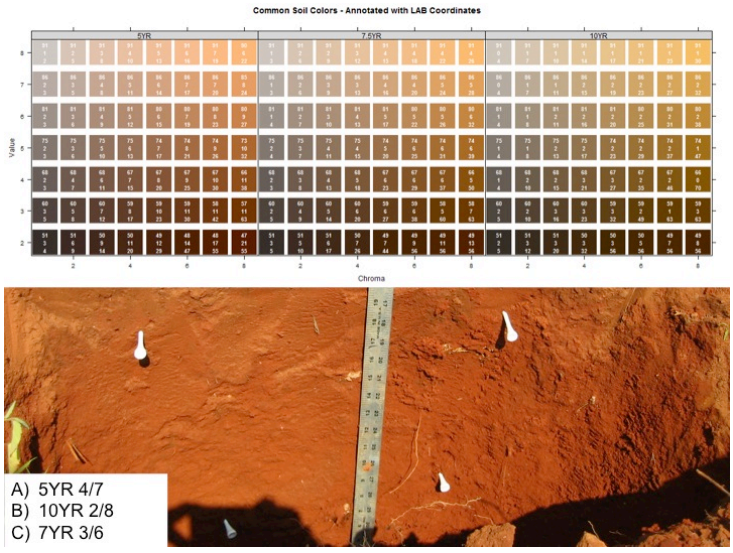




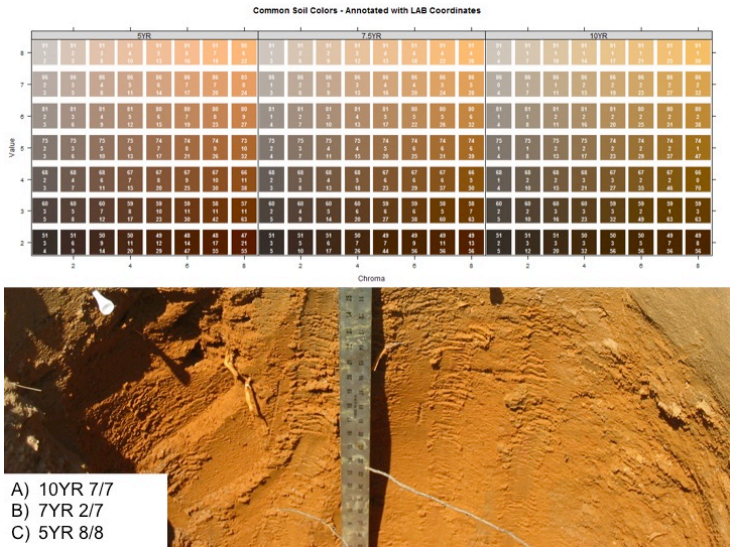


Quick Quiz #4

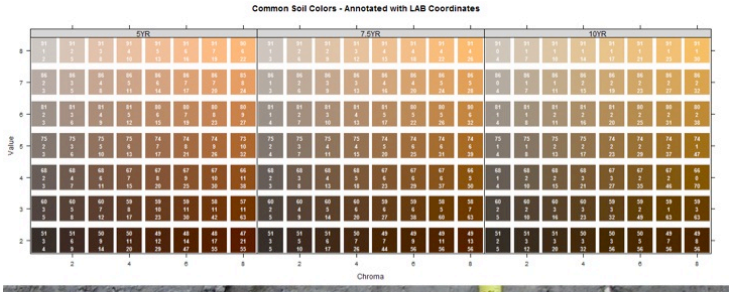
Identify the soil color of the subsoil horizon



