

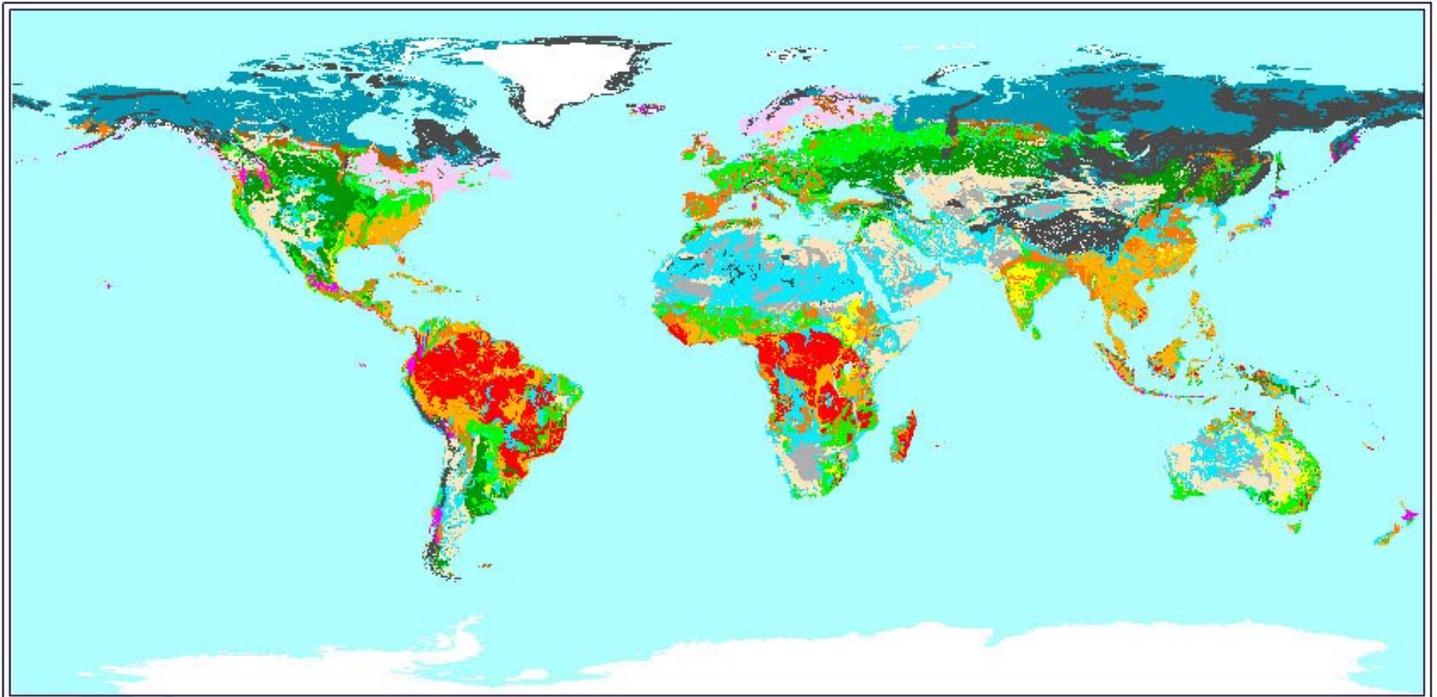


United States Department of Agriculture
Natural Resources Conservation Service



Keys to Soil Taxonomy

Eighth Edition, 1998



Alfisols	Gelisols	Oxisols	Ice/glacier
Andisols	Histosols	Spodosols	Ocean/water
Aridisols	Inceptisols	Ultisols	Rocky land
Entisols	Mollisols	Vertisols	Shifting sand

Keys to Soil Taxonomy

By Soil Survey Staff

United States Department of Agriculture
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Table of Contents

Foreword	7
Chapter 1: The Soils That We Classify	9
Chapter 2: Differentiae for Mineral Soils and Organic Soils	11
Chapter 3: Horizons and Characteristics Diagnostic for the Higher Categories	13
Chapter 4: Identification of the Taxonomic Class of a Soil	37
Chapter 5: Alfisols	41
Chapter 6: Andisols	83
Chapter 7: Aridisols	103
Chapter 8: Entisols	129
Chapter 9: Gelisols	149
Chapter 10: Histosols	159
Chapter 11: Inceptisols	165
Chapter 12: Mollisols	191
Chapter 13: Oxisols	233
Chapter 14: Spodosols	249
Chapter 15: Ultisols	259
Chapter 16: Vertisols	281
Chapter 17: Family and Series Differentiae and Names	295
Chapter 18: Designations for Horizons and Layers	311
Appendix	317
Index	319

Foreword

The publication *Keys to Soil Taxonomy* serves two purposes. It provides the taxonomic keys necessary for the classification of soils in a form that can be used easily in the field. It also acquaints users of the taxonomic system with recent changes in the classification of soils. This volume includes all revisions of the keys that so far have been approved, replacing the original keys in *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys* (1975), the work on which this and other abridged versions, the first of which was published in 1983, are based. We plan to continue issuing updated editions of the *Keys to Soil Taxonomy* as changes warrant new editions. Plans are under way to publish an updated version of *Soil Taxonomy* in its entirety in 1999.

This publication incorporates all amendments approved to date and published in the National Soil Taxonomy Handbook (NSTH) Issues 1-18. It includes the recommendations of the International Committee on Low Activity Clays (NSTH Issue 8), the International Committee on Oxisols (NSTH Issue 11), the International Committee on Andisols (NSTH Issue 13), the International Committee on Vertisols (NSTH Issue 16), the International Committee on Aquic Moisture Regime (NSTH Issue 16), the International Committee on Spodosols (NSTH Issue 16), the International Committee on Aridisols (NSTH Issue 17), and the International Committee on Families (NSTH Issue 18). Editorial changes have been made throughout the *Keys to Soil Taxonomy* to correct grammatical errors and clarify the intent of the criteria.

The keys reproduced here were extracted from a computerized copy of *Soil Taxonomy*, which is maintained in complete, up-to-date form.

The authors of the *Keys to Soil Taxonomy* are identified as the "Soil Survey Staff." This term is meant to include all of the soil classifiers in the National Cooperative Soil Survey program and in the international community who have made significant contributions to the improvement of the taxonomic system.

Horace Smith
Director, Soil Survey Division
Natural Resources Conservation Service
1998

CHAPTER 1

The Soils That We Classify

The word “soil,” like many common words, has several meanings. In its traditional meaning, soil is the natural medium for the growth of land plants, whether or not it has discernible soil horizons. This meaning is still the common understanding of the word, and the greatest interest in soil is centered on this meaning. People consider soil important because it supports plants that supply food, fibers, drugs, and other wants of humans and because it filters water and recycles wastes. Soil covers the earth’s surface as a continuum, except on bare rock, in areas of perpetual frost or deep water, or on the bare ice of glaciers. In this sense, soil has a thickness that is determined by the rooting depth of plants.

Soil in this text is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter *or* the ability to support rooted plants in a natural environment. This definition is expanded from the 1975 version of *Soil Taxonomy* to include soils in areas of Antarctica where pedogenesis occurs but where the climate is too harsh to support the higher plant forms.

The upper limit of soil is the boundary between soil and air, shallow water, live plants, or plant materials that have not begun to decompose. Areas are not considered to have soil if the surface is permanently covered by water too deep (typically more than 2.5 m) for the growth of rooted plants. The horizontal boundaries of soil are areas where the soil grades to deep water, barren areas, rock, or ice. In some places the separation between soil and nonsoil is so gradual that clear distinctions cannot be made.

The lower boundary that separates soil from the nonsoil underneath is most difficult to define. Soil consists of the horizons near the earth’s surface that, in contrast to the underlying parent material, have been altered by the interactions of climate, relief, and living organisms over time. Commonly, soil grades at its lower boundary to hard rock or to earthy materials virtually devoid of animals, roots, or other marks of biological activity. The lowest depth of biological activity, however, is difficult to discern and is often gradual. For purposes of classification, the lower boundary of soil is

arbitrarily set at 200 cm. In soils where either biological activity or current pedogenic processes extend to depths greater than 200 cm, the lower limit of the soil for classification purposes is still 200 cm. In some instances the more weakly cemented bedrocks (paralithic materials, defined later) have been described and used to differentiate soil series (series control section, defined later), even though the paralithic materials below a paralithic contact are not considered soil in the true sense. In areas where soil has thin cemented horizons that are impermeable to roots, the soil extends as deep as the deepest cemented horizon, but not below 200 cm. For certain management goals, layers deeper than the lower boundary of the soil that is classified (200 cm) must also be described if they affect the content and movement of water and air or other interpretative concerns.

In the humid tropics, earthy materials may extend to a depth of many meters with no obvious changes below the upper 1 or 2 m, except for an occasional stone line. In many wet soils, gleyed soil material may begin a few centimeters below the surface and, in some areas, continue down for several meters apparently unchanged with increasing depth. The latter condition can arise through the gradual filling of a wet basin in which the A horizon is gradually added to the surface and becomes gleyed beneath. Finally, the A horizon rests on a thick mass of gleyed material that may be relatively uniform. In both of these situations, there is no alternative but to set the lower limit of soil at the arbitrary limit of 200 cm.

Soil, as defined in this text, does not need to have discernible horizons, although the presence or absence of horizons and their nature are of extreme importance in soil classification. Plants can be grown under glass in pots filled with earthy materials, such as peat or sand, or even in water. Under proper conditions all these media are productive for plants, but they are nonsoil here in the sense that they cannot be classified in the same system that is used for the soils of a survey area, county, or even nation. Plants even grow on trees, but trees are regarded as nonsoil.

