What should you know?

- Rational behind the Soil Taxonomy
- The epipedons and keys
- The common endopedons
- The taxonomic levels and bases for differentiation
- The soil Orders and keys
- How to identify the soil Order in a taxonomic name

What is Soil Taxonomy?

- Need to classify to understand, organize, discuss, and interpret for land management
- 1st US System: 1938
- 1950s - 60s, new systems developed with each improvement called an approximation
- 7th Approximation in 1965, published as SOIL TAXONOMY in 1975.

Rationale for Taxonomy

- Based on observed soil properties as found today
- Group soils based on their physical, chemical, and biological properties
- Flexible and open to modification
- Includes:
  - Texture, color, structure
  - Organic carbon, pH, % base saturation, clay type and content, iron oxides
  - Diagnostic horizons
    - Epipedons = surface horizons or layers
    - Endopedons = subsurface horizons or layers

% Base Saturation

- Clay minerals and organic matter have negative charge on their surfaces (they are large anions) = cation exchange complex
- Cations are adsorbed to the exchange complex so that electroneutrality is maintained
- The cations that commonly satisfy charge are:
  - Ca²⁺, Mg²⁺, K⁺, Na⁺ which are called the base cations
  - H⁺ and Al³⁺ which are acidic
- % Base saturation (% BS, or simply, BS) is the percentage of soil exchange complex occupied by the base cations
- % BS is a measure of inherent soil fertility

Diagnostic Epipedons

- Layers of soil at surface (encompass one or more surface soil horizons)
- There are 8 epipedons (5 are common); all soils have an epipedon
- Mollis (mollis – Latin for soft)
  - Dark colored: value and chroma < 3 moist
  - > 25 cm thick
  - High organic carbon, > 0.6 %, (soft to the touch – friable)
  - > 50% BS
Diagnostic Epipedons

- **Umbric** (umbra, Latin for shade, dark)
  - An acidic Mollic epipedon
  - Meets all requirements for Mollic except % BS < 50%
- **Ochric** (ochros, Greek for pale)
  - Too thin, too light in color, or too low in organic carbon to meet requirements for a mollic or an umbric horizon

Diagnostic Epipedons

- **Melanic** (melas, Greek for black)
  - 6% < organic C < 25%
  - Volcanic soils (> 5% volcanic glass; > 0.4% Al + ½Fe content)
  - High phosphate retention capacity
  - Very low density (< 0.9 g cm⁻³), light fluffy type of soil material
  - > 30 cm thick

Diagnostic Epipedons

- **Histic** (histos, Greek for tissue)
  - Surface organic horizon, saturated > 30 days cumulative during the year
  - If > 60% clay: > 16% organic C
  - If no clay: > 8% organic C
  - If < 60% clay: > 8% organic C + % clay + 7.5 (example: if 30% clay, organic C must be greater than 8% + 30/7.5 > 12%)
  - 20- to 60-cm thick

Diagnostic Epipedons

- **Folistic** (folia, Latin for leaf)
  - Surface organic horizon, saturated for < 30 days cumulative during the year
  - If > 60% clay: > 16% organic C
  - If no clay: > 8% organic C
  - If < 60% clay: > 8% organic C + % clay ÷ 7.5
  - > 15 cm thick

Diagnostic Epipedons

- **Anthropic** (anthropikos, Greek for human)
  - Evidence of disturbance by human activities
    - Man-made mollic
    - High available P content
    - Centuries of use
- **Plaggen** (plaggen, German for sod)
  - Human-made surface layer > 50 cm thick from long-term manuring
  - Artifacts or spade marks below 30 cm depth
  - Color value < 4; chroma < 2
  - Organic C > 0.6%