A) 5YR 4/7
B) 10YR 2/8
C) 7YR 3/6



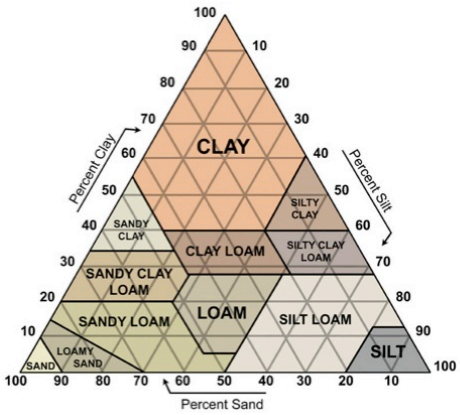
A) 10YR 7/7
B) 7YR 2/7
C) 5YR 8/8

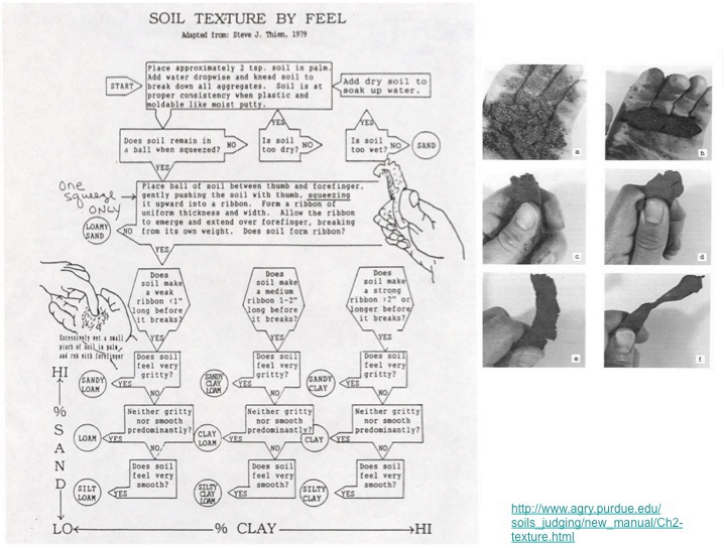


A) 10YR 8/1
B) 7YR 8/1
C) 5YR 8/1

Texture

Size and relative abundance of mineral particles





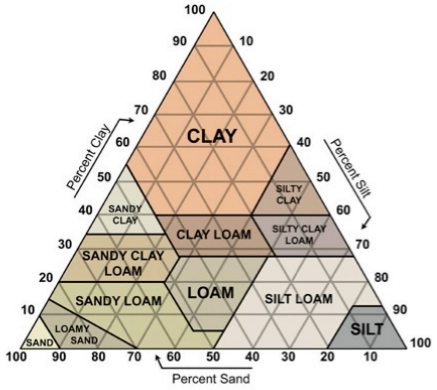
http://www.agry.purdue.edu/soils_judging/new_manual/Ch2-texture.html

Quick Quiz #3

What is this soil texture?

- 20% clay
- 40% silt
- 40% sand

A) Sandy Loam
B) Clay Loam
C) Loam



What is this soil texture?

- Soil forms a >2 inch ribbon
- Has a very smooth feel

A) Clay
B) Clay Loam
C) Silty Clay

Drainage Class

Characterizes movement of water through soil

- Drainage classes
  - Excessively Drained
  - Somewhat Excessively Drained
  - Well Drained
  - Moderately Well Drained
  - Somewhat Poorly Drained
  - Poorly Drained
  - Very Poorly Drained

- Identified by texture, color, structure, and landscape position

What is the drainage class?

A) Excessively drained
B) Well drained
C) Moderately Well drained
D) Poorly drained

What is the drainage class?

A) Excessively drained

Texture–sand

Alpin series
Formed in thick eolian sands
Thermic, coated Lamellic
Quartzipsamments

What is the drainage class?

A) Excessively drained
B) Well drained
C) Moderately Well drained
D) Poorly drained

What is the drainage class?

D)Poorly drained

Color-dark brown organic accumulation in subsoil

Sapelo series
Formed in marine deposits
Sandy, siliceous,
thermic Ultic Alaquods

What is the drainage class?

A) Excessively drained
B) Well drained
C) Moderately Well drained
D) Poorly drained

What is the drainage class?

B) Well drained

color-bright red

Bama series
(Yes it is the State soil of Alabama)
Fine-loamy, siliceous, subactive, thermic
Typic Paleudult

What is the drainage class?

