Family Criteria

- Soil families serve purposes that are largely pragmatic and to enhance interpretation ability
- Family names include and are listed as part of the classification in the following order:
  - ***Particle-size class***
  - ***Mineralogy class***
  - Cation-exchange activity class*
  - Calcareous and reaction class *
  - ***Soil temperature class***
  - Soil depth class *
  - Soil rupture resistance or consistence class *
  - Class of coatings (on sands) *
  - Class of cracks *

"Fine, kaolinitic, thermic"   "Loamy-skeletal, mixed, mesic"

Key to Particle Size Control Section:

A. For mineral soils that have a root-limiting layer within 36 cm of the mineral soil surface:

From the mineral soil to the root-limiting layer; or

B. For those Alfisols, Ultisols, and great groups of Aridisols and Mollisols that have an argillic, kandic, or natric horizon that has its **upper boundary within 100 cm of the mineral soil surface** and its lower boundary at a depth of 25 cm or more below the mineral soil surface or that are in a Grossarenic or Arenic subgroup:

Either the entire argillic, kandic, or natric horizon if 50 cm or less thick, or

the upper 50 cm of the horizon if more than 50 cm thick; or

C. For those Alfisols, Ultisols, and great groups of Aridisols and Mollisols have an argillic, kandic, or natric horizon that has its **upper boundary at a depth of 100 cm or more from the mineral surface** and that are not in a Grossarenic or Arenic subgroup:

Between 25 cm from the mineral soil surface and 100 cm below the mineral soil surface or a root-limiting layer, whichever is shallower; or

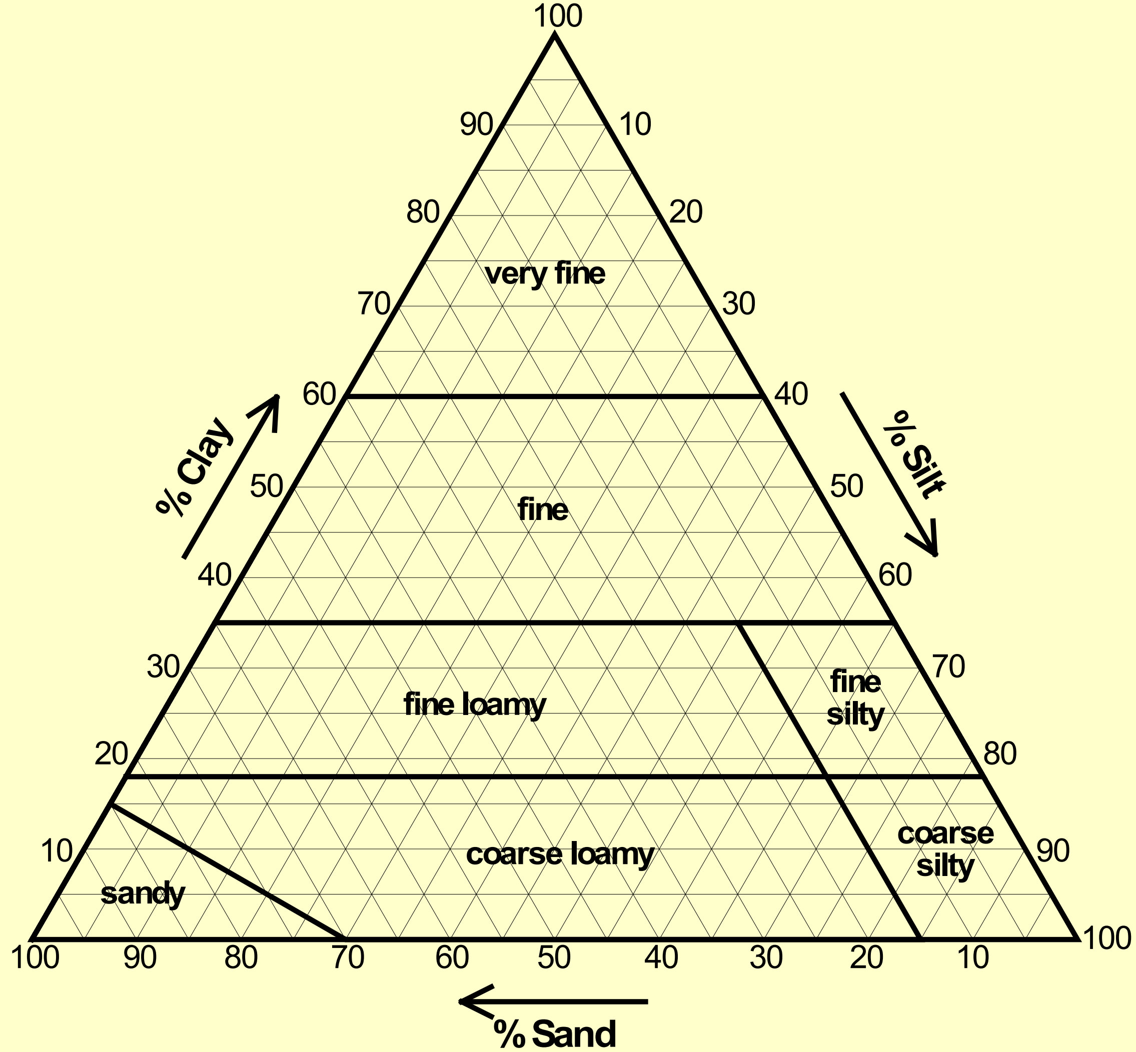
D. For other soils that have an argillic or natric horizon that has its lower boundary at a depth of less than 25 cm from the mineral soil surface:

Between the upper boundary of the argillic or natric horizon and a depth of 100 cm below the mineral soil surface or a root-limiting layer, whichever is shallower; or

E. All other mineral soils:

Between 25 cm below the mineral soil surface and either 100 cm below the mineral soil surface or a root limiting layer, whichever is shallower.

Family Particle-Size Classes



PARTICLE SIZE FAMILIES

For soils that are <50 cm to root-limiting layer, or are in a Lithic, Arenic, or Grossarenic subgroup:

<35% clay in control section: ***"loamy"***
≥35% clay in control section: ***"clayey"***

Soils that are >50 cm to a root-limiting layer use the following family names:

35-60% clay in control section: ***"fine"***
>60% clay in control section: ***"very fine"***

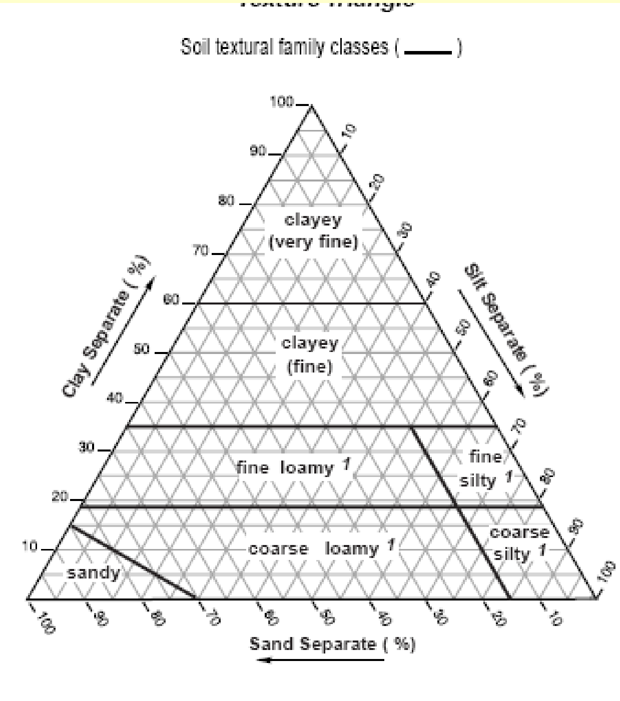
NOTE clay % for "textural classes" do NOT correspond *exactly* to this triangle….