Epipedon Relationships

- **Melanic**
  - Volcanic materials
  - Centuries of manuring
  - Molllic

- **Histic**
  - Wet
  - Organic materials
  - Ochric

- **Folistic**
  - Dry
  - High OC, low BS
  - Anthropic

- **Umbric**
  - High OC, high BS
  - Plaggen

- **Anthropic**
  - Centuries of refuse disposal
Key to the Epipedons

Diagnostic Subsurface Horizons

- Not all soils have subsurface diagnostic horizons
- There are 19 diagnostic subsurface horizons
- Usually given the B horizon designation, one exception, the albic horizon, is an E horizon
- Argillic, spodic, cambic, and albic are most common in North America

Diagnostic Subsurface Horizons

- Albic horizon (albus, Latin for white)
  - Strongly leached eluvial “E” horizon
  - Leached of clays, oxides, organic C
  - Common in Spodosols
- Argillic horizon (argilla, Latin for clay)
  - Illuvial accumulation of high activity silicate clays (phylllosilicates)
  - Clay films on peds, in pores, called clay skins or cutans
  - Designated “Bt”

Diagnostic Subsurface Horizons

- Cambic horizon (cambiare, Latin for to change)
  - Weakly developed B horizon
  - Evidence of color and/or structure development
  - Designated simply as “B”
  - Given enough time and appropriate conditions, will eventually become an argillic or other type of B horizon

Diagnostic Subsurface Horizons

- Fragipan
  - Weakly cemented, dense, brittle horizon
  - Restricts movement of water and roots
  - Management problem
  - Very common in west Tennessee; > 50% of upland soils in the Loess region
  - Designated “Bx”

Diagnostic Subsurface Horizons

- Kandic horizon
  - Illuvial accumulation of low activity silicate clays
  - Kaolinite and Fe and Al oxides
  - Low CEC and nutrient holding capacity (< 16 cmol kg⁻¹ of clay)
  - Clay films not necessary
  - These are B horizons, usually refer to a “kandic Bt”
  - Common in SE USA
Diagnostic Subsurface Horizons

- Natric horizon (*natrium*, Latin for sodium)
  - Same as an argillic, except > 15% of all exchangeable cations are Na+
  - Columnar or prismatic structure
  - These are B horizons designated “Btn”
  - Common in arid and semi-arid regions with little leaching

- Oxic horizon
  - Highly weathered B horizon
  - Very high in low activity clays
  - Primarily Fe and Al oxides and some kaolinite
  - Low cation exchange capacity and nutrient holding capacity (< 16 cmol kg⁻¹ of clay)
  - < 10% weatherable primary minerals
  - Very infertile,
  - These are B horizons designated “Bo”
  - Tropical soils

Diagnostic Subsurface Horizons

- Spodic horizon (*spodos*, Greek for wood ash)
  - Illuvial accumulation of Al oxides (with or without Fe) and/or colloidal organic matter (humus)
  - These are B horizons designated “Bh”, “Bs”, or “Bhs”
    - h for humus
    - s for sesquioxides (Al and Fe oxides)
  - Typically in coarse textured soils in cool climates

Other Important Horizon Designations

- Ap
  - Indicates an A horizon that has been plowed
  - Found in most agricultural areas.

- Ab
  - Indicates a buried A horizon.
  - Common in floodplain and volcanic landscapes

Horizon Naming Conventions

- Use letters and numbers
- O, A, E, B, C, and R are the Master Horizons
- Transition horizons, e.g., AE, EB, BC, ..., dominant/subordinate
- Use lowercase letters to modify master for diagnostic horizons (Bt, Bw, Bg, Bh, Bs, Bo, Bx)
- Use numbers 1, 2, 3, … to further subdivide based on color or structural changes within (Bt1, Bt2, Bt3)
- Use numbers to indicate lithologic discontinuities (different parent materials) (Bt1, 2Bt2, 2Bt3, …)

Example: Dexter silt loam

- Soil formed in loess material: Ap, Bw, Bt1, Bt2, Bt3
- Soil formed in alluvium: 2BC1, 2BC2
- Soil formed in marine deposits: 3C
Organization of Soil Taxonomy

Example
Order: Alfisols
Suborder: Udalfs
Great group: Hapludalfs
Subgroup: Ultic Hapludalfs
Family: fine-silty, mixed, active, thermic Ultic Hapludalfs
Series: Lexington silt loam

