SIMPLIFIED DEFINITIONS OF DIAGNOSTIC HORIZONS AND CHARACTERISTICS USED WITH SOIL TAXONOMY (13th Ed.)

These materials are based on the Keys but are simplified explanations and with examples for soil judging contestants to use. If these versions produce different answers than the Keys, both will be considered correct.

Assumptions:

1. Dry value is 1 color chip higher than the moist value.
2. Dry chroma and moist chroma are the same.

DIAGNOSTIC SURFACE HORIZONS (EPIPEDONS)

1. When *rock structure* (fine stratification of layers 5 mm or thinner) derived from highly weathered formerly consolidated bedrock) makes up 50% or more of the volume of a layer that occurs within 18 cm of the soil surface OR starts at the base of an Ap at less than 25 cm, there is no epipedon and ***None*** should be marked on the scorecard.

2. **Mollic Epipedon** – Thick, dark-colored soil surface layer with high organic carbon content and base saturation.

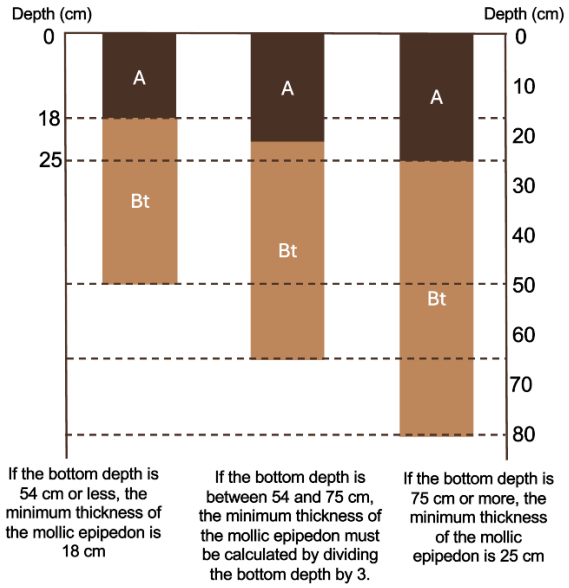
   Mixed upper 18 cm rule: If the surface layer is < 18 cm thick, mix (average) the properties in the upper 18 cm of the profile. Average moist color is assumed to be 3/3 or darker if at least 12 cm of value 3 or less and chroma 2 or less occur over a layer with value 3 and chroma 4 or less, or if 15 cm or more of value 3 or less and chroma 3 or less occur over a layer with either value or chroma 3 or less. Base saturation and OC% are taken as weighted averages.

   A. Sum the layers (including any mixed upper 18 cm layer, if that is done) that meet all of the following:

      1) Moist color 3/3 or darker (value $\leqslant$ 3 and chroma $\leqslant$ 3); AND
      2) Base saturation 50% or more; AND
      3) Organic carbon content 0.6% or more.

   B. The cumulative thickness of the layers that meet all of part A. must be either:

      1. 25 cm IF the texture throughout the upper 25 cm is loamy sand or coarser/sandier; OR
      2. One of the following if any texture in the upper 25 cm is finer than loamy



sand:

a. 25 cm; OR
b. 10 cm IF the layers that meet all of part A. extend from the surface to a bedrock (R or Cr) layer; OR
c. 18 to 25 cm IF the bottom of the argillic or cambic horizon or the depth to secondary $CaCO_3$ is between 54 and 75 cm and the cumulative thickness is 1/3 or more of the shallowest of those depths; OR
d. 18 cm IF none of the diagnostic horizons or characteristics in 2.b. or 2.c. occur.

Examples of how to calculate minimum thickness of the mollic epipedon in soils with an argillic horizon:

	EX 1	EX 2	EX 3	EX 4	EX 5	EX 6
Thickness of dark, high OC, high B.S.	<18 cm, fails color after mixing	18 cm after mixing	18 cm after mixing	18 cm	22 cm	28 cm
Base of argillic or cambic	None occurs	None occurs	50 cm	66 cm	66 cm	≥ 75 cm
Top of secondary $CaCO_3$	None, or > 75 cm	None, or > 75 cm	None, or > 50 cm	≤ 36 cm	None, or > 66 cm	≥ 75 cm
Mollic?	No	Yes	Yes 18 > 50/3	Yes 18 < 66/3 but 18 ≥ 36/3	Yes 22 ≥ 66/3	Yes 28 ≥ 25 and ≥ 75/3

3. **Umbric epipedon** – Thick, dark-colored soil surface layer with high organic carbon and low base saturation. It meets all other requirements of a mollic epipedon, except the base saturation is less than 50% in some part.
4. **Ochric Epipedon –** An epipedon that does not meet the requirements for mollic and umbric epipedons.