Soil has many properties that fluctuate with the seasons. It may be alternately cold and warm or dry and moist. Biological activity is slowed or stopped if the soil becomes too cold or too dry. The soil receives flushes of organic matter when leaves fall or grasses die. Soil is not static. The pH, soluble salts, amount

of organic matter and carbon-nitrogen ratio, numbers of micro-organisms, soil fauna, temperature, and moisture all change with the seasons as well as with more extended periods of time. Soil must be viewed from both the short-term and long-term perspective.

Buried Soils

A buried soil is covered with a surface mantle of new soil material that either is 50 cm or more thick or is 30 to 50 cm thick and has a thickness that equals at least half the total thickness of the named diagnostic horizons that are preserved in the buried soil. A surface mantle of new material that does not have the required thickness for buried soils can be used to

establish a phase of the mantled soil or even another soil series if the mantle affects the use of the soil.

Any horizons or layers underlying a plaggan epipedon are considered to be buried.

A surface mantle of new material, as defined here, is largely unaltered, at least in the lower part. It may have a diagnostic surface horizon (epipedon) and/or a cambic horizon, but it has no other diagnostic subsurface horizons, all defined later. However, there remains a layer 7.5 cm or more thick that fails the requirements for all diagnostic horizons, as defined later, overlying a horizon sequence that can be clearly identified as the solum of a buried soil in at least half of each pedon. The recognition of a surface mantle should not be based only on studies of associated soils.

CHAPTER 2

Differentiae for Mineral Soils¹ and Organic Soils

Soil taxonomy differentiates between mineral soils and organic soils. To do this, first, it is necessary to distinguish mineral soil material from organic soil material. Second, it is necessary to define the minimum part of a soil that should be mineral if a soil is to be classified as a mineral soil and the minimum part that should be organic if the soil is to be classified as an organic soil.

Nearly all soils contain more than traces of both mineral and organic components in some horizons, but most soils are dominantly one or the other. The horizons that are less than about 20 to 35 percent organic matter, by weight, have properties that are more nearly those of mineral than of organic soils. Even with this separation, the volume of organic matter at the upper limit exceeds that of the mineral material in the fine-earth fraction.

Mineral Soil Material

Mineral soil material (less than 2.0 mm in diameter) *either*:

1. Is saturated with water for less than 30 days (cumulative) per year in normal years and contains less than 20 percent (by weight) organic carbon; *or*
2. Is saturated with water for 30 days or more cumulative in normal years (or is artificially drained) and, excluding live roots, has an organic carbon content (by weight) of:
 - a. Less than 18 percent if the mineral fraction contains 60 percent or more clay; *or*
 - b. Less than 12 percent if the mineral fraction contains no clay; *or*
 - c. Less than 12 + (clay percentage multiplied by 0.1) percent if the mineral fraction contains less than 60 percent clay.

Organic Soil Material

Soil material that contains more than the amounts of organic carbon described above for mineral soil material is considered organic soil material.

In the definition of mineral soil material above, material that has more organic carbon than in item 1 is intended to

include what has been called litter or an O horizon. Material that has more organic carbon than in item 2 has been called peat or muck. Not all organic soil material accumulates in or under water. Leaf litter may rest on a lithic contact and support forest vegetation. The soil in this situation is organic only in the sense that the mineral fraction is appreciably less than half the weight and is only a small percentage of the volume of the soil.

Distinction Between Mineral Soils and Organic Soils

Most soils are dominantly mineral material, but many mineral soils have horizons of organic material. For simplicity in writing definitions of taxa, a distinction between what is meant by a mineral soil and an organic soil is useful. To apply the definitions of many taxa, one must first decide whether the soil is mineral or organic. An exception is the Andisols (defined later). These generally are considered to consist of mineral soils, but some may be organic if they meet other criteria for Andisols. Those that exceed the organic carbon limit defined for mineral soils have a colloidal fraction dominated by short-range-order minerals or aluminum-humus complexes. The mineral fraction in these soils is believed to give more control to the soil properties than the organic fraction. Therefore, the soils are included with the Andisols rather than the organic soils defined later as Histosols.

If a soil has both organic and mineral horizons, the relative thickness of the organic and mineral soil materials must be considered. At some point one must decide that the mineral horizons are more important. This point is arbitrary and depends in part on the nature of the materials. A thick layer of sphagnum has a very low bulk density and contains less organic matter than a thinner layer of well-decomposed muck. It is much easier to measure the thickness of layers in the field than it is to determine tons of organic matter per hectare. The definition of a mineral soil, therefore, is based on the thickness of the horizons, or layers, but the limits of thickness must vary with the kinds of materials. The definition that follows is intended to classify as mineral soils those that have both thick mineral soil layers and no more organic material than the amount permitted in the histic epipedon, which is defined in chapter 3.

In the determination of whether a soil is organic or mineral, the thickness of horizons is measured from the surface of the

¹ Mineral soils include all soils except the suborder Histels and the order Histosols.

soil whether that is the surface of a mineral or an organic horizon, unless the soil is buried as defined in chapter 1. Thus, any O horizon at the surface is considered an organic horizon if it meets the requirements of organic soil material as defined later, and its thickness is added to that of any other organic horizons to determine the total thickness of organic soil materials.

Definition of Mineral Soils

Mineral soils are soils that have *either* of the following:

1. Mineral soil materials that meet *one or more* of the following:
 - a. Overlie cindery, fragmental, or pumiceous materials and/or have voids² that are filled with 10 percent or less organic materials *and* directly below these materials have either a densic, lithic, or paralithic contact; *or*
 - b. When added with underlying cindery, fragmental, or pumiceous materials, total more than 10 cm between the soil surface and a depth of 50 cm; *or*
 - c. Constitute more than one-third of the total thickness of the soil to a densic, lithic, or paralithic contact or have a total thickness of more than 10 cm; *or*
 - d. If they are saturated with water for 30 days or more per year in normal years (or are artificially drained) and have organic materials with an upper boundary within 40 cm of the soil surface, have a total thickness of *either*:
 - (1) Less than 60 cm if three-fourths or more of their volume consists of moss fibers or if their bulk density, moist, is less than 0.1 g/cm³; *or*
 - (2) Less than 40 cm if they consist either of sapric or hemic materials, or of fibric materials with less than three-fourths (by volume) moss fibers and a bulk density, moist, of 0.1 g/cm³ or more; *or*
2. More than 20 percent, by volume, mineral soil materials from the soil surface to a depth of 50 cm or to a glacic layer or a densic, lithic, or paralithic contact, whichever is shallowest; *and*

² Materials that meet the definition of cindery, fragmental, or pumiceous but have more than 10 percent, by volume, voids that are filled with organic soil materials are considered to be organic soil materials.

- a. Permafrost within 100 cm of the soil surface; *or*
- b. Gelic materials within 100 cm of the soil surface and permafrost within 200 cm of the soil surface.

Definition of Organic Soils

Organic soils have organic soil materials that:

1. Do not have andic soil properties in 60 percent or more of the thickness between the soil surface and either a depth of 60 cm or a densic, lithic, or paralithic contact or duripan if shallower; *and*
2. Meet *one or more* of the following:
 - a. Overlie cindery, fragmental, or pumiceous materials and/or fill their interstices² *and* directly below these materials have a densic, lithic, or paralithic contact; *or*
 - b. When added with the underlying cindery, fragmental, or pumiceous materials, total 40 cm or more between the soil surface and a depth of 50 cm; *or*
 - c. Constitute two-thirds or more of the total thickness of the soil to a densic, lithic, or paralithic contact *and* have no mineral horizons or have mineral horizons with a total thickness of 10 cm or less; *or*
 - d. Are saturated with water for 30 days or more per year in normal years (or are artificially drained), have an upper boundary within 40 cm of the soil surface, and have a total thickness of *either*:
 - (1) 60 cm or more if three-fourths or more of their volume consists of moss fibers or if their bulk density, moist, is less than 0.1 g/cm³; *or*
 - (2) 40 cm or more if they consist either of sapric or hemic materials, or of fibric materials with less than three-fourths (by volume) moss fibers and a bulk density, moist, of 0.1 g/cm³ or more; *or*
 - e. Are 80 percent or more, by volume, from the soil surface to a depth of 50 cm or to a glacic layer or a densic, lithic, or paralithic contact, whichever is shallowest.

It is a general rule that a soil is classified as an organic soil (Histosol) if more than half of the upper 80 cm (32 in) of the soil is organic or if organic soil material of any thickness rests on rock or on fragmental material having interstices filled with organic materials.

CHAPTER 3

Horizons and Characteristics Diagnostic for the Higher Categories

This chapter defines the horizons and characteristics of both mineral and organic soils. It is divided into three parts—horizons and characteristics diagnostic for mineral soils, characteristics diagnostic for organic soils, and horizons and characteristics diagnostic for both mineral and organic soils.

The horizons and characteristics defined below are not in a key format. Some diagnostic horizons are mutually exclusive, and some are not. An umbric epipedon, for example, could not also be a mollic epipedon. A kandic horizon with clay films, however, could also meet the definition of an argillic horizon.

Horizons and Characteristics Diagnostic for Mineral Soils

The criteria for some of the following horizons and characteristics, such as histic and folistic epipedons, can be met in organic soils. They are diagnostic, however, only for the mineral soils.