Orders
• Most general
• Very broad, general properties
• Based on presence or absence of diagnostic horizons
• Example: Bt or Btn present, no Mollic, Oxic, or Spodic epipedon, BS > 35 % → Alfisols

Suborders
• Further defines order based on characteristics related to
  – Soil moisture
  – Soil temperature
  – Dominant chemical or textural features
• Example: Alfisol Suborders determined by soil moisture regimes, e.g., Udalfs

Great groups
• Divides suborders
• Based on differentiating horizons or soil features
• Example: Udalfs with minimum horizonation, Hapludalfs

Subgroups
• Further divides Great groups
• Always a Typic group: central concept of that Great group
• Others represent properties that may be common to other orders or to no other soils
  – e.g., Ultic Hapludalfs (tending towards and Ultisol)
Family

- Divisions gives information on
  - Texture
  - Mineralogy
  - Reactivity
  - Temperature regime
- fine-silty, mixed, active, thermic Ultic Hapludalfs

Series

- More specific properties
- All members of series have about same properties: # horizons, textural characteristics, ...
- Named for town, river, area, etc., near where first described (type location)
- e.g., Lexington SiL, fine-silty, mixed, active, thermic Ultic Hapludalfs

The 12 Soil Orders

- Permafrost within 100 cm or cryoturbation and permafrost within 200 cm
  - Yes: Gelisols (el) Orthels
  - No
- Organic soil material extending to an impermeable layer or an organic layer that is > 40 cm thick and not andic
  - Yes: Histosols (ist) Fibrists
  - No: Spodosols (od) Orthods
- Spodic horizon within 2 m of surface and not andic
  - Yes: Spodosols (od) Orthods
  - No: Andisols (and) Vertands
- Andic properties (low density, glass pumice, allophane)
  - Yes: Andisols (and) Vertands
  - No
- Oxic horizon within 150 cm
  - Yes: Oxisols (ox) Ustox
  - No
- > 30 % clay to 50 cm and shrinking & swelling properties
  - Yes: Vertisols (ert) Usterts
  - No
- Aridic moisture regime with a B horizon
  - Yes: Aridisols (id) Orthids
  - No
- Mollic epipedon, BS > 50 %
  - Yes: Mollisols (oll) Udolls
  - No
- Mollic epipedon, BS > 50 %
  - Yes: Mollisols (oll) Udolls
  - No
- Argillic, kandic, or natric; clay skins
  - Yes: Vertisols (ert) Usterts
  - No
- Some diagnostic horizon(s)
  - Yes: Inceptisols (ept) Ustepts
  - No: Entisols (ent) Orthents
- Argillic, kandic, or natric; clay skins
  - Yes: Inceptisols (ept) Ustepts
  - No: Entisols (ent) Orthents
- Some diagnostic horizon(s)
  - Yes: Entisols (ent) Orthents
  - No

What is the Order for Each?

- Typic Haplocryalf
  - Alfisol
- Typic Haplargid
  - Aridisol
- Typic Udifluvent
  - Entisol
- Terric Cryohemist
  - Histisol
What is the Order for Each?

- Typic Dystrochrept
  - Inceptisol
- Typic Hapludoll
  - Mollisol
- Typic Hapludand
  - Andisol
- Andic Hapludox
  - Oxisol

What is the Order for Each?

- Typic Haplorthod
  - Spodosol
- Umbric Kandiaquult
  - Ultisol
- Sodic Haplustert
  - Vertisol
- Andic Mollorthel
  - Gelisol

Surface layer with 5% OC, 10YR 3/2, BS = 38%

What is this?

- Umbric epipedon
- This is an acidic Mollic epipedon

B horizon with accumulation of high activity clays. What type of horizon and what designation?

- Argilllic
- Bt

Dense, brittle subsurface horizon. Relatively impermeable to roots and water. What is this and what designation?

- Fragipan
- Bx