DIAGNOSTIC SUBSURFACE HORIZONS

A. Argillic – subsurface layer(s) (usually Bt or BCt) with illuvial clay coatings or bridges and a relative clay content increase with depth. Requirements of included layers:

1. Evidence of clay illuviation (Clay coatings OR Clay bridging between sand grains) AND
2. An increase in clay content relative to the eluvial layer above with lowest clay content (this is waived if there is a lithologic discontinuity at the top of the illuvial layer or an Ap layer directly above the illuvial layer)

Clay content of eluvial layer	Clay increase needed	Example
Less than 15%	+ 3%	10% to 13%
15 to 40%	1.2x	20% to 24%
40% or more	+ 8%	45% to 53%

3. Minimum thickness of 7.5 cm, or 15 cm if texture is sand or loamy sand.

B. Cambic – weakly developed subsurface layer(s) (usually BA, Bw, BC or strongly gleyed equivalent such as BAg, Bg, BCg)
Requirements of included layers:

1. Finer textured than sand or loamy sand (very fine sand and loamy very fine sand are okay)

1. Has soil structure in 50% or more of the volume
2. Has some additional development:
   a) Higher chroma, higher value, redder hue, or higher clay content than the underlying layer or an overlying layer
   b) OR Chroma of 2 or less and redox concentrations
   c) OR hue (N), value of 3 or less and chroma of 0

   d) OR value of 4 or more and chroma of 1 or less on any hue
3. Not part of any epipedon or other diagnostic horizon
4. 15 cm minimum thickness of combined layers

C. None – None of the above diagnostic horizons.

DIAGNOSTIC CHARACTERISTICS

A. Anthraquic conditions – Aquic conditions (see below) caused by human-controlled
flooding of a field for agricultural purposes and all of the following:

1. Episaturation (reductimorphic features in the upper layers of the soil and one or
more layers beneath that without reductimorphic features); AND
2. A tilled surface layer and a directly underlying a slowly permeable layer that has a matrix chroma 2 or less and oximorphic features; AND
3. A subsurface layer immediately below the slowly permeable layer with either:
   a. Reductimorphic features with a color value of 4 or more and chroma of 2 or less (in macropores); OR
   b. Oximorphic features of Mn or Fe; OR
   c. 2 times or more the amount of iron (extractable by dithionite-citrate) than is
   contained in the tilled surface layer.

B. Aquic conditions – Prolonged saturation, reduction and removal of Fe or Mn oxides produces visible reductimorphic and oximorphic features. Reductimorphic features or strong gleying (layers with “g” in the name) indicate that aquic conditions have taken place. There is no subordinate letter associated with aquic conditions unless strong gleying has taken place. Oximorphic features by themselves are not proof of aquic conditions.

C. Densic contact - The boundary or contact between soil that is dense and root-limiting (fine and very fine roots cannot penetrate through or between

aggregates (if any occur) except at average spacing of 10 cm or more) and soil that does not have that combination of properties. Dense layers below the contact do not qualify for any diagnostic horizons and contain "*d*" (e.g., Cd).

D. Free carbonates – The layer is calcareous in some part, whether due to pedogenesis or inherited from the parent material. There is no subordinate letter associated with free carbonates.

E. Lithic Contact - The boundary or contact between soil and an underlying strongly-cemented R bedrock layer that is continuous across the no-pick zone.

F. Lithologic Discontinuity - A lithologic discontinuity is a significant change in morphology that indicates that the described soil genetic layers have formed in two or more deposits that are significantly different physically or mineralogically or in age. Examples:

1. Abrupt textural differences between adjacent layers not due to pedogenesis (clay eluviation/illuviation) such as when the compared adjacent horizons have similar amounts of clay coatings (if any). Example comparisons between adjacent layers:
   a. The textural class in one layer ends in *sand* and the adjacent layer has a textural class that is *sandy clay loam*, *loam*, *silt loam*, or finer; OR
   b. The textural class in one layer with clay content of 8% or more begins with *sandy* and the adjacent layer textural class begins with *silt* or *silty*; OR
   c. The clay content differs by more than 25% (absolute difference); OR
   d. One layer is overbank alluvium with 5% or less rock fragments and the adjacent underlying layer is a gravel bar deposit (absolute differences of 50% or more rock fragments are typical).
2. Contrasting dominant sand sizes – Adjacent layers change from dominantly fine or very fine sand to dominantly coarse or very coarse sand.
3. Bedrock lithology – Rock fragments in adjacent layers change from one bedrock type to another not commonly associated (e.g., shale fragments over granite).
4. Stone lines – A layer of concentrated gravel representing a former erosional surface lag deposit separates two deposits (e.g., colluvium over residuum).
5. Inverse distribution of rock fragments – The upper layer contains 5% or more rocks and the one below does not contain any.
6. Rock fragment weathering rinds – Rocks in the upper layer contains no

weathering rinds and the one below does.