Control sections that have >35% fragments use the following family names:

--sand or loamy sand textures***: "sandy-skeletal"***
--<35% clay: ***"loamy-skeletal"***
--≥35% clay: ***"clayey-skeletal"***

Family particle size name is NOT used with "psamments" ("sandy" family is implied)

NOTE: "Lithic" families have lithic contact at <50 cm;
"Arenic" families have 50-100 cm of sandy particle size class at surface (A+E);
"Grossarenic" have >100 cm sand at surface.



[1] Very fine sand fraction (0.05 – 0.1 mm) is treated as silt for Soil Taxonomy family groupings; coarse fragments are considered the equivalent of coarse sand in the boundary between silty and loamy classes.

Particle-Size Class

- The particle-size class is determined from the weighted average particle size within the control section.
- The weighted average is calculated by:

SUM(% fraction horizon X thickness of horizon) / control section thickness

Particle-Size Control Section

Horizon	Depth, cm	Sand, %	Clay, %
Ap	0-15	68	12
E1	15-33	72	13
E2	33-47	74	11
BE	47-62	45	25
Bt1	62-88	48	39
Bt2	88-132	53	32

Horizon	Depth, cm		Sand, %	Clay, %
Ap	0-15	15	68	12
E1	15-33	18	72	13
E2	33-47	14	74	11
BE	47-62	15	45	25
Bt1	62-88	26	48	39
Bt2	88-132	44	53	32

Weighted average clay = [(15 X 25) + (26 X 39) + (9 X 32)] / 50 = 33.5

Weighted average sand = [(15 X 45) + (26 X 48) + (9 X 53)] / 50 = 48.0

Family particle-size class is fine-loamy

Particle-Size Classes

- Three generalized particle-size classes
  - clayey - >35% clay
  - loamy - <35% clay
  - sandy – weighted average particle size is sand or loamy sand
  - used for soils in shallow families and for soils in arenic, grossarenic, lithic, and pergelic subgroups
- Other soils (fall-out key in Soil Taxonomy)
  - Fragmental - <10% fine earth material (<2mm); >90% coarse fragments
  - Sandy-skeletal - sand or loamy sand texture and 35-90% coarse fragments
  - Loamy-skeletal - <35% clay and 35-90% coarse fragments
  - Clayey-skeletal - >35% clay and 35-90% coarse fragments

Particle-Size Classes

- There are two situations in which particle-size class names are not used.
  - The name is redundant, e.g. Psamments
  - The soil is such that particle-size analysis is difficult to apply and particle-size does not adequately describe particle characteristics
    - Soils with andic properties
  - For anisols: terms used to replace particle-size classes include ashy, pumiceous, medial, hydrous, and others.
- Strongly contrasting particle-size classes:
  - If the particle size changes significantly within the control section and the transition is less than 12.5 cm, terms are used to describe the strongly contrasting particle size classes, e.g. clayey over loamy.

Mineralogy Classes

- Control section is the same as that for particle size.
- Mineralogy placement is dependent on particle-size class which determines the fraction of the soil used to determine mineralogy
- **For many soils, the mineralogy class is determined either for the whole soil (<2 mm) or for the sand and silt fractions**
- Clay mineralogy specified only for
  - Oxisols
  - Kandi and Kanhap great groups
  - Soils with fine, very-fine, clayey, or clayey-skeletal particle-size class
- Mineralogy class is determined from the key for mineralogy classes

Common Mineralogy Classes for SE Soils

- **Sandy or loamy particle-size class**
  - **Mineralogy of coarse silt and sand (0.02-2 mm)**
    - **Siliceous – >90% quartz and other resistant minerals**
    - **Mixed – other soils**
- **Fine or very-fine particle size class and kandi or kanhap great groups**
  - **Mineralogy of clay separate (<0.002 mm)**
    - **Kaolinitic – >50% kaolinite and <10% smectite**
    - **Smectitic – more smectite than any other clay mineral**
    - **Mixed – other soils**

