Soil Classification
Historical Perspective

• The first documented attempt at soil classification was over 4000 years ago in China
• Between that time and the mid 1800’s, soil classification systems were based on soil suitability for various crops.
• In the late 1800’s, systems were developed in Europe that considered the soil on its own properties
• The first U.S. soil classification system was used for making soil maps beginning in 1899
  – Category I - Soil Provinces - broad physiographic regions
  – Category II - Soil Series - kind of parent rock, color, and structure
  – Category III - Soil Type - texture of whole soil which also included consistence.
• Cecil was one of the early map units
Pedologic Systems

• Dokuchaev in about 1860 developed the theory that soil was a natural body affected by parent material, climate, topography, vegetation, and time
  – Russian's developed and published a classification system based on differences in soil genesis in late 1800's and early 1900's.
• The Russian model and classification system was described in the U.S. in the early 1920's, but it was largely ignored
• A U.S. "scheme" for soil classification was presented by C.F. Marbut in 1927
  – Marbut translated the Russian system and credited most of his ideas presented in the system to the Russians.
  – This "scheme" became the U.S. soil classification system that was published in 1935
1935 U.S. System

• The 1935 classification system had six categories.
  – Category VI - solum composition - Pedocals and Pedalfers –
  – Category V - Inorganic colloids
  – Category IV - Great Soil Groups - based on genesis
  – Category III - Family groups
  – Category II - Soil Series
  – Category I - Soil type – surface horizon texture and slope range

• Marbut borrowed concept of "normal" and "abnormal" soils from Russians
  – Related back to Davis’ description of hillslope development
  – “Normal” soil was in equilibrium with landscape downwasting

• Marbut’s classification system only addressed normal soils
1938 U.S. System

• The 1938 system did away with pedalfers and pedocals and had three classes at category VI
  – Zonal soils – soils in equilibrium with the climate, vegetation, and landscape
  – Intrazonal soils – soils with properties that suggested a transition between climate zones
  – Azonal soils – soils that had properties due to factors other than zonality

• Problems with this system were
  – vague definitions
  – too much reliance on "virgin" conditions
  – overemphasis on theories of genesis
  – too little emphasis on morphology
  – exclusion of soils that were not considered "normal"
Soil Taxonomy

• In 1951, the decision was made to totally redo the U.S. system of soil classification
• Series of six "approximations" between 1952 and 1960
  – "Seventh Approximation" published for general testing
• After additional revision, adopted for use in 1965
• "Soil Taxonomy" was published in 1975
• Testing and revision have continued
  – 2 orders have been added
  – Moisture regimes have been redefined
  – Classification of most orders has been extensively revised
• A good model ultimately destroys itself in whole or in part.
Classification Background

• Any classification system has certain purposes. These include:
  – to organize knowledge
  – to deal with large numbers of objects, concepts, or ideas
  – to understand relationships among individuals
  – to permit retention of knowledge collected in the past and to enable the collection of new knowledge
  – to establish classes for a particular purpose
Definitions

• **Category**: a level of classification

• **Class (Taxon)**: a group of individuals similar in selected properties and distinguished from all other classes by these properties.

• **Differentiating characteristic**: a property chosen as the basis for grouping individuals.

• **Accessory property**: a property that is not directly part of the classification system but that is related to a differentiating characteristic.
Desirable Attributes of Any Classification System

• Differentiating characteristics should:
  • Be important to the thing being classified;
  • carry many accessory properties;
  • be an identifiable property of the things classified
  • classify all individuals in any population;
  • not separate like things in a lower category.
Desirable Attributes of Any Classification System

• System must be applied uniformly by individuals having different backgrounds and training.

• Classification system should be multi-categorical
  – limitation of human mind to comprehend more than a few things at one time.
  – enables population to be considered at different levels of generalization.

• System must be flexible and change as concepts change.

• Definitions must be operational.

• Nomenclature should be systematic and have formative elements indicative of specific categorical levels represented.
Soil Taxonomy

• Six categorical levels:
  – Order
  – Suborder
  – Great Group
  – Subgroup
  – Family
  – Series

• A soil's placement in a particular taxon depends on the presence or absence of diagnostic horizons and features

• A soil's classification offers information on processes that have been important in its development

• Taxa are defined by the soil's properties and can be interpreted in terms of expected behavior and response of the soil to use and management

• Nomenclature is indicative of the important properties of a soil if a person is familiar with the classification system.
Nomenclature

• Orders: names of orders end in "sol"

alf - Alfisol
and - Andisol
id - Aridisol
ent - Entisol
el - Gelisol
ist - Histisol

ept - Inceptisol
oll - Mollisol
ox - Oxisol
od - Spodosol
ult - Ultisol

er - Vertisol
Nomenclature

• Suborders: names of suborders have two syllables
  – First connotes something about the soil
  – Second is the formative element from the order
    • Udalf - an Alfisol with a udic moisture regime
    • Psamment - (psamm: sandy) an Entisol with a sandy particle size throughout
    • Aquult - an Ultisol with an aquic moisture regime.