Diagnostic Surface Horizons: The Epipedon

The epipedon (Gr. *epi*, over, upon, and *pedon*, soil) is a horizon that forms at or near the surface and in which most of the rock structure has been destroyed. It is darkened by organic matter or shows evidence of eluviation, or both. Rock structure as used here and in other places in this taxonomy includes fine stratification (less than 5 mm) in unconsolidated sediments (eolian, alluvial, lacustrine, or marine) and saprolite derived from consolidated rocks in which the unweathered minerals and pseudomorphs of weathered minerals retain their relative positions to each other.

Any horizon may be at the surface of a truncated soil. The following section, however, is concerned with eight diagnostic horizons that have formed at or near the soil surface. These horizons can be covered by a surface mantle of new soil material. If the surface mantle has rock structure, the top of the epipedon is considered the soil surface unless the mantle meets the definition of buried soils in chapter 1. If the soil includes a buried soil, the epipedon, if any, is at the soil surface and the epipedon of the buried soil is considered a buried epipedon and is not considered in selecting taxa unless the keys specifically indicate buried horizons, such as those in Thapto-Histic

subgroups. A soil with a mantle thick enough to have a buried soil has no epipedon if the soil has rock structure to the surface or has an Ap horizon less than 25 cm thick that is underlain by soil material with rock structure. The melanic epipedon (defined below) is unique among epipedons. It forms commonly in volcanic deposits and can receive fresh deposits of ash. Therefore, this horizon is permitted to have layers within and above the epipedon that are not part of the melanic epipedon.

A recent alluvial or eolian deposit that retains stratifications (5 mm or less thick) or an Ap horizon directly underlain by such stratified material is not included in the concept of the epipedon because time has not been sufficient for soil-forming processes to erase these transient marks of deposition and for diagnostic and accessory properties to develop.

An epipedon is not the same as an A horizon. It may include part or all of an illuvial B horizon if the darkening by organic matter extends from the soil surface into or through the B horizon.

Anthropic Epipedon

Required Characteristics

The anthropic epipedon shows some evidence of disturbance by human activity and meets all of the requirements for a mollic epipedon, except for *one or both* of the following:

- 1,500 milligrams per kilogram or more P_2O_5 soluble in 1 percent citric acid and a regular decrease in P_2O_5 to a depth of 125 cm; *or*
- If the soil is not irrigated, all parts of the epipedon are dry for 9 months or more in normal years.

Folistic Epipedon

Required Characteristics

The folistic epipedon is defined as a layer (one or more horizons) that is saturated for less than 30 days (cumulative) in normal years (and is not artificially drained) and *either*:

- Consists of organic soil material that:
 - Is 20 cm or more thick and either contains 75 percent or more (by volume) *Sphagnum* fibers or has a bulk density, moist, of less than 0.1; *or*

- b. Is 15 cm or more thick; *or*
- 2. Is an Ap horizon that, when mixed to a depth of 25 cm, has an organic-carbon content (by weight) of:
 - a. 16 percent or more if the mineral fraction contains 60 percent or more clay; *or*
 - b. 8 percent or more if the mineral fraction contains no clay; *or*
 - c. $8 + (\text{clay percentage divided by } 7.5)$ percent or more if the mineral fraction contains less than 60 percent clay.

Most folic epipedons consist of organic soil material (defined in chapter 2). Item 2 provides for a folic epipedon that is an Ap horizon consisting of mineral soil material.

Histic Epipedon

Required Characteristics

The histic epipedon is a layer (one or more horizons) that is characterized by saturation (for 30 days or more, cumulative) and reduction for some time during normal years (or is artificially drained) and *either*:

1. Consists of organic soil material that:
 - a. Is 20 to 60 cm thick and either contains 75 percent or more (by volume) *Sphagnum* fibers or has a bulk density, moist, of less than 0.1; *or*
 - b. Is 20 to 40 cm thick; *or*
2. Is an Ap horizon that, when mixed to a depth of 25 cm, has an organic-carbon content (by weight) of:
 - a. 16 percent or more if the mineral fraction contains 60 percent or more clay; *or*
 - b. 8 percent or more if the mineral fraction contains no clay; *or*
 - c. $8 + (\text{clay percentage divided by } 7.5)$ percent or more if the mineral fraction contains less than 60 percent clay.

Most histic epipedons consist of organic soil material (defined in chapter 2). Item 2 provides for a histic epipedon that is an Ap horizon consisting of mineral soil material. A histic epipedon consisting of mineral soil material can also be part of a mollic or umbric epipedon.

Melanic Epipedon

Required Characteristics

The melanic epipedon has *both* of the following:

1. An upper boundary at, or within 30 cm of, either the mineral soil surface or the upper boundary of an organic layer

with andic soil properties (defined below), whichever is shallower; *and*

2. In layers with a cumulative thickness of 30 cm or more within a total thickness of 40 cm, *all* of the following:
 - a. Andic soil properties throughout; *and*
 - b. A color value, moist, and chroma (Munsell designations) of 2 or less throughout and a melanic index of 1.70 or less throughout; *and*
 - c. 6 percent or more organic carbon as a weighted average and 4 percent or more organic carbon in all layers.

Mollic Epipedon

Required Characteristics

The mollic epipedon consists of mineral soil materials and has the following properties:

1. When dry, *either or both*:
 - a. Structural units with a diameter of 30 cm or less or secondary structure with a diameter of 30 cm or less; *or*
 - b. A moderately hard or softer rupture-resistance class; *and*
2. Rock structure, including fine (less than 5 mm) stratifications, in less than one-half of the volume of all parts; *and*
3. *One* of the following:
 - a. *All* of the following:
 - (1) Colors with a value of 3 or less, moist, and of 5 or less, dry; *and*
 - (2) Colors with chroma of 3 or less, moist; *and*
 - (3) If the soil has a C horizon, the mollic epipedon has a color value at least 1 Munsell unit lower or chroma at least 2 units lower (both moist and dry) than that of the C horizon or the epipedon has at least 0.6 percent more organic carbon than the C horizon; *or*
 - b. A fine-earth fraction that has a calcium carbonate equivalent of 15 to 40 percent and colors with a value and chroma of 3 or less, moist; *or*
 - c. A fine-earth fraction that has a calcium carbonate equivalent of 40 percent or more and a color value, moist, of 5 or less; *and*
4. A base saturation (by NH_4OAc) of 50 percent or more; *and*
5. An organic-carbon content of:
 - a. 2.5 percent or more if the epipedon has a color value, moist, of 4 or 5; *or*

- b. 0.6 percent more than that of the C horizon (if one occurs) if the mollic epipedon has a color value less than 1 Munsell unit lower or chroma less than 2 units lower (both moist and dry) than the C horizon; *or*
- c. 0.6 percent or more; *and*
6. After mixing of the upper 18 cm of the mineral soil or of the whole mineral soil if its depth to a densic, lithic, or paralithic contact, petrocalcic horizon, or duripan (all defined below) is less than 18 cm, the minimum thickness of the epipedon is as follows:
- a. 10 cm or the depth of the noncemented soil if the epipedon is loamy very fine sand or finer and is directly above a densic, lithic, or paralithic contact, a petrocalcic horizon, or a duripan that is within 18 cm of the mineral soil surface; *or*
- b. 25 cm or more if the epipedon is loamy fine sand or coarser throughout or if there are no underlying diagnostic horizons (defined below) and the organic-carbon content of the underlying materials decreases irregularly with increasing depth; *or*
- c. 25 cm or more if *all* of the following are 75 cm or more below the mineral soil surface:
- (1) The upper boundary of any pedogenic lime that is present as filaments, soft coatings, or soft nodules; *and*
 - (2) The lower boundary of any argillic, cambic, natric, oxic, or spodic horizon (defined below); *and*
 - (3) The upper boundary of any petrocalcic horizon, duripan, or fragipan; *or*
- d. 18 cm if the epipedon is loamy very fine sand or finer in some part and one-third or more of the total thickness between the top of the epipedon and the shallowest of any features listed in item 6-c is less than 75 cm below the mineral soil surface; *or*
- e. 18 cm or more if none of the above conditions apply; *and*
7. Phosphate:
- a. Content less than 1,500 milligrams per kilogram soluble in 1 percent citric acid; *or*
- b. Content decreasing irregularly with increasing depth below the epipedon; *or*
- c. Nodules are within the epipedon; *and*
8. Some part of the epipedon is moist for 90 days or more (cumulative) in normal years during times when the soil temperature at a depth of 50 cm is 5 °C or higher, if the soil is not irrigated; *and*
9. The *n* value (defined below) is less than 0.7.

Ochric Epipedon

The ochric epipedon fails to meet the definitions for any of the other seven epipedons because it is too thin or too dry, has too high a color value or chroma, contains too little organic carbon, has too high an *n* value or melanic index, or is both massive and hard or harder when dry. Many ochric epipedons have either a Munsell color value of 4 or more, moist, and 6 or more, dry, or chroma of 4 or more, or they include an A or Ap horizon that has both low color values and low chroma but is too thin to be recognized as a mollic or umbric epipedon (and has less than 15 percent calcium carbonate equivalent in the fine-earth fraction). Ochric epipedons also include horizons of organic materials that are too thin to meet the requirements for a histic or folistic epipedon.