A) Excessively drained
B) Well drained
C) Moderately Well drained
D) Poorly drained

What is the drainage class?

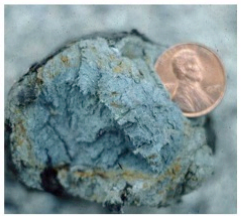
C) Moderately Well Drained
Color –reduced colors in subsoil

Goldsboro series
Formed in marine sediment
Fine-loamy, siliceous, subaactive, thermic
Aquic Paleudults

A note on Redox features

Redox color is largely driven by changes in iron minerals

Form	Chemical Formula	Color
Ferric Oxide (Hematite)	Fe_2O_3	Red
Hydrated Ferric Oxide (Geothite)	FeO(OH)	Yellow
Ferrous oxide	FeO	Gray



A Note on Redox features

- Mottling and redoximorphic features can inform us about water relations at a site
- Depth to mottling can be used to:
  - infer the extent of water table rise
  - subsoil saturation
  - rooting depth

Soil Profile Description

- NRCS soil series
- https://soilseries.sc.egov.usda.gov/osdnamequery.asp

CECIL SERIES

The Cecil series consists of very deep, well drained moderately permeable soils on ridges and side slopes of the Piedmont uplands. They are deep to saprolite and very deep to bedrock. They formed in residuum weathered from felsic, igneous and high-grade metamorphic rocks of the Piedmont uplands. Slopes range from 0 to 25 percent. Mean annual precipitation is 48 inches and mean annual temperature is 59 degrees F. near the type location.

TAXONOMIC CLASS: Fine, kaolinitic, thermic Typic Kanhapludults

TYPICAL PEDON: Cecil sandy loam--forested. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 8 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium granular structure; very friable; slightly acid; abrupt smooth boundary. (2 to 8 inches thick)

Bt1--8 to 26 inches; red (10R 4/8) clay; moderate medium subangular blocky structure; firm; sticky, plastic; common clay films on faces of peds; few fine flakes of mica; strongly acid; gradual wavy boundary.

Bt2--26 to 42 inches; red (10R 4/8) clay; few fine prominent yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; firm; sticky, plastic; common clay films on faces of peds; few fine flakes of mica; very strongly acid; gradual wavy boundary. (Combined thickness of the Bt horizon is 24 to 50 inches)

BC--42 to 50 inches; red (2.5YR 4/8) clay loam; few distinct yellowish red (5YR 5/8) mottles; weak medium subangular blocky structure; friable; few fine flakes of mica; very strongly acid; gradual wavy boundary. (0 to 10 inches thick)

C--50 to 80 inches; red (2.5YR 4/8) loam saprolite; common medium distinct pale yellow (2.5Y 7/4) and common distinct brown (7.5YR 5/4) mottles; massive; very friable; few fine flakes of mica; very strongly acid.

Competing Series

Relate to differences in the attributes discussed

Parent Material

COMPETING SERIES: These are the Appling, Bethlehem, Georgeville, Herndon, Madison, Nanford, Nankin, Pacolet, Saw, Tarrus, and Wedowee series in the same family. Those in closely related families are the Cataula, Chestatee, Cullen, Hulett, Lloyd, Mayodan, and Mecklenburg series. Appling soils have dominant hue of 7.5YR or yellower or where hue is 5YR it has evident patterns of mottling in a subhorizon of the Bt or BC horizon. Bethlehem soils have soft bedrock at depths of 20 to 40 inches. Cataula soils have a perched water table at 2 to 4 feet, Chestatee soils contain more than 15 percent, by volume, coarse fragments throughout. Cullen soils have more clay in the Bt horizon. Mayodan and Mecklenburg soils have mixed mineralogy and in addition, Mayodan soils formed in Triassic age sediments and Mecklenburg soils formed from basic diabase parent material. Georgeville, Herndon, Nanford, and Tarrus soils formed in Carolina slate and contain more than 30 percent silt. Hulett, Nankin, and Wedowee soils have a Bt horizon with hue of 5YR or yellower. In addition, Nankin soils formed from marine sediments. Lloyd soils have rhodic colors to depths of 40 inches or more. Madison, Pacolet, and Wedowee soils have thinner argillic horizons. Saw soils have hard bedrock at depths of 20 to 40 inches.