• Great Groups: name consists of the suborder and a prefix that suggests something of the diagnostic properties of the soil
  – Paleudalf - (Pale: old); an old (deeply weathered) Udalf
  – Udipsamment - sandy Entisol with a udic moisture regime.
  – Plinthaquult - wet Ultisol with plinthite.
Nomenclature

- Subgroups: name consists of the great group modified by one or more adjectives
  - "Typic" - central concept of the great group
  - Other types of subgroups are:
    - Intergrades toward other great groups
      - Spodic Udipsamment is an intergrade to Spodosols,
    - Extragrades - subgroups not intergrading toward any known kind of soil
      - Lithic Udipsamment is a intergrade to not soil (hard rock within 50 cm of the soil surface)
The Soil We Classify

• The upper surface is at soil-air interface
• The lower limit is arbitrarily set at 2 m
• Buried Soils
  – A soil is considered to be buried if it is covered with a surface mantle of new soil material >50 cm thick
• Organic vs. Mineral Soil Material
  – If never saturated, mineral soil material has <20% organic C, or
  – If saturated for long periods:
    • If the soil has 0% clay, mineral soil material has <12% organic C
    • If the soil has 60% clay, mineral soil material has <18% organic C
    • At intermediate clay contents, mineral soil material has < 12 + (0.1 * % clay) % organic C
Mineral and Organic Soil Material

![Graph showing the relationship between Organic C, % and Clay, % for Organic soil material, Mucky mineral soil material, and Mineral soil material.]
Mineral or Organic Soil

- A mineral soil has mineral soil material in $> \frac{1}{2}$ the thickness of the upper 80 cm.
Diagnostic Horizons

- Classification is determined by the presence or absence of diagnostic horizons and features.
- Diagnostic horizons are similar to A, E, and B horizons, but they are not the same.
  - Diagnostic horizons have precise definitions, unlike field nomenclature.
- A diagnostic horizon can be composed of one or many soil horizons.
  - Soil with Bt1, Bt2, Bt3, and BCt horizons.
  - All of these may be part of the “argillic” horizon.
Epipedons (Surface Horizons)

- In general, all soils have an epipedon
  - The exception is if the soil surface horizon still retains its rock structure or has had no accumulation of organic matter.

- Requirements for soil materials to be a epipedon are:
  - Formed at the surface
  - It has been darkened by organic matter or has been eluviated.
  - Rock structure that may have been present has been destroyed.

- Epipedon is not a synonym for an A horizon. It may include all or part of any E and/or B horizon.
DIAGNOSTIC SURFACE HORIZONS:

*Deep, dark horizons*
- mineral soils:
  - value & chroma ≤ 3
  - ≥ 25 cm (10”) thick
- mollic ***
- umbric ***
- anthropic *
- plaggen *
- melanic *

*Organic horizons*
- histic **
- folistic *

*Light colored and/or shallow*
- ochric ***
Mollic Epipedon

- **Concept** - thick dark surface layer with high base saturation and high native fertility; highly productive agricultural soils
- **Identification**
  - Color: moist value and chroma ≤3
  - Depth: colors and other properties ≥25 cm thick (or less in some cases: can be as little as 10 cm if directly over R horizon).
  - Base saturation: must have base saturation ≥50%
  - Structure and consistence: soils with both massive structure and hard, very hard, or harder dry consistence are excluded
  - Organic C content: must have ≥0.6% organic C
  - Moisture: must be moist 3 months out of the year
  - P: must have <1,500 mg/kg (ppm) P soluble in 1% citric acid
  - N value: must have an N value <0.7
Mollic Epipedon
Mollic Epipedon

A - 0 to 18 cm; very dark grayish brown (10YR 3/2) loam; moderate fine and medium granular structure; very friable; many fine roots; slightly acid; gradual smooth boundary.

AB - 18 to 35 cm; dark brown (10YR 3/3) loam; weak fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

“Epipedon” is NOT synonymous with “A horizon”
Mollic Epipedon

A - 0 to 15 cm; very dark grayish brown (10YR 2/2) silt loam; weak fine granular structure; friable; few very fine pores; slightly acid; clear smooth boundary.

Bt1 - 15 to 29 cm; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine subangular blocky structure; friable; few thin clay films; slightly acid; clear smooth boundary.