The ochric epipedon includes eluvial horizons that are at or near the soil surface, and it extends to the first underlying diagnostic illuvial horizon (defined below as an argillic, kandic, natric, or spodic horizon). If the underlying horizon is a B horizon of alteration (defined below as a cambic or oxic horizon) and there is no surface horizon that is appreciably darkened by humus, the lower limit of the ochric epipedon is the lower boundary of the plow layer or an equivalent depth (18 cm) in a soil that has not been plowed. Actually, the same horizon in an unplowed soil may be both part of the epipedon and part of the cambic horizon; the ochric epipedon and the subsurface diagnostic horizons are not all mutually exclusive. The ochric epipedon does not have rock structure and does not include finely stratified fresh sediments, nor can it be an Ap horizon directly overlying such deposits.

Plaggen Epipedon

The plaggen epipedon is a human-made surface layer 50 cm or more thick that has been produced by long-continued manuring.

A plaggen epipedon can be identified by several means. Commonly, it contains artifacts, such as bits of brick and pottery, throughout its depth. There may be chunks of diverse materials, such as black sand and light gray sand, as large as the size held by a spade. The plaggen epipedon normally shows spade marks throughout its depth and also remnants of thin stratified beds of sand that were probably produced on the soil surface by beating rains and were later buried by spading. A map unit delineation of soils with plaggen epipedons would tend to have straight-sided rectangular bodies that are higher than the adjacent soils by as much as or more than the thickness of the plaggen epipedon.

Umbric Epipedon

Required Characteristics

The umbric epipedon consists of mineral soil materials and has the following properties:

1. When dry, *either or both*:
 - a. Structural units with a diameter of 30 cm or less or secondary structure with a diameter of 30 cm or less; *or*
 - b. A moderately hard or softer rupture-resistance class; *and*
2. All of the following:
 - a. Colors with a value of 3 or less, moist, and of 5 or less, dry; *and*
 - b. Colors with chroma of 3 or less; *and*
 - c. If the soil has a C horizon, the umbric epipedon has a color value at least 1 Munsell unit lower or chroma at least 2 units lower (both moist and dry) than that of the C horizon or the epipedon has at least 0.6 percent more organic carbon than that of the C horizon; *and*
3. A base saturation (by NH_4OAc) of less than 50 percent in some or all parts; *and*
4. An organic-carbon content of:
 - a. 0.6 percent more than that of the C horizon (if one occurs) if the umbric epipedon has a color value less than 1 Munsell unit lower or chroma less than 2 units lower (both moist and dry) than the C horizon; *or*
 - b. 0.6 percent or more; *and*
5. After mixing of the upper 18 cm of the mineral soil or of the whole mineral soil if its depth to a densic, lithic, or paralithic contact or a duripan (all defined below) is less than 18 cm, the minimum thickness of the epipedon is as follows:
 - a. 10 cm or the depth of the noncemented soil if the epipedon is loamy very fine sand or finer and is directly above a densic, lithic, or paralithic contact or a duripan that is within 18 cm of the mineral soil surface; *or*
 - b. 25 cm or more if the epipedon is loamy fine sand or coarser throughout or if there are no underlying diagnostic horizons (defined below) and the organic-carbon content of the underlying materials decreases irregularly with increasing depth; *or*
 - c. 25 cm or more if the lower boundary of any argillic, cambic, natric, oxic, or spodic horizon (defined below) is 75 cm or more below the mineral soil surface; *or*
 - d. 18 cm if the epipedon is loamy very fine sand or finer in some part and one-third or more of the total thickness between the top of the epipedon and the shallowest of any features listed in item 5-c is less than 75 cm below the mineral soil surface; *or*
 - e. 18 cm or more if none of the above conditions apply; *and*
6. Phosphate:
 - a. Content less than 1,500 milligrams per kilogram soluble in 1 percent citric acid; *or*
 - b. Content decreasing irregularly with increasing depth below the epipedon; *or*
 - c. Nodules are within the epipedon; *and*
7. Some part of the epipedon is moist for 90 days or more (cumulative) in normal years during times when the soil temperature at a depth of 50 cm is 5 °C or higher, if the soil is not irrigated; *and*
8. The *n* value (defined below) is less than 0.7; *and*
9. The umbric epipedon does not have the artifacts, spade marks, and raised surfaces that are characteristic of the plaggen epipedon.

Diagnostic Subsurface Horizons

The horizons described in this section form below the surface of the soil, although in some areas they form directly below a layer of leaf litter. They may be exposed at the surface by truncation of the soil. Some of these horizons are generally regarded as B horizons, some are considered B horizons by many but not all pedologists, and others are generally regarded as parts of the A horizon.

Agric Horizon

The agric horizon is an illuvial horizon that has formed under cultivation and contains significant amounts of illuvial silt, clay, and humus.

Required Characteristics

The agric horizon is directly below an Ap horizon and has the following properties:

1. A thickness of 10 cm or more and *either*:
 - a. 5 percent or more (by volume) wormholes, including coatings that are 2 mm or more thick and have a value, moist, of 4 or less and chroma of 2 or less; *or*
 - b. 5 percent or more (by volume) lamellae that have a thickness of 5 mm or more and have a value, moist, of 4 or less and chroma of 2 or less.

Albic Horizon

The albic horizon is an eluvial horizon, 1.0 cm or more thick, that has 85 percent or more (by volume) albic materials (defined below). It generally occurs below an A horizon but may be at the mineral soil surface. Under the albic horizon there generally is an argillic, cambic, kandic, natric, or spodic

horizon or a fragipan (defined below). The albic horizon may lie between a spodic horizon and either a fragipan or an argillic horizon, or it may be between an argillic or kandic horizon and a fragipan. It may lie between a mollic epipedon and an argillic or natric horizon or between a cambic horizon and an argillic, kandic, or natric horizon or a fragipan. The albic horizon may separate horizons that, if they were together, would meet the requirements for a mollic epipedon. It may separate lamellae that together meet the requirements for an argillic horizon. These lamellae are not considered to be part of the albic horizon.

Argillic Horizon

An argillic horizon is normally a subsurface horizon with a significantly higher percentage of phyllosilicate clay than the overlying soil material. It shows evidence of clay illuviation. The argillic horizon forms below the soil surface, but it may be exposed at the surface later by erosion.

Required Characteristics

1. All argillic horizons must meet *both* of the following requirements:
 - a. *One* of the following:
 - (1) If the argillic horizon is coarse-loamy, fine-loamy, coarse-silty, fine-silty, fine, or very-fine or is loamy or clayey, including skeletal counterparts, it must be at least 7.5 cm thick or at least one-tenth as thick as the sum of the thickness of all overlying horizons, whichever is greater. For example, if the eluvial and illuvial horizons together are more than 150 cm thick, then the argillic horizon must be 15 cm or more thick; *or*
 - (2) If the argillic horizon is sandy or sandy-skeletal, it must be at least 15 cm thick; *or*
 - (3) If the argillic horizon is composed entirely of lamellae, the combined thickness of the lamellae that are 0.5 cm or more thick must be 15 cm or more; *and*
 - b. Evidence of clay illuviation in at least *one* of the following forms:
 - (1) Oriented clay bridging the sand grains; *or*
 - (2) Clay films lining pores; *or*
 - (3) Clay films on both vertical and horizontal surfaces of peds; *or*
 - (4) Thin sections with oriented clay bodies that are more than 1 percent of the section; *or*
 - (5) If the coefficient of linear extensibility is 0.04 or higher and the soil has distinct wet and dry seasons, then

the ratio of fine clay to total clay in the illuvial horizon is greater by 1.2 times or more than the ratio in the eluvial horizon; *and*

2. If an eluvial horizon remains and there is no lithologic discontinuity between it and the illuvial horizon and no plow layer directly above the illuvial layer, then the illuvial horizon must contain more total clay than the eluvial horizon within a vertical distance of 30 cm or less, as follows:
 - a. If any part of the eluvial horizon has less than 15 percent total clay in the fine-earth fraction, the argillic horizon must contain at least 3 percent (absolute) more clay (10 percent versus 13 percent, for example); *or*
 - b. If the eluvial horizon has 15 to 40 percent total clay in the fine-earth fraction, the argillic horizon must have at least 1.2 times more clay than the eluvial horizon; *or*
 - c. If the eluvial horizon has 40 percent or more total clay in the fine-earth fraction, the argillic horizon must contain at least 8 percent (absolute) more clay (42 percent versus 50 percent, for example).

Calcic Horizon

The calcic horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to a significant extent.

Required Characteristics

The calcic horizon has *all* of the following properties:

1. Is 15 cm or more thick; *and*
2. Is not indurated or cemented to such a degree that it meets the requirements for a petrocalcic horizon; *and*
3. Has *one or more* of the following:
 - a. 15 percent or more CaCO₃ equivalent (see below), and its CaCO₃ equivalent is 5 percent or more (absolute) higher than that of an underlying horizon; *or*
 - b. 15 percent or more CaCO₃ equivalent and 5 percent or more (by volume) identifiable secondary carbonates; *or*
 - c. 5 percent or more calcium carbonate equivalent and has:
 - (1) Less than 18 percent clay in the fine-earth fraction; *and*
 - (2) A sandy, sandy-skeletal, coarse-loamy, or loamy-skeletal particle-size class; *and*
 - (3) 5 percent or more (by volume) identifiable secondary carbonates or a calcium carbonate equivalent

(by weight) that is 5 percent or more (absolute) higher than that of an underlying horizon.

Cambic Horizon

A cambic horizon is the result of physical alterations, chemical transformations, or removals or of a combination of two or more of these processes.