Cation-Exchange Activity Classes

- Intended to help interpret mineralogy and nutrient retention capacity of soils in mixed and siliceous mineralogy classes
- Not used in Histosols, Oxisols, kandi and kanhap great groups, or in soils with sandy or sandy-skeletal particle size classes
- Control section same as particle-size and mineralogy
- Based on CEC (pH 7.0) to clay ratio
  - superactive - >0.60; smectite and other reactive clays
  - active - 0.40 to 0.60
  - semiactive - 0.24 to 0.40
  - subactive - <0.24; kaolinite and other low-activity clays

Calcareous and Reaction Classes

- Only used for selected taxa
- Control section - 25 to 50 cm
- Classes
  - allic – high extractable Al
  - calcareous - effervesces with HCl in all of control section
  - acid - pH <5.0 in 0.01 M CaCl2 (about 5.5 in water) throughout the control section.
  - non-acid - pH >5.0 in 0.01 M CaCl2 in some or all of the control section - not used in family name of calcareous soils.

Soil Temperature Classes

- Mean annual soil temperature estimated by adding 1° C to mean annual air temperature.
- Classes of soil temperature:
  - Pergelic - mean annual soil temperature <0° C
    - Permafrost at a shallow depth.
  - Cryic - mean annual soil temperature between 0 and 8° C and mean summer soil temperature is <15°
  - Frigid - mean annual soil temperature between 0 and 8° C (mean summer temperature >15° C is implied)
  - Mesic - mean annual soil temperature between 8 and 15° C
    - Corn and winter wheat
  - Thermic - mean annual soil temperature between 15 and 22° C
    - Cotton and yellow pine
  - Hyperthermic - mean annual soil temperature is 22° C or higher
    - Citrus
- For frigid, mesic, thermic, and hyperthermic temperature regimes; an iso prefix is used if the mean summer and mean winter soil temperature differ by less than 6° C, i.e. isofrigid, isomesic, isothermic, and isohyperthermic.
  - Designates tropical climates

Other Family Groupings

- Used to provide reasonable groupings of certain series
- Many of the characteristics are poorly understood
- Depth of soil
  - "shallow" - less than 50 cm (100 cm in Oxisols) to upper boundary of rock or root limiting horizon and not in lithic subgroup
- Rupture Resistance
  - "ortstein" and "noncemented" - used only for Spodosols.
- Classes of coatings - only used for Psamments
  - "coated" - silt + (2 X clay) > 5
  - "Uncoated" - silt + (2 X clay) < 5
- Classes of permanent cracks
  - "Cracked" is the only class
  - Used only in Fluvaquents and Humaquepts

Series

- Lowest category in Soil Taxonomy
  - More than 19,000 series in the United States
- Purpose is mainly pragmatic
  - Closely related to interpretations
- Differentiae used for series are the same as those used for classes in other categories
  - Series properties cannot range across limits of classes in higher categories
    - Cecil must be a fine, kaolinitic, thermic Typic Kanhapludult
    - Rion must be a fine-loamy, siliceous, themic Typic Kanhapludult
    - Cataula must be a fine, kaolinitic, themic Oxyaquic Kanhapludult
  - Many families only have one series

Greater Restriction within a Family

- Fine, kaolinitic, thermic Typic Kanhapludults
  - Cecil – Bt horizon has hue of 2.5YR or redder
  - Appling – Bt horizon has hue of 5YR or yellower
- fine-loamy, siliceous, thermic Plinthic Kandiudults
  - Tifton – common Fe stone in upper Bt
  - Dothan – no Fe stone in upper Bt
- Distinctions within a family are restrictions in the range of one or more properties of the family
  - Only those differences that serve to distinguish one series from another are included in statements of series differences