7. Shape of rock fragments - The upper horizon contains almost all angular or sharp-edged rocks and almost all the rocks in the one below are well rounded, or vice-versa.
8. Soil color – Changes in soil color not associated with strong gleying or illuvial secondary mineral accumulation. For example, the matrix color in the overlying layer is two or more hues different in the adjacent underlying layer (10YR over 2.5YR or 2.5YR over 7.5YR).

G. Paralithic Contact - The boundary or contact between soil and paralithic materials where the paralithic materials have no cracks or the spacing of cracks that roots can enter is 10 cm or more. Paralithic materials are weakly- to moderately-cemented bedrock materials and are designated as *Cr* horizons.

H. Secondary carbonates – Calcium carbonate that has been precipitated in place from the soil solution rather than inherited from a soil parent material, such as a calcareous loess or limestone residuum. Layer names contain *k* or *kk*.

I. Slickensides - polished and grooved surfaces with dimensions usually exceeding 5 cm produced when one soil mass slides past another following differential wetting of materials containing significant amounts of expansive clays. Layer names include *ss*.

J. None - None of the diagnostic characteristics listed above are found in the described soil.

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Rules applied to this contest:

1) Dry value is 1 color chip higher than the moist value.
2) Dry chroma and moist chroma are the same.
3) If a layer has reductimorphic features, aquic conditions are assumed to be present even if the soil has been artificially drained to remove the saturation.
4) The percent of resistant minerals in the 0.02 to 2.0 mm fraction must be provided by the contest host on the pitcard if it is important to ST classification.

5) Ap2 layers in soils with human-controlled flooding are assumed to be slowly permeable in this contest.

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1. **Before using the keys (Step 2 and 3 below), determine if there is a buried soil.**

   Note: Not all buried layers with “b” in the name qualify as buried soils. C and R layers do not allow “b” in the name.

   Buried soil - Is there a layer with “b” in the name at 50 cm or more below the mineral soil surface and immediately beneath is a layer that does not qualify as part of any diagnostic horizons?

   Y – The buried layer and below is a buried soil and the layers above the buried soil are a mantle. If the mantle is 50 cm or more thick, then classify only the mantle and ignore the buried soil layers at the order level.

   N – Consider all diagnostic horizons, characteristics and properties in the profile for classification.

   Note: All diagnostic horizons and characteristics of the whole profile must be marked on the scoresheet regardless if there is a buried soil or not.

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2. **KEY TO THE SOIL ORDERS**

   A) Does the soil have all of the following:

      (1) A layer 25 cm or more thick, within 100 cm of the mineral soil surface, that
      has *either* slickensides *or* wedge-shaped aggregates; AND

      (2) Weighted average of 30 percent or more clay between the mineral soil surface and a depth of 18 cm or in an Ap layer, whichever is thicker, AND

      (3) 30 percent or more clay in all layers between a depth of 18 cm and 50 cm; AND

(4) Cracks that open and close periodically (as indicated on the pitcard) **Vertisols**

B) Does the soil have a mollic epipedon and does the base saturation remain at 50% or above throughout? **Mollisols**

C) Does this soil have an argillic horizon? **Alfisols**

D) Does the soil have a mollic or umbric epipedon or a cambic horizon that starts within 100 cm? **Inceptisols**

E) All other soils **Entisols**

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3. KEY TO SUBORDERS, GREAT GROUPS, AND SUBGROUPS

* **Anthraquic** subgroups are used provisionally in this contest

A) **Vertisols** – Have within 50 cm of the mineral soil surface, both:

(1) Aquic conditions; AND

(2) 50% or more volume of either:

a. Chroma 2 or less if oximorphic features are present; OR

b. Chroma 1 or less?

Y – **Aquerts** - Are there reductimorphic features in layers above but not in or below a lower layer with relatively low hydraulic conductivity?