Required Characteristics

The cambic horizon is an altered horizon 15 cm or more thick. If it is composed of lamellae, the combined thickness of the lamellae must be 15 cm or more. In addition, the cambic horizon must meet *all* of the following:

1. Has a texture of very fine sand, loamy very fine sand, or finer; *and*
2. Shows evidence of alteration in *one* of the following forms:
 - a. Aquic conditions within 50 cm of the soil surface or artificial drainage and *all* of the following:
 - (1) Soil structure or the absence of rock structure in more than one-half of the volume; *and*
 - (2) Colors that do not change on exposure to air; *and*
 - (3) Dominant color, moist, on faces of peds or in the matrix as follows:
 - (a) Value of 3 or less and chroma of 0; *or*
 - (b) Value of 4 or more and chroma of 1 or less; *or*
 - (c) Any value, chroma of 2 or less, and redox concentrations; *or*
 - b. Does not have the combination of aquic conditions within 50 cm of the soil surface or artificial drainage and colors, moist, as defined in item 2-a-(3) above, and has soil structure or the absence of rock structure in more than one-half of the volume and *one or more* of the following properties:
 - (1) Higher chroma, higher value, redder hue, (or higher clay content than the underlying horizon or an overlying horizon); *or*
 - (2) Evidence of the removal of carbonates or gypsum; *and*
3. Has properties that do not meet the requirements for an anthropic, histic, folistic, melanic, mollic, plaggen, or umbric epipedon, a duripan or fragipan, or an argillic, calcic, gypsic, natric, oxic, petrocalcic, petrogypsic, placic, or spodic horizon; *and*
4. Is not part of an Ap horizon, is not appreciably darkened

(does not meet the color requirements for a mollic or umbric epipedon), and is not brittle.

Duripan

Required Characteristics

A duripan is a silica-cemented subsurface horizon with or without auxiliary cementing agents. It can occur in conjunction with a petrocalcic horizon.

A duripan must meet *all* of the following requirements:

1. The pan is cemented or indurated in more than 50 percent of the volume of some horizon; *and*
2. The pan shows evidence of the accumulation of opal or other forms of silica, such as laminar caps, coatings, lenses, partly filled interstices, bridges between sand-sized grains, or coatings on rock and pararock fragments; *and*
3. Less than 50 percent of the volume of air-dry fragments slakes in 1N HCl even during prolonged soaking, but more than 50 percent slakes in concentrated KOH or NaOH or in alternating acid and alkali; *and*
4. Because of lateral continuity, roots can penetrate the pan only along vertical fractures with a horizontal spacing of 10 cm or more.

Fragipan

Required Characteristics

To be identified as a fragipan, a layer must have *all* of the following characteristics:

1. The layer is 15 cm or more thick; *and*
2. The layer shows evidence of pedogenesis within the horizon or, at a minimum, on the faces of structural units; *and*
3. The layer has very coarse prismatic, columnar, or blocky structure of any grade, has weak structure of any size, or is massive. Separations between structural units that allow roots to enter have an average spacing of 10 cm or more on the horizontal dimensions; *and*
4. Air-dry fragments of the natural soil fabric, 5 to 10 cm in diameter, from more than 50 percent of the horizon slake when they are submerged in water; *and*
5. The layer has, in 60 percent or more of the volume, a firm or firmer rupture-resistance class, a brittle manner of failure at or near field capacity, and virtually no roots.

Glossic Horizon

The glossic horizon (Gr. *glossa*, tongue) develops as a result of the degradation of an argillic, kandic, or natric horizon from which clay and free iron oxides are removed.

Required Characteristics

The glossic horizon is 5 cm or more thick and consists of:

1. An eluvial part, i.e., albic materials (defined below), which constitute 15 to 85 percent (by volume) of the glossic horizon; *and*
2. An illuvial part, i.e., remnants (pieces) of an argillic, kandic, or natric horizon (defined below).

Gypsic Horizon

The gypsic horizon is an illuvial horizon in which secondary gypsum has accumulated to a significant extent.

Required Characteristics

A gypsic horizon has *all* of the following properties:

1. Is 15 cm or more thick; *and*
2. Is not cemented or indurated to such a degree that it meets the requirements for a petrogypsic horizon; *and*
3. Is 5 percent or more gypsum and 1 percent or more (by volume) secondary visible gypsum; *and*
4. Has a product of thickness, in cm, multiplied by the gypsum content percentage of 150 or more.

Thus, a horizon 30 cm thick that is 5 percent gypsum qualifies as a gypsic horizon if it is 1 percent or more (by volume) visible gypsum and is not cemented or indurated to such a degree that it meets the requirements for a petrogypsic horizon.

The gypsum percentage can be calculated by multiplying the milliequivalents of gypsum per 100 g soil by the milliequivalent weight of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, which is 0.086.

Kandic Horizon¹

Required Characteristics

The kandic horizon:

1. Is a vertically continuous subsurface horizon that underlies a coarser textured surface horizon. The minimum thickness of the surface horizon is 18 cm after mixing or 5 cm if the textural transition to the kandic horizon is abrupt and there is no densic, lithic, paralithic, or petroferric contact (defined below) within 50 cm of the mineral soil surface; *and*
2. Has its upper boundary:
 - a. At the point where the clay percentage in the fine-earth fraction, increasing with depth within a vertical distance of 15 cm or less, is *either*:

(1) 4 percent or more (absolute) higher than that in the surface horizon if that horizon has less than 20 percent total clay in the fine-earth fraction; *or*

(2) 20 percent or more (relative) higher than that in the surface horizon if that horizon has 20 to 40 percent total clay in the fine-earth fraction; *or*

(3) 8 percent or more (absolute) higher than that in the surface horizon if that horizon has more than 40 percent total clay in the fine-earth fraction; *and*

b. At a depth:

(1) Between 100 cm and 200 cm from the mineral soil surface if the particle-size class is sandy or sandy-skeletal throughout the upper 100 cm; *or*

(2) Within 100 cm from the mineral soil surface if the clay content in the fine-earth fraction of the surface horizon is 20 percent or more; *or*

(3) Within 125 cm from the mineral soil surface for all other soils; *and*

3. Has a thickness of *either*:

a. 30 cm or more; *or*

b. 15 cm or more if there is a densic, lithic, paralithic, or petroferric contact within 50 cm of the mineral soil surface and the kandic horizon constitutes 60 percent or more of the vertical distance between a depth of 18 cm and the contact; *and*

4. Has a texture of loamy very fine sand or finer; *and*

5. Has an apparent CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an apparent ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7 plus 1N KCl-extractable Al) in 50 percent or more of its thickness between the point where the clay increase requirements are met and either a depth of 100 cm below that point or a densic, lithic, paralithic, or petroferric contact if shallower. (The percentage of clay is either measured by the pipette method or estimated to be 2.5 times [percent water retained at 1500 kPa tension minus percent organic carbon], whichever is higher, but no more than 100); *and*

6. Has a regular decrease in organic-carbon content with increasing depth, no fine stratification, and no overlying layers more than 30 cm thick that have fine stratification and/or an organic-carbon content that decreases irregularly with increasing depth.

Natric Horizon

Required Characteristics

The natric horizon has, in addition to the properties of the argillic horizon:

¹The concept of the kandic horizon and the “kandi” and “kanhapli” great groups of soils represent the work of the International Committee on the Classification of Low Activity Clays (ICOMLAC), chaired by Dr. Frank R. Moormann.

1. *Either*:
 - a. Columns or prisms in some part (generally the upper part), which may break to blocks; *or*
 - b. Both blocky structure and eluvial materials, which contain uncoated silt or sand grains and extend more than 2.5 cm into the horizon; *and*
2. *Either*:
 - a. An exchangeable sodium percentage (ESP) of 15 percent or more (or a sodium adsorption ratio [SAR] of 13 or more) in one or more horizons within 40 cm of its upper boundary; *or*
 - b. More exchangeable magnesium plus sodium than calcium plus exchange acidity (at pH 8.2) in one or more horizons within 40 cm of its upper boundary if the ESP is 15 or more (or the SAR is 13 or more) in one or more horizons within 200 cm of the mineral soil surface.

Ortstein

Required Characteristics

Ortstein has *all* of the following:

1. Consists of spodic materials; *and*
2. Is in a layer that is 50 percent or more cemented; *and*
3. Is 25 mm or more thick.

Oxic Horizon

Required Characteristics

The oxic horizon is a subsurface horizon that does not have andic soil properties (defined below) and has *all* of the following characteristics:

1. A thickness of 30 cm or more; *and*
2. A texture of sandy loam or finer in the fine-earth fraction; *and*
3. Less than 10 percent weatherable minerals in the 50- to 200-micron fraction; *and*
4. Rock structure in less than 5 percent of its volume, unless the lithorelicts with weatherable minerals are coated with sesquioxides; *and*
5. A diffuse upper boundary, i.e., within a vertical distance of 15 cm, a clay increase with increasing depth of:
 - a. Less than 4 percent (absolute) in its fine-earth fraction if the fine-earth fraction of the surface horizon contains less than 20 percent clay; *or*
 - b. Less than 20 percent (relative) in its fine-earth fraction

if the fine-earth fraction of the surface horizon contains 20 to 40 percent clay; *or*

c. Less than 8 percent (absolute) in its fine-earth fraction if the fine-earth fraction of the surface horizon contains 40 percent or more clay); *and*

6. An apparent CEC of 16 cmol(+) or less per kg clay (by 1N NH₄OAc pH 7) and an apparent ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH₄OAc pH 7 plus 1N KCl-extractable Al). (The percentage of clay is either measured by the pipette method or estimated to be 3 times [percent water retained at 1500 kPa tension minus percent organic carbon], whichever value is higher, but no more than 100).