Bt2 - 29 to 63 cm; grayish brown (7.5YR 3/3) silty clay loam; weak fine subangular blocky structure; friable; common thin clay films; neutral; gradual smooth boundary.
Accessory Properties

- 2:1 clays
- No Al or Mn toxicity to plants.
- Reserves of Ca, Mg, K, and N
- Structure favors movement of water and air in upper horizons
- Soil receives enough water to support reasonable plant growth most years.
- Almost exclusively form under grassland vegetation.

- DO NOT occur in GA due to low %BS associated with our parent materials and leaching regimes; DO occur in FL on limestone outcrops (wet areas, shallow to R)
Umbric Epipedon

• Thick, dark colored, humus-rich surface horizon or horizons
• Cannot be distinguished from a mollic epipedon by eye
• Difference between mollic and umbric epipedons is base saturation
  – Mollic epipedon has >50% base saturation in all parts
  – Umbric epipedon has <50% base saturation in some or all parts
• Accessory properties
  – Potential toxicity from aluminum
  – Commonly low in calcium, magnesium, and potassium
  – Structure facilitates the movement of moisture and air if the soil is not saturated with water
Umbric Epipedon

Found in moist, N-facing coves in Blue Ridge Mts
Umbric Epipedon

- Organic matter content indicates the soil has received enough moisture to support fair to luxuriant plant growth
- The composition and functional groups of organic matter differs between umbric and mollic epipedons
  - CEC of OM with base saturation <35% - 250-270 cmol/kg C
  - CEC on OM with base saturation >50% - 400-450 cmol/kg C
- Umbric epipedons are found in two general settings;
  - high elevations over acid parent materials and
  - poorly drained or very poorly drained soils with low base saturation
  - Both of these environments slow organic matter decomposition
- Umbric epipedon affects classification at great group and lower levels of classification (Umbraquults, Umbric Dystrudepts)
Melanic Epipedon

• Thick, dark colored (commonly black) horizon
• High concentrations of organic carbon associated with short-range-order minerals or aluminum-humus complexes
  – volcanic ash parent material
• Intense dark colors attributed to the accumulation of organic matter (humic acid)
  • Results from large amounts of root residues supplied by a gramineous vegetation
  – Secondary minerals are dominated by allophane
  – Soil material has a low bulk density and a high anion (P) adsorption capacity
Anthropic Epipedon

- Same limits as mollic epipedon in color, structure, and organic-carbon content
- Formed during long-continued use of the soil by humans
  - Place of residence (kitchen midden)
    ★ Disposal of bones and shells has supplied calcium and phosphorus (>1,500 mg/kg (ppm) P soluble in 1% citric acid)
    ★ Phosphorus in the epipedon is too high for a mollic epipedon
  - Site for growing irrigated crops
    ★ In arid regions, long-irrigated soils have an epipedon that is like the mollic epipedon
      ★ Consequence of irrigation by humans
    ★ If not irrigated, dry in all its parts for more than 9 months in normal years.

Recently discovered “terra preta” soils of Amazon basin (high charcoal)
Plaggen Epipedon

- Human-made surface layer 50 cm or more thick produced by long-term manuring.
  - Sod or other materials used for bedding livestock
  - Manure was spread on fields over long periods of cultivation
  - Mineral materials brought in by manuring produced an appreciably thickened Ap horizon
- Color and organic C content depend on the materials used for bedding
- Identified by:
  - Artifacts, diverse materials
  - Spade marks
  - Map unit delineation would tend to be straight-sided and rectangular and higher elevation than adjacent soils
  - Rare in US, fairly common in Europe (old agricultural fields)
Histic and Folistic Epipedons

• Histic
  – Organic soil material (peat or muck) >20 but ≤40 cm thick
    ★ Organic material >40 cm thick is a Histosol
    ★ Histosols do not have a histic epipedon
  – Characterized by saturation and reduction for some time in normal years

• Folistic
  – Organic soil material
  – Occurs primarily in cool, humid regions
  – Differ from histic epipedons because they are saturated with water for less than 30 days (cumulative) in normal years.
Ochric Epipedon

- Fails to meet the definitions for any of the other seven epipedons
  - Many ochric epipedons have either a Munsell value or chroma of 4 or more, or
  - have low value and chroma but are is too thin to be a mollic or umbric epipedon
  - Includes horizons of organic materials that are too thin to meet the requirements for a histic epipedon
- Includes eluvial horizons and extends to the first underlying diagnostic illuvial horizon (A + E, to top of Bt)
- If the underlying horizon is a B horizon of alteration (cambic or oxic horizon), the lower limit of the ochric epipedon is the lower boundary of the plow layer or an equivalent depth in a soil that has not been plowed.