Competing Series

Relate to differences in the attributes discussed

Horizons

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Color

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Competing Series

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Texture

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Competing Series

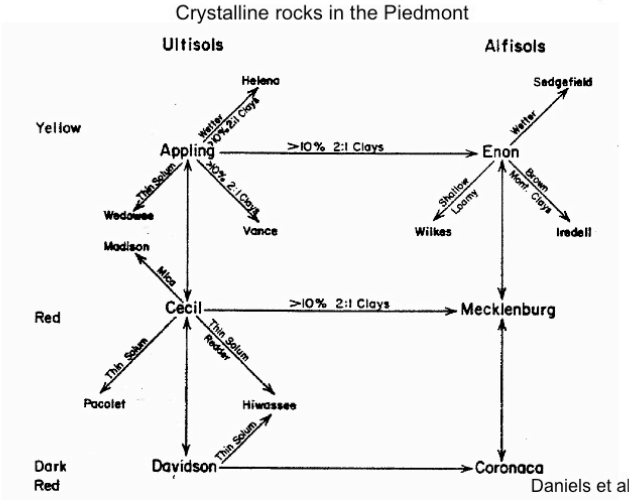
Relate to differences in the attributes discussed

Drainage

COMPETING SERIES: These are the Appling, Bethlehem, Georgeville, Herndon, Madison, Nanford, Nankin, Pacolet, Saw, Tarrus, and Wedowee series in the same family. Those in closely related families are the Cataula, Chestatee, Cullen, Hulett, Lloyd, Mayodan, and Mecklenburg series. Appling soils have dominant hue of 7.5YR or yellower or where hue is 5YR it has evident patterns of mottling in a subhorizon of the Bt or BC horizon. Bethlehem soils have soft bedrock at depths of 20 to 40 inches. Cataula soils have a perched water table at 2 to 4 feet, Chestatee soils contain more than 15 percent, by volume, coarse fragments throughout. Cullen soils have more clay in the Bt horizon. Mayodan and Mecklenburg soils have mixed mineralogy and in addition, Mayodan soils formed in Triassic age sediments and Mecklenburg soils formed from basic diabase parent material. Georgeville, Herndon, Nanford, and Tarrus soils formed in Carolina slate and contain more than 30 percent silt. Hulett, Nankin, and Wedowee soils have a Bt horizon with hue of 5YR or yellower. In addition, Nankin soils formed from marine sediments. Lloyd soils have rhodic colors to depths of 40 inches or more. Madison, Pacolet, and Wedowee soils have thinner argillic horizons. Saw soils have hard bedrock at depths of 20 to 40 inches.

Soil Series Classification Relationships

Crystalline rocks in the Piedmont



Daniels et al 1984

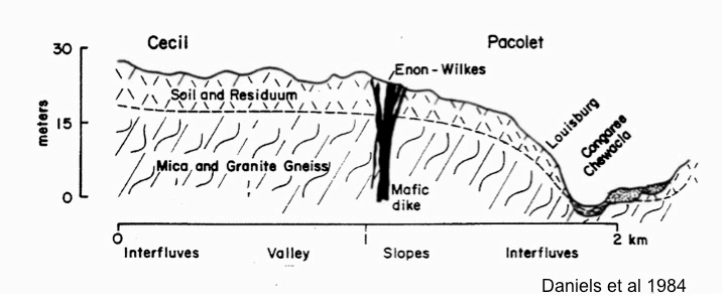
Soil Series are Geographicall Associated in the Landscape

GEOGRAPHIC SETTING: Cecil soils are on nearly level to steep Piedmont uplands. Slope gradients are 0 to 25 percent, most commonly between 2 and 15 percent. These soils have developed in weathered felsic igneous and high-grade metamorphic rocks. Average annual precipitation is about 48 inches. Mean annual soil temperature is about 59 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: In addition to the competing Appling, Bethlehem, Cataula, Chestatee, Cullen, Lloyd, Madison, Mecklenburg, Pacolet, Saw, and Wedowee series these are the Durham, Louisburg, Rion, and Worsham series. Durham, Louisburg, and Rion soils have less clay in the Bt horizon. Worsham soils are poorly drained and are around the heads of drains.