Petrocalcic Horizon

The petrocalcic horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to the extent that the horizon is cemented or indurated.

Required Characteristics

A petrocalcic horizon must meet the following requirements:

1. The horizon is cemented or indurated by carbonates, with or without silica or other cementing agents; *and*
2. Because of lateral continuity, roots can penetrate only along vertical fractures with a horizontal spacing of 10 cm or more; *and*
3. The horizon has a thickness of:
 - a. 10 cm or more; *or*
 - b. 1 cm or more if it consists of a laminar cap directly underlain by bedrock.

Petrogypsic Horizon

The petrogypsic horizon is an illuvial horizon, 10 cm or more thick, in which secondary gypsum has accumulated to the extent that the horizon is cemented or indurated.

Required Characteristics

A petrogypsic horizon must meet the following requirements:

1. The horizon is cemented or indurated by gypsum, with or without other cementing agents; *and*
2. Because of lateral continuity, roots can penetrate only along vertical fractures with a horizontal spacing of 10 cm or more; *and*
3. The horizon is 10 cm or more thick; *and*

4. The horizon is 5 percent or more gypsum, and the product of its thickness, in cm, multiplied by the gypsum content percentage is 150 or more.

Placic Horizon

The placic horizon (Gr. base of *plax*, flat stone; meaning a thin cemented pan) is a thin, black to dark reddish pan that is cemented by iron (or iron and manganese) and organic matter.

Required Characteristics

A placic horizon must meet the following requirements:

1. The horizon is cemented or indurated with iron or iron and manganese and organic matter, with or without other cementing agents; *and*
2. Because of lateral continuity, roots can penetrate only along vertical fractures with a horizontal spacing of 10 cm or more; *and*
3. The horizon has a minimum thickness of 1 mm and, where associated with spodic materials, is less than 25 mm thick.

Salic Horizon

A salic horizon is a horizon of accumulation of salts that are more soluble than gypsum in cold water.

Required Characteristics

A salic horizon is 15 cm or more thick and has, for 90 consecutive days or more in normal years:

1. An electrical conductivity (EC) equal to or greater than 30 dS/m in a saturated paste; *and*
2. A product of the EC, in dS/m, and thickness, in cm, equal to 900 or more.

Sombric Horizon

A sombric horizon (F. *sombre*, dark) is a subsurface horizon in mineral soils that has formed under free drainage. It contains illuvial humus that is neither associated with aluminum, as is the humus in the spodic horizon, nor dispersed by sodium, as is common in the natric horizon. Consequently, the sombric horizon does not have the high cation-exchange capacity in its clay that characterizes a spodic horizon and does not have the high base saturation of a natric horizon. It does not underlie an albic horizon.

Sombric horizons are thought to be restricted to the cool, moist soils of high plateaus and mountains in tropical or subtropical regions. Because of strong leaching, their base saturation is low (less than 50 percent by NH_4OAc).

The sombric horizon has a lower color value or chroma, or both, than the overlying horizon and commonly contains more organic matter. It may have formed in an argillic, cambic, or

oxic horizon. If peds are present, the dark colors are most pronounced on surfaces of peds.

In the field a sombric horizon is easily mistaken for a buried A horizon. It can be distinguished from some buried epipedons by lateral tracing. In thin sections the organic matter of a sombric horizon appears more concentrated on peds and in pores than uniformly dispersed throughout the matrix.

Spodic Horizon

A spodic horizon is an illuvial layer with 85 percent or more spodic materials (defined below).

Required Characteristics

A spodic horizon is normally a subsurface horizon underlying an O, A, Ap, or E horizon. It may, however, meet the definition of an umbric epipedon.

A spodic horizon must have 85 percent or more spodic materials in a layer 2.5 cm or more thick that is not part of any Ap horizon.

Other Diagnostic Soil Characteristics (Mineral Soils)

Diagnostic soil characteristics are features of the soil that are used in various places in the keys or in definitions of diagnostic horizons.

Abrupt Textural Change

An abrupt textural change is a specific kind of change that may occur between an ochric epipedon or an albic horizon and an argillic horizon. It is characterized by a considerable increase in clay content within a very short vertical distance in the zone of contact. If the clay content in the fine-earth fraction of the ochric epipedon or albic horizon is less than 20 percent, it doubles within a vertical distance of 7.5 cm or less. If the clay content in the fine-earth fraction of the ochric epipedon or the albic horizon is 20 percent or more, there is an increase of 20 percent or more (absolute) within a vertical distance of 7.5 cm or less (e.g., an increase from 22 to 42 percent) and the clay content in some part of the argillic horizon is 2 times or more the amount contained in the overlying horizon.

Normally, there is no transitional horizon between an ochric epipedon or an albic horizon and an argillic horizon, or the transitional horizon is too thin to be sampled. Some soils, however, have a glossic horizon or interfingering of albic materials (defined below) in parts of the argillic horizon. The upper boundary of such a horizon is irregular or even discontinuous. Sampling this mixture as a single horizon might create the impression of a relatively thick transitional horizon, whereas the thickness of the actual transition at the contact may be no more than 1 mm.

Albic Materials

Albic (*L. albus*, white) materials are soil materials with a color that is largely determined by the color of primary sand and silt particles rather than by the color of their coatings. This definition implies that clay and/or free iron oxides have been removed from the materials or that the oxides have been segregated to such an extent that the color of the materials is largely determined by the color of the primary particles.

Required Characteristics

Albic materials have *one* of the following colors:

1. Chroma of 2 or less; *and either*
 - a. A color value, moist, of 3 and a color value, dry, of 6 or more; *or*
 - b. A color value, moist, of 4 or more and a color value, dry, of 5 or more; *or*
2. Chroma of 3 or less; *and either*
 - a. A color value, moist, of 6 or more; *or*
 - b. A color value, dry, of 7 or more; *or*
3. Chroma that is controlled by the color of uncoated grains of silt or sand, hue of 5YR or redder, and the color values listed in item 1-a or 1-b above.

Relatively unaltered layers of light colored sand, volcanic ash, or other materials deposited by wind or water are not considered albic materials, although they may have the same color and apparent morphology. These deposits are parent materials that are not characterized by the removal of clay and/or free iron and do not overlie an illuvial horizon or other soil horizon, except for a buried soil. Light colored krotovinas or filled root channels should be considered albic materials only if they have no fine stratifications or lamellae, if any sealing along the krotovina walls has been destroyed, and if these intrusions have been leached of free iron oxides and/or clay after deposition.

Andic Soil Properties

Andic soil properties result mainly from the presence of significant amounts of allophane, imogolite, ferrihydrite, or aluminum-humus complexes in soils. These materials, originally termed “amorphous” (but understood to contain allophane) in the 1975 edition of *Soil Taxonomy* (USDA, SCS, 1975), are commonly formed during the weathering of tephra and other parent materials with a significant content of volcanic glass. Although volcanic glass is or was a common component in many Andisols, it is not a requirement of the Andisol order.

Required Characteristics

To be recognized as having andic soil properties, soil materials must contain less than 25 percent (by weight) organic carbon and meet *one or both* of the following requirements:

1. In the fine-earth fraction, *all* of the following:
 - a. Aluminum plus $\frac{1}{2}$ iron percentages (by ammonium oxalate) totaling 2.0 percent or more; *and*
 - b. A bulk density, measured at 33 kPa water retention, of 0.90 g/cm³ or less; *and*
 - c. A phosphate retention of 85 percent or more; *or*
2. In the fine-earth fraction, a phosphate retention of 25 percent or more, 30 percent or more particles 0.02 to 2.0 mm in size, and *one* of the following:
 - a. Aluminum plus $\frac{1}{2}$ iron percentages (by ammonium oxalate) totaling 0.40 or more and, in the 0.02 to 2.0 mm fraction, 30 percent or more volcanic glass; *or*
 - b. Aluminum plus $\frac{1}{2}$ iron percentages (by ammonium oxalate) totaling 2.0 or more and, in the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *or*
 - c. Aluminum plus $\frac{1}{2}$ iron percentages (by ammonium oxalate) totaling between 0.40 and 2.0 and, in the 0.02 to 2.0 mm fraction, enough volcanic glass so that the glass percentage, when plotted against the value obtained by adding aluminum plus $\frac{1}{2}$ iron percentages in the fine-earth fraction, falls within the shaded area of figure 1.

Anhydrous Conditions

Anhydrous conditions (Gr. *anydros*, waterless) refer to the active layer in soils of cold deserts and other areas with permafrost (often dry permafrost) and low precipitation (usually less than 50 mm water equivalent). Anhydrous soil conditions are similar to the aridic (torric) soil moisture regimes, except that the soil temperature is less than 0 °C.

Coefficient of Linear Extensibility (COLE)

The coefficient of linear extensibility (COLE) is the ratio of the difference between the moist length and dry length of a clod to its dry length. It is $(L_m - L_d)/L_d$, where L_m is the length at 33 kPa tension and L_d is the length when dry. COLE can be calculated from the differences in bulk density of the clod when moist and when dry. An estimate of COLE can be calculated in the field by measuring the distance between two pins in a clod of undisturbed soil at field capacity and again after the clod has dried. COLE does not apply if the shrinkage is irreversible.