3 Tests of Series Differentiae

- Properties serving as differentiae can be observed or can be inferred with reasonable assurance
- Differentiae must create soil series having a unique range of properties
  - Difference among series should be greater than normal errors made by qualified pedologists
- Differentiae must reflect a property of the soils
  - Can be reflected in the nature or degree of expression of one or more horizons.
    - Can be almost any horizon or soil property
  - May also be
    - Landscape property
    - Commonly associated soils
    - Climate
  - We may not be as smart as we think

Phase

- Properties that may influence certain but not all uses of a soil
  - Slope
  - Stoniness
  - Aspect
  - “Wind swept”
- Not a part of Soil Taxonomy
- Utilitarian classification that can be superimposed at any categorical level to permit more precise interpretations for soil use

Competing Series Statement - Cecil

- These are the Appling, Bethlehem, Madison, Nankin, Pacolet, Tumbleton, and Wedowee series in the same family
- Those in closely related families are the Aragon, Braddock, Cataula, Chestatee, Cullen, Georgeville, Hayesville, Herndon, Hulett, Kolomoki, Lloyd, Mayodan, Mecklenburg, Spotsylvania, Tatum and Wedowee 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
- Aragon soils contain fragments of chert, and have a cherty limestone C horizon.
- Bethlehem soils are moderately deep to weathered bedrock of sillimanite schist, phyllite schist, or mica schist.
- Braddock and Hayesville soils are mesic
- Cataula soils have a fragipan, Chestatee soils contain more than 15 percent, by volume, of coarse fragments throughout the pedon . . . .

Piedmont Series Key

- Upper 50 cm of Bt horizon has >35% clay
  - Bt horizon has hue of 5YR or redder
    - Upper part of Bt horizon has common mica flakes - Madison
    - Bottom of Bt horizon with more than 35% clay is 45 to 75 cm below the surface – Pacolet
    - Bottom of Bt horizon with more than 35% clay is more than 75 cm below the surface – Cecil

PEDON 1:

- moisture control section is dry for 30 cumulative days per year
- aquic conditions and 10YR 6/2 redox depletions begin at 155 cm and continue to 2 m.
- redox concentrations begin at 135 cm and continue to 2 m.
- clay content for 20 to 35 cm depth = 5%; texture is fine sand
- clay content for 35 to 85 cm depth = 11%; texture is loamy fine sand
- clay content for 85 to 115 cm depth = 10%; texture is loamy fine sand
- clay content for 115 to 165 cm depth = 6%; texture is fine sand
- clay content for 165 to 200 cm depth = 5%; texture is fine sand
- base saturation in ochric epipedon = 45%
- base saturation at 180 cm from soil surface = 25%
- CEC (pH 7) for 35 to 85 cm depth = 3.3 cmol/kg soil
- CEC (pH 7) for 85 to 115 cm depth = 2.9 cmol/kg soil
- CEC (pH 7) for 115 to 165 cm depth = 2.0 cmol/kg soil
- CEC (pH 7) for 165 to 200 cm depth = 2.0 cmol/kg soil

Depth cm		% Clay & Texture	CEC Cmol/kg	% BS	
0-20	Ochric			45	
20-35	Albic	5 fine sand			
35-85		11 loamy fine sand	3.3		
85-115		10 loamy fine sand	2.9		
115-165		6 fine sand	2.0		
165-200		5 fine sand	2.0	25	

- If this soil is an Ultisol, classify it to the great group level.
- If this soil is not an Ultisol, what is its order?
- What are the upper and lower boundaries of the particle-size control section?
- What is the family particle-size class?