Y – **Epiaquerts**

a) Have, between either an Ap layer or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, matrix colors as follows:

i. Hue of 2.5Y or redder and color value of 5 or less and chroma of 2 or more; OR

ii. Chroma of 2 or more and no oximorphic features; OR **Aeric**

b) Have, within 30 cm of the mineral soil surface, color value of 4 or more; OR **Chromic**

c) All others **Typic**

N – **Endoaquerts**

a) Have, between either an Ap layer or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, matrix colors as follows:
   i. Hue of 2.5Y or redder and color value of 5 or less and chroma of 2 or more; OR
   ii. Chroma of 2 or more and no oximorphic features; OR **Aeric**

b) Within 30 cm of the mineral soil surface, color value of 4 or more; OR **Chromic**

c) All others **Typic**

N – **Uderts**

All are Hapluderts

1. Have aquic conditions within 100 cm of the mineral soil surface; OR **Aquic**
2. Have, within 30 cm of the mineral soil surface, a layer with matrix colors as follows:
   a) Value of 4 or more; OR
   b) Chroma of 3 or more; OR **Chromic**
3. All others **Typic**

B) **Mollisols** – The soil has all of the following:

(1) Reductimorphic features starting within the upper 40 cm; AND

(2) Either one of these:

a. The lower part of the mollic epipedon has chroma 1 or 2 with oximorphic features that are easily seen with contrasting colors; OR
b. The layer immediately below the mollic is strongly gleyed layer (has “g” in name and value 4 or more, chroma 2 or less)

Y - **Aquolls**. Is there an argillic horizon?

Y – **Argiaquolls**

a) A linear extensibility of 6.0 cm or more between the mineral soil surface and a depth of 100 cm ; OR **Vertic**

b) Have anthraquic conditions; OR **Anthraquic***

c) All others **Typic**

N - Are there reductimorphic features in layers above but not in or below a lower layer with relatively low hydraulic conductivity?

Y – **Epiaquolls**

i. A linear extensibility of 6.0 cm or more between the mineral soil surface and 100 cm; OR **Vertic**

ii. Have anthraquic conditions; OR **Anthraquic***

iii. All others **Typic**

N - **Endoaquolls** (saturation from the bottom of the profile to the upper boundary of saturation)

i. A linear extensibility of 6.0 cm or more between the mineral soil surface and 100 cm; OR **Vertic**

ii. Have anthraquic conditions; OR **Anthraquic***

iii. All others **Typic**

N – **Udolls** - Is there both:

All are **Hapludolls**

1. A linear extensibility of 6.0 cm or more between the mineral soil surface and a depth of 100 cm; OR **Vertic**
2. Have aquic conditions *either*:
   a) Within 40 cm of the mineral soil surface; OR
   b) Within 75 cm of the mineral soil surface, in layers with a total thickness of 15 cm or more that have *one or more* of the following:
      i. Color value of 4 or more and reductimorphic features with chroma of 2 or less; OR
      ii. Hue of 10YR or redder and chroma of 2 or less; OR **Aquic**
3. All others **Typic**

C) **Alfisols** - Are there both:

(1) A gleyed layer (has “g” in layer name and color value 4 or more, chroma 2 or less) within the upper 12.5 cm of the argillic horizon; AND

(2) Reductimorphic and/or oximorphic features in all layers between the bottom
of the Ap (or 25 cm if the Ap is thinner) and 40 cm?

Y – **Aqualfs** - Are there reductimorphic features in layers above but not in or
below a lower layer with relatively low hydraulic conductivity?

Y – **Epiaqualfs**

1. Have, between the A or Ap layer and a depth of 75 cm below the mineral soil surface, in 50 % or more of the matrix, *either*:
   i. Both a color value of 3 or more and chroma of 3 or more; OR
   ii. Chroma of 2 or more and no oximorphic features; OR **Aeric**
2. All others **Typic**

N - **Endoaqualfs** (saturation from the bottom of the profile to the upper boundary of saturation)

1. Have, between the A or Ap layer and a depth of 75 cm below the mineral soil surface, matrix color with *either*:
   i. Both a color value of 3 or more and chroma of 3 or more; OR
   ii. Chroma of 2 or more and no oximorphic features; OR **Aeric**
2. All others **Typic**

N – **Udalfs**

All are Hapludalfs

a) Have a lithic contact within 50 cm of the mineral soil surface; OR **Lithic**

b) Have both:
   i. Color value of 3 or less either throughout the upper 18 cm of the mineral soil (unmixed) or between the mineral soil surface and a depth of 18 cm after mixing to 18 cm; AND
   ii. Reductimorphic features with chroma of 2 or less and aquic conditions
   EITHER:

(A) Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; OR

(B) Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface; OR **Aquollic**

iii. Have aquic conditions EITHER:

(A) Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *OR*

(B) Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface; OR **Aquic**

c) All others **Typic**

D) **Inceptisols** - Does the soil have both:

(1) Reductimorphic features between 40 and 50 cm of the mineral soil surface, AND

(2) A strongly gleyed layer (has "g" in the name and color value 4 or more, chroma 2 or less) within 50 cm of the mineral soil surface?