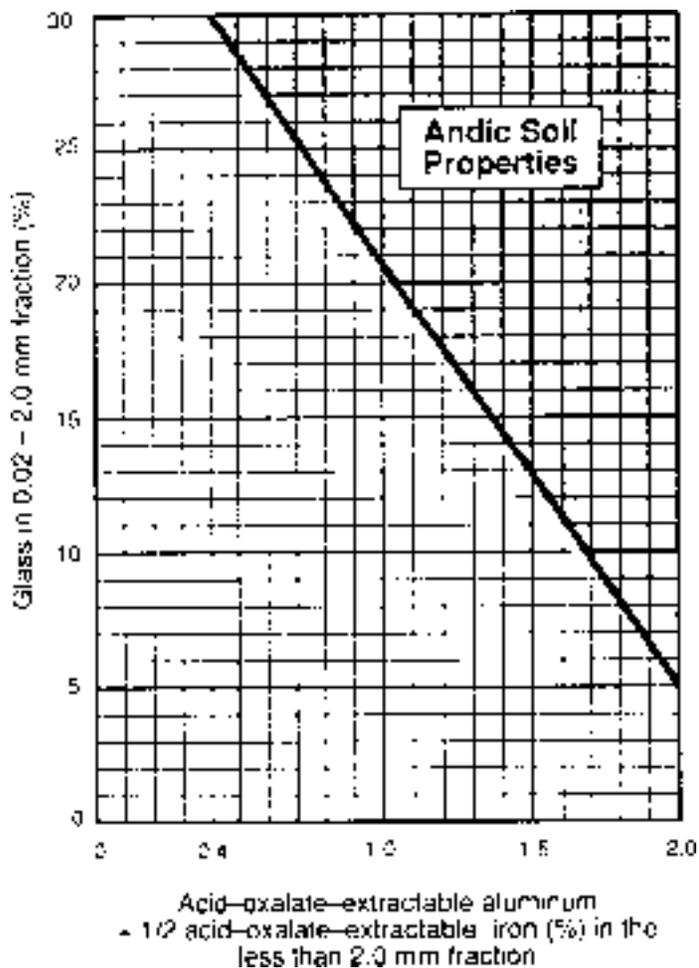


Figure 1.—Soils that are plotted in the shaded area have andic soil properties. A soil has these properties if the fraction less than 2.0 mm in size has phosphate retention of more than 25 percent and the 0.02 to 2.0 mm fraction is at least 30 percent of the fraction less than 2.0 mm in size.

Durinodes

Durinodes (*L. durus*, hard, and *nodus*, knot) are weakly cemented to indurated nodules with a diameter of 1 cm or more. The cement is SiO_2 , presumably opal and microcrystalline forms of silica. Durinodes break down in hot concentrated KOH after treatment with HCl to remove carbonates but do not break down with concentrated HCl alone. Dry durinodes do not slake appreciably in water, but prolonged soaking can result in spalling of very thin platelets. Durinodes are firm or firmer and brittle when wet, both before and after treatment with acid. Most durinodes are roughly concentric when viewed in cross section, and concentric stringers of opal are visible under a hand lens.

Fragic Soil Properties

Fragic soil properties are the essential properties of a fragipan. They have neither the layer thickness nor volume requirements for the fragipan. Fragic soil properties are in subsurface horizons, although they can be at or near the surface in truncated soils. Aggregates with fragic soil properties have a firm or firmer rupture-resistance class and a brittle manner of failure when soil water is at or near field capacity. Air-dry fragments of the natural fabric, 5 to 10 cm in diameter, slake when they are submerged in water. Aggregates with fragic soil properties show evidence of pedogenesis, including one or more of the following: oriented clay within the matrix or on faces of peds, redoximorphic features within the matrix or on faces of peds, strong or moderate soil structure, and coatings of albic materials or uncoated silt and sand grains on faces of peds or in seams. Peds with these properties are considered to have fragic soil properties regardless of whether or not the density and brittleness are pedogenic.

Soil aggregates with fragic soil properties must:

1. Show evidence of pedogenesis within the aggregates or, at a minimum, on the faces of the aggregates; *and*
2. Slake when air-dry fragments of the natural fabric, 5 to 10 cm in diameter, are submerged in water; *and*
3. Have a firm or firmer rupture-resistance class and a brittle manner of failure when soil water is at or near field capacity; *and*
4. Restrict the entry of roots into the matrix when soil water is at or near field capacity.

Identifiable Secondary Carbonates

The term “identifiable secondary carbonates” is used in the definitions of a number of taxa. It refers to translocated authigenic 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 till.

Identifiable secondary carbonates either may disrupt the soil structure or fabric, forming masses, nodules, concretions, or spheroidal aggregates (white eyes) that are soft and powdery when dry, or may be present as coatings in pores, on structural faces, or on the undersides of rock or pararock fragments. If present as coatings, the secondary carbonates cover a significant part of the surfaces. Commonly, they coat all of the surfaces to a thickness of 1 mm or more. If little calcium carbonate is present in the soil, however, the surfaces may be only partially coated. The coatings must be thick enough to be visible when moist. Some horizons are entirely engulfed by

carbonates. The color of these horizons is largely determined by the carbonates. The carbonates in these horizons are within the concept of identifiable secondary carbonates.

The filaments commonly seen in a dry calcareous horizon are within the meaning of identifiable secondary carbonates if the filaments are thick enough to be visible when the soil is moist. Filaments commonly branch on structural faces.

Interfingering of Albic Materials

The term “interfingering of albic materials” refers to albic materials that penetrate 5 cm or more into an underlying argillic, kandic, or natric horizon along vertical and, to a lesser degree, horizontal faces of peds. There need not be a continuous overlying albic horizon. The albic materials constitute less than 15 percent of the layer that they penetrate, but they form continuous skeletans (ped coatings of clean silt or sand defined by Brewer, 1976) 1 mm or more thick on the vertical faces of peds, which means a total width of 2 mm or more between abutting peds. Because quartz is such a common constituent of silt and sand, these skeletans are usually light gray when moist and nearly white when dry, but their color is determined in large part by the color of the sand or silt fraction.

Required Characteristics

Interfingering of albic materials is recognized if albic materials:

1. Penetrate 5 cm or more into an underlying argillic or natric horizon; *and*
2. Are 2 mm or more thick between vertical faces of abutting peds; *and*
3. Constitute less than 15 percent (by volume) of the layer that they penetrate.

Lamellae

A lamella is an illuvial horizon less than 7.5 cm thick. Each lamella contains an accumulation of oriented silicate clay on or bridging sand and silt grains (and rock fragments if any are present). A lamella has more silicate clay than the overlying eluvial horizon.

Required Characteristics

A lamella is an illuvial horizon less than 7.5 cm thick formed in unconsolidated regolith more than 50 cm thick. Each lamella contains an accumulation of oriented silicate clay on or bridging the sand and silt grains (and coarse fragments if any are present). Each lamella is required to have more silicate clay than the overlying eluvial horizon.

Lamellae occur in a vertical series of two or more, and each lamella must have an overlying eluvial horizon.

is not required above the uppermost lamella if the soil is truncated.)

Lamellae may meet the requirements for either a cambic or an argillic horizon. A combination of two or more lamellae 15 cm or more thick is a cambic horizon if the texture is very fine sand, loamy very fine sand, or finer. A combination of two or more lamellae meets the requirements for an argillic horizon if there is 15 cm or more cumulative thickness of lamellae that are 0.5 cm or more thick and that have a clay content of *either*:

1. 3 percent or more (absolute) higher than in the overlying eluvial horizon (e.g., 13 percent versus 10 percent) if any part of the eluvial horizon has less than 15 percent clay in the fine-earth fraction; *or*
2. 20 percent or more (relative) higher than in the overlying eluvial horizon (e.g., 24 percent versus 20 percent) if all parts of the eluvial horizon have more than 15 percent clay in the fine-earth fraction.

Linear Extensibility (LE)

Linear extensibility (LE) helps to predict the potential of a soil to shrink and swell. The LE of a soil layer is the product of the thickness, in cm, multiplied by the COLE of the layer in question. The LE of a soil is the sum of these products for all soil horizons.

Lithologic Discontinuities

Lithologic discontinuities are significant changes in particle-size distribution or mineralogy that represent differences in lithology within a soil. A lithologic discontinuity can also denote an age difference. For information on using horizon designations for lithologic discontinuities, see the *Soil Survey Manual* (USDA, SCS, 1993).

Not everyone agrees on the degree of change required for a lithologic discontinuity. No attempt is made to quantify lithologic discontinuities. The discussion below is meant to serve as a guideline.

Several lines of field evidence can be used to evaluate lithologic discontinuities. In addition to mineralogical and textural differences that may require laboratory studies, certain observations can be made in the field. These include but are not limited to the following:

1. **Abrupt textural contacts.**—An abrupt change in particle-size distribution, which is not solely a change in clay content resulting from pedogenesis, can often be observed.
2. **Contrasting sand sizes.**—Significant changes in sand size can be detected. For example, if material containing mostly medium sand or finer sand abruptly overlies material containing mostly coarse sand and very coarse sand, one can assume that there are two different materials. Although the materials may be of the same mineralogy, the contrasting sand

sizes result from differences in energy at the time of deposition by water and/or wind.

3. Bedrock lithology vs. rock fragment lithology in the soil.—If a soil with rock fragments overlies a lithic contact, one would expect the rock fragments to have a lithology similar to that of the material below the lithic contact. If many of the rock fragments do not have the same lithology as the underlying bedrock, the soil is not derived completely from the underlying bedrock.