Soil Series Relations in the Piedmont landscape

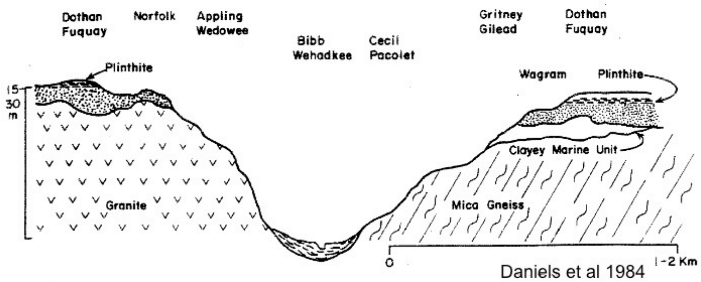
- Note the soil series parent material relation
- Also, we have not discussed relief as a soil forming factor but its role effect here is evident



Daniels et al 1984

Soil Series Relations in the Upper Coastal Plain landscape

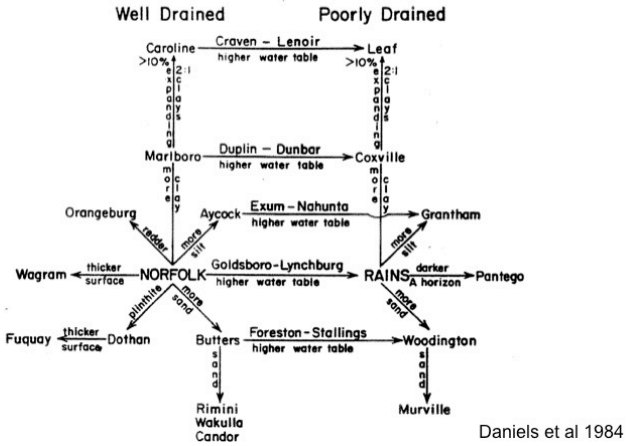
- Note intermingling of some Piedmont series



Daniels et al 1984

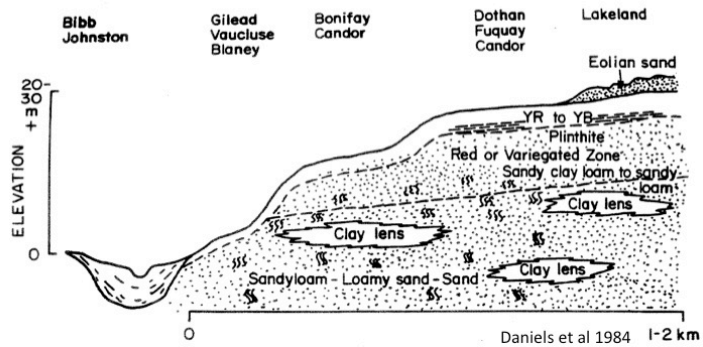
Soil Series Classification Relationships

Loamy Sediments of the Coastal Plain



Daniels et al 1984

Soil Series Relations in the Sandhills and Lower Coastal Plain landscape



Daniels et al 1984

Soil Series in the landscape

- Websoil Survey
- Soilweb App

Learning Objectives Revisited:

- Identify relevant soil attributes in photographs provided (but ideally in a field setting).
  - Physiographic region/Parent Material
  - Horizons
  - Texture
  - Color
  - Drainage Class (mottling)

- Read an NRCS soil series description with sufficient comprehension to identify the relevant soil attributes of interest.

- Describe how soil series or soil attributes might change across the landscape if provided a soil map, topographic map, or aerial image.