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 on 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 cateories.
  - 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 <u>diagnostic horizons and features</u>
- 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

ert - 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.

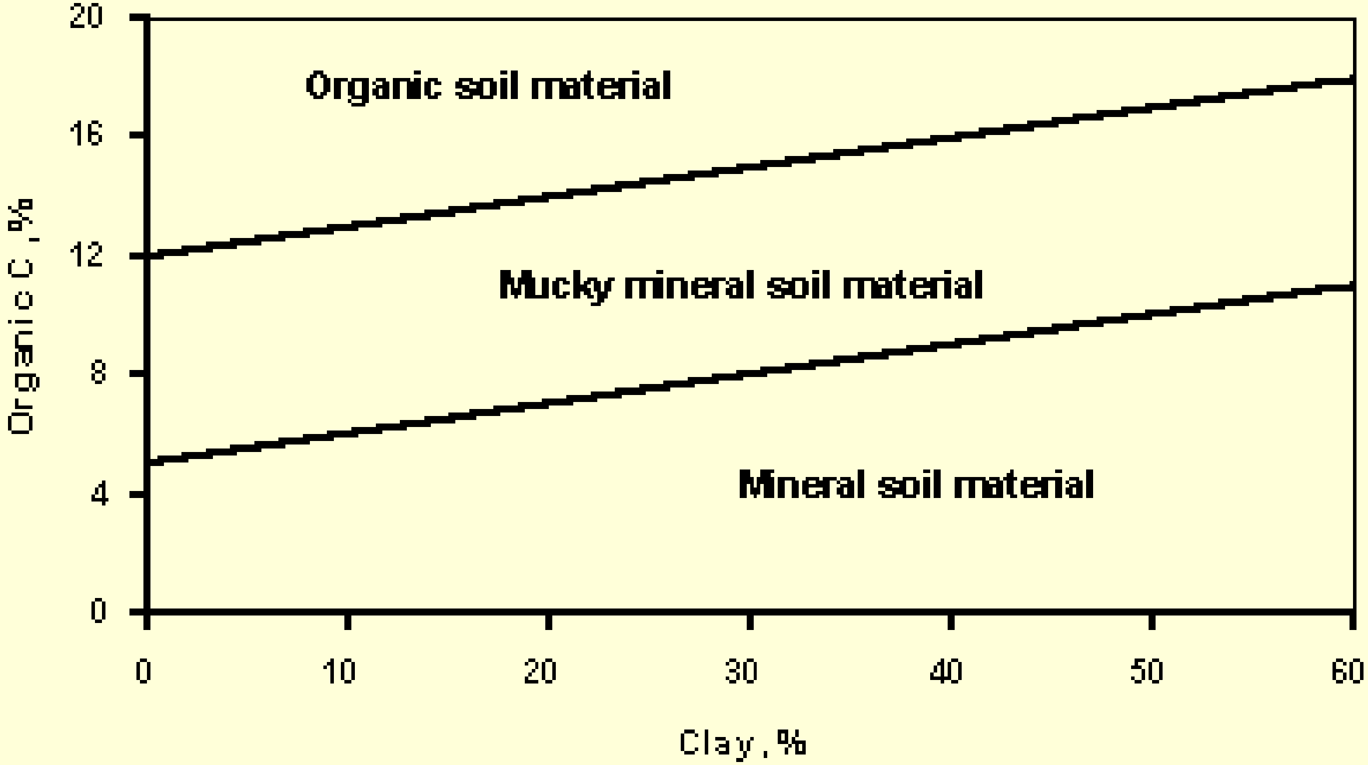
Nomenclature

- 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

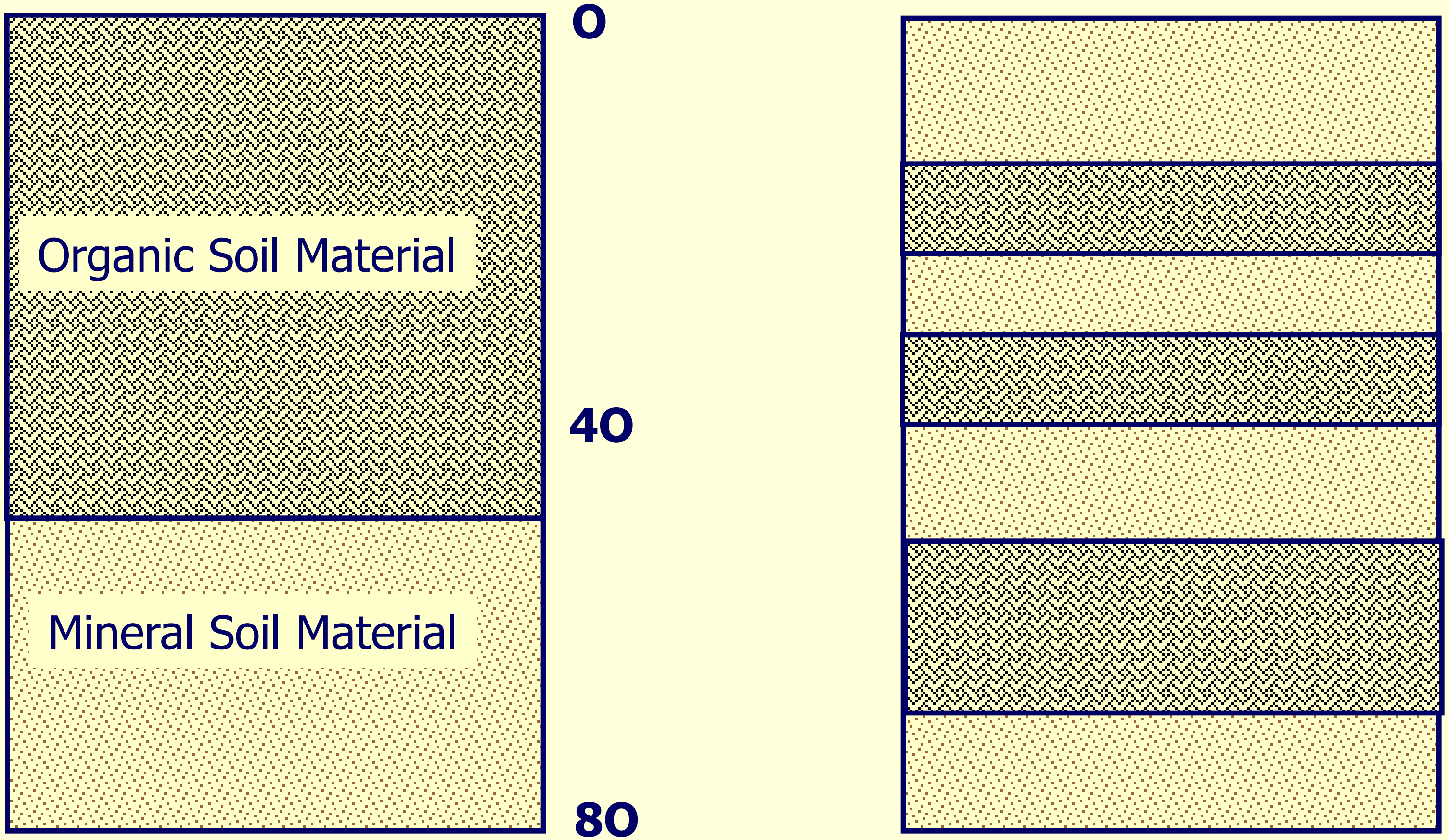
- The upper surface is at soil-air interface
- The lower limit is arbitrarily set at 2 m
- Buried Soils
  - A soil is considered to be buried if it is covered with a surface mantle of <u>new</u> soil material >50 cm thick
- Organic vs. Mineral Soil Material
  - If never saturated, mineral soil material has <20% organic C, <u>or</u>
  - 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



Mineral or Organic Soil

- A mineral soil has mineral soil material in > ½ 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	mollic	***
mineral soils:	umbric	***
value & chroma ≤ 3	anthropic	*
≥ 25 cm (10”) thick	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.