Theoretical soil order development pathways

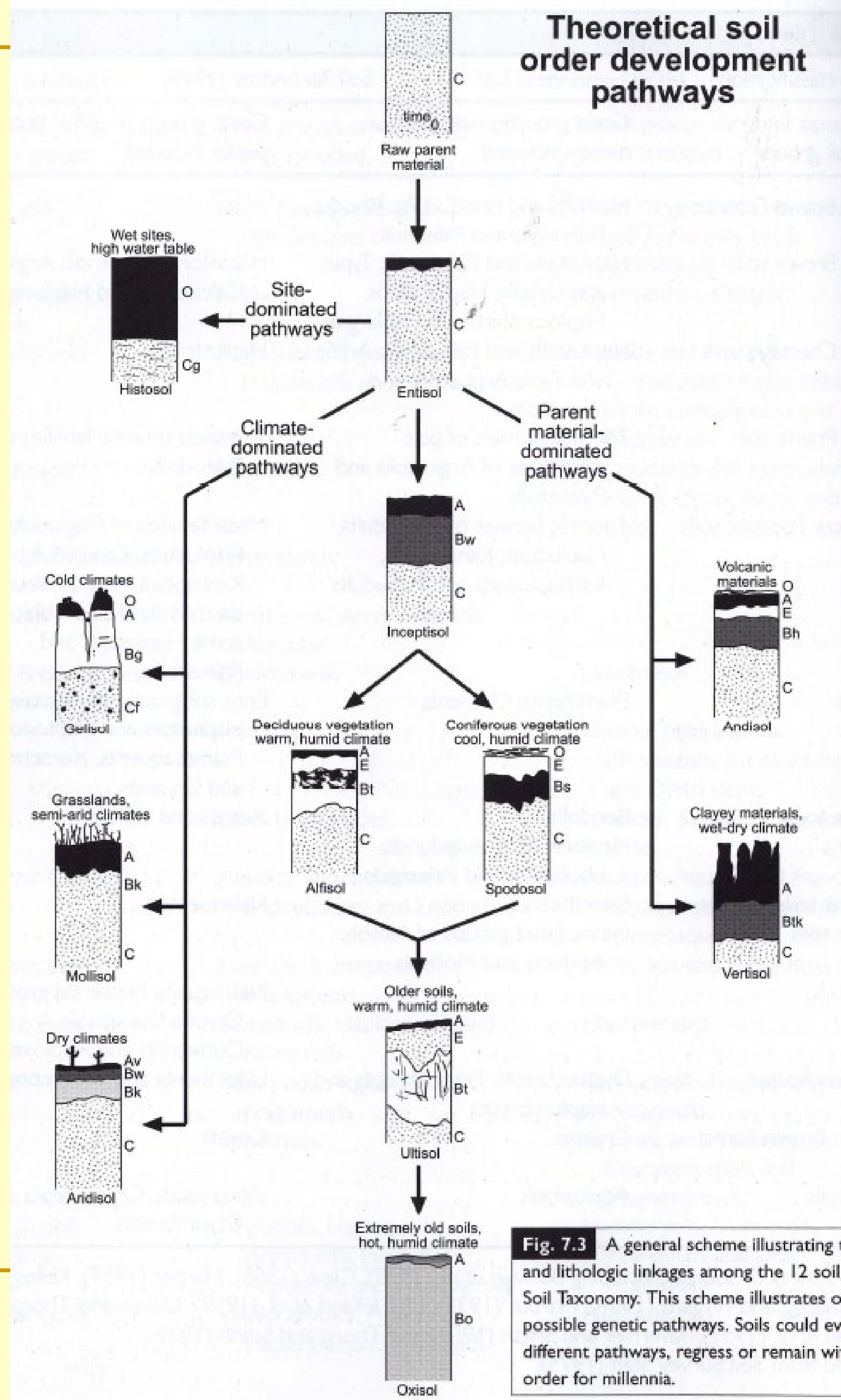


Fig. 7.3 A general scheme illustrating t
and lithologic linkages among the 12 soil
Soil Taxonomy. This scheme illustrates or
possible genetic pathways. Soils could evo
different pathways, regress or remain wit
order for millennia.