Y – **Aquepts** - Are there reductimorphic features in layers above but not in or below a layer with relatively low hydraulic conductivity?

Y – **Epiaquepts**

1. Have anthraquic conditions; OR **Anthraquic***
2. Have, between the A or Ap layer and a depth of 75 cm below the mineral soil surface, hue of 10YR or yellower and EITHER:
   a) Both a color value and chroma of 3 or more; OR
   b) Chroma of 2 or more if there are no oximorphic features; OR **Aeric**
3. All others **Typic**

N - **Endoaquepts** (saturation from the bottom of the profile to the upper boundary of saturation)

1. Have anthraquic conditions; OR **Anthraquic***

2. Have, between the A or Ap layer and a depth of 75 cm below the mineral soil surface, hue of 10YR or yellower and *EITHER*:
   a) Both a color value and chroma of 3 or more; OR
   b) Chroma of 2 or more if there are no oximorphic features; OR **Aeric**
3. All others **Typic**

N – **Udepts**

All are Eutrudepts

a. Have a lithic contact within 50 cm of the mineral soil surface; OR **Lithic**
b. Have, within 60 cm of the mineral soil surface, reductimorphic features with chroma of 2 or less; OR **Aquic**
c. All others **Typic**

E) **Entisols** - Does the soil have both:

(1) Reductimorphic features between 40 and 50 cm of the mineral soil surface, AND

(2) A gleyed layer (has “g” in the name and color value 4 or more, chroma 2 or less) within 50 cm of the mineral soil surface

Y – **Aquents** - Does the soil have either:

a. An irregular decrease in OC% between 25 and 125 cm, OR
b. OC content more than 0.2% at 125 cm?

Y – **Fluvaquents**

1. Have, between either the Ap layer or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, matrix colors as follows:
   a) Color value of 5 or less, and chroma of 2 or more; OR
   b) Chroma of 2 or more and no oximorphic features; OR **Aeric**
2. All others **Typic**

N - Are there reductimorphic features in layers above but not in or below a lower layer with relatively low hydraulic conductivity?

Y – **Epiaquents**

a) Have, between either the Ap layer or a depth of 25 cm from
the mineral soil surface, whichever is deeper, and a depth of
75 cm, matrix colors as follows:
i. Hue of 2.5Y or redder, a color value of 5 or less, and chroma of 2 or more; OR
ii. Chroma of 2 or more if there are no oximorphic features; OR **Aeric**

b) All others **Typic**

N - **Endoaquents** (saturation from the bottom of the profile to the
upper boundary of saturation)

a) Have, between either the Ap layer or a depth of 25 cm from
the mineral soil surface, whichever is deeper, and a depth of
75 cm, matrix colors as follows:
i. Hue of 2.5Y or redder, a color value of 5 or less, and chroma of 2 or more; OR
ii. Chroma of 2 or more and no oximorphic features; OR **Aeric**

b) All others **Typic**

N - Does the soil between 25 and 100 have both:

a. Less than 35% (by volume) rock fragments, AND
b. Texture class of loamy fine sand or coarser in all layers (sandy loam lamellae are permitted)

Y – **Psamments**

All are Udipsamments

1. Have, within 100 cm of the mineral soil surface, reductimorphic features with chroma of 2 or less; OR **Aquic**
2. All others **Typic**

N - Does the soil have either:

1. An irregular decrease in OC% between 25 and 125 cm, OR
2. Organic carbon content more than 0.2% at 125 cm?

Y – **Fluvents**

All are Udifluvents

a) Have within 50 cm of the mineral soil surface, aquic conditions; OR **Aquic**

b) All others **Typic**

N - **Orthents**

All are Udorthents

a) Have a densic contact due to mechanical compaction within 100 cm of the soil surface; OR **Anthrodensic**

b) Have 50 cm or more of human-transported material; OR **Anthroportic**

c) Have aquic conditions within 100 cm of the mineral soil surface; OR **Aquic**

d) All others **Typic**