4. Stone lines.—The occurrence of a horizontal line of rock fragments in the vertical sequence of a soil indicates that the soil may have developed in more than one kind of parent material. The material above the stone line is most likely transported, and the material below may be of different origin.

5. Inverse distribution of rock fragments.—A lithologic discontinuity is often indicated by an erratic distribution of rock fragments. The percentage of rock fragments decreases with increasing depth. This line of evidence is useful in areas of soils that have relatively unweathered rock fragments.

6. Rock fragment weathering rinds.—Horizons containing rock fragments with no rinds that overlie horizons containing rocks with rinds suggest that the upper material is in part depositional and not related to the lower part in time and perhaps in lithology.

7. Shape of rock fragments.—A soil with horizons containing angular rock fragments overlying horizons containing well rounded rock fragments may indicate a discontinuity. This line of evidence represents different mechanisms of transport (colluvial vs. alluvial) or even different transport distances.

8. Soil color.—Abrupt changes in color that are not the result of pedogenic processes can be used as indicators of discontinuity.

9. Micromorphological features.—Marked differences in the size and shape of resistant minerals in one horizon and not in another are indicators of differences in materials.

Use of Laboratory Data

Discontinuities are not always readily apparent in the field. In these cases laboratory data are necessary. Even with laboratory data, detecting discontinuities may be difficult. The decision is a qualitative or perhaps a partly quantitative judgment. General concepts of lithology as a function of depth might include:

1. Laboratory data—visual scan.—The array of laboratory data is assessed in an attempt to determine if a field-designated discontinuity is corroborated and if any data show evidence of a discontinuity not observed in the field. One must sort changes in lithology from changes caused by pedogenic processes. In most cases the quantities of sand and coarser fractions are not altered significantly by soil-forming processes. Therefore, an abrupt change in sand size or sand mineralogy is a clue to lithologic change. Gross soil mineralogy and the resistant mineral suite are other clues.

2. Data on a clay-free basis.—A common manipulation in assessing lithologic change is computation of sand and silt separates on a carbonate-free, clay-free basis (percent fraction, e.g., fine sand and very fine sand, divided by percent sand plus silt, times 100). Clay distribution is subject to pedogenic change and may either mask inherited lithologic differences or produce differences that are not inherited from lithology. The numerical array computed on a clay-free basis can be inspected visually or plotted as a function of depth.

Another aid used to assess lithologic changes is computation of the ratios of one sand separate to another. The ratios can be computed and examined as a numerical array, or they can be plotted. The ratios work well if sufficient quantities of the two fractions are available. Low quantities magnify changes in ratios, especially if the denominator is low.

n Value

The *n* value (Pons and Zonneveld, 1965) characterizes the relation between the percentage of water in a soil under field conditions and its percentages of inorganic clay and humus. The *n* value is helpful in predicting whether a soil can be grazed by livestock or can support other loads and in predicting what degree of subsidence would occur after drainage.

For mineral soil materials that are not thixotropic, the *n* value can be calculated by the following formula:

$$n = (A - 0.2R)/(L + 3H)$$

In this formula, A is the percentage of water in the soil in field condition, calculated on a dry-soil basis; R is the percentage of silt plus sand; L is the percentage of clay; and H is the percentage of organic matter (percent organic carbon multiplied by 1.724).

Few data for calculations of the *n* value are available in the United States, but the critical *n* value of 0.7 can be approximated closely in the field by a simple test of squeezing a soil sample in the hand. If the soil flows between the fingers with difficulty, the *n* value is between 0.7 and 1.0 (slightly fluid manner of failure class); if the soil flows easily between the fingers, the *n* value is 1 or more (moderately fluid or very fluid manner of failure class).

Petroferric Contact

A petroferric (Gr. *petra*, rock, and L. *ferrum*, iron; implying ironstone) contact is a boundary between soil and a continuous layer of indurated material in which iron is an important cement and organic matter is either absent or present only in traces. The indurated layer must be continuous within the limits of each pedon, but it may be fractured if the average lateral distance between fractures is 10 cm or more. The fact that this ironstone layer contains little or no organic matter distinguishes it from a placic horizon and an indurated spodic horizon (ortstein), both of which contain organic matter.

Several features can aid in making the distinction between a lithic contact and a petroferric contact. First, a petroferric contact is roughly horizontal. Second, the material directly below a petroferric contact contains a high amount of iron (normally 30 percent or more Fe_2O_3). Third, the ironstone sheets below a petroferric contact are thin; their thickness ranges from a few centimeters to very few meters. Sandstone, on the other hand, may be thin or very thick, may be level-bedded or tilted, and may contain only a small percentage of Fe_2O_3 . In the Tropics, the ironstone is generally more or less vesicular.

Plinthite

Plinthite (Gr. *plinthos*, brick) is an iron-rich, humus-poor mixture of clay with quartz and other minerals. It commonly occurs as dark red redox concentrations that usually form platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on exposure to repeated wetting and drying, especially if it is also exposed to heat from the sun. The lower boundary of a zone in which plinthite occurs generally is diffuse or gradual, but it may be abrupt at a lithologic discontinuity.

Generally, plinthite forms in a horizon that is saturated with water for some time during the year. Initially, iron is normally segregated in the form of soft, more or less clayey, red or dark red redox concentrations. These concentrations are not considered plinthite unless there has been enough segregation of iron to permit their irreversible hardening on exposure to repeated wetting and drying. Plinthite is firm or very firm when the soil moisture content is near field capacity and hard when the moisture content is below the wilting point. Plinthite does not harden irreversibly as a result of a single cycle of drying and rewetting. After a single drying, it will remoisten and then can be dispersed in large part if one shakes it in water with a dispersing agent.

In a moist soil, plinthite is soft enough to be cut with a spade. After irreversible hardening, it is no longer considered plinthite but is called ironstone. Indurated ironstone materials can be broken or shattered with a spade but cannot be dispersed if one shakes them in water with a dispersing agent.

Resistant Minerals

Several references are made to resistant minerals in this taxonomy. Obviously, the stability of a mineral in the soil is a partial function of the soil moisture regime. Where resistant minerals are referred to in the definitions of diagnostic horizons and of various taxa, a humid climate, past or present, is always assumed.

Resistant minerals are durable minerals in the 0.02 to 2.0 mm fraction. Quartz is the most common resistant mineral in

soils. The less common ones include sphene, rutile, zircon, tourmaline, and beryl.

Slickensides

Slickensides are polished and grooved surfaces and generally have dimensions exceeding 5 cm. They are produced when one soil mass slides past another. Some slickensides occur at the lower boundary of a slip surface where a mass of soil moves downward on a relatively steep slope. Slickensides result directly from the swelling of clay minerals and shear failure. They are very common in swelling clays that undergo marked changes in moisture content.

Spodic Materials

Spodic materials form in an illuvial horizon that normally underlies a histic, ochric, or umbric epipedon or an albic horizon. In most undisturbed areas, spodic materials underlie an albic horizon. They may occur within an umbric epipedon or an Ap horizon.

A horizon consisting of spodic materials normally has an optical-density-of-oxalate-extract (ODOE) value of 0.25 or more, and that value is commonly at least 2 times as high as the ODOE value in an overlying eluvial horizon. This increase in ODOE value indicates an accumulation of translocated organic materials in an illuvial horizon. Soils with spodic materials show evidence that organic materials and aluminum, with or without iron, have been moved from an eluvial horizon to an illuvial horizon.

Definition of Spodic Materials

Spodic materials are mineral soil materials that do not have all of the properties of an argillic or kandic horizon; are dominated by active amorphous materials that are illuvial and are composed of organic matter and aluminum, with or without iron; and have *both* of the following:

1. A pH value in water (1:1) of 5.9 or less and an organic-carbon content of 0.6 percent or more; *and*
2. *One or both* of the following:
 - a. An overlying albic horizon that extends horizontally through 50 percent or more of each pedon and, directly under the albic horizon, colors, moist (crushed and smoothed sample), as follows:
 - (1) Hue of 5YR or redder; *or*
 - (2) Hue of 5YR, color value of 5 or less, and chroma of 4 or less; *or*
 - (3) Hue of 10YR or neutral and a color value and chroma of 2 or less; *or*

(4) A color of 10YR 3/1; *or*

b. With or without an albic horizon and one of the colors listed above or hue of 7.5YR, color value, moist, of 5 or less, chroma of 5 or 6 (crushed and smoothed sample), and *one or more* of the following morphological or chemical properties:

(1) Cementation by organic matter and aluminum, with or without iron, in 50 percent or more of each pedon and a very firm or firmer rupture-resistance class in the cemented part; *or*

(2) 10 percent or more cracked coatings on sand grains; *or*

(3) Aluminum plus $\frac{1}{2}$ iron percentages (by ammonium oxalate) totaling 0.50 or more, and half that amount or less in an overlying umbric (or subhorizon of an umbric) epipedon, ochric epipedon, or albic horizon; *or*

(4) An optical-density-of-oxalate-extract (ODOE) value of 0.25 or more, and a value half as high or lower in an overlying umbric (or subhorizon of an umbric) epipedon, ochric epipedon, or albic horizon.

Weatherable Minerals

Several references are made to weatherable minerals in this taxonomy. Obviously, the stability of a mineral in a soil is a partial function of the soil moisture regime. Where weatherable minerals are referred to in the definitions of diagnostic horizons and of various taxa in this taxonomy, a humid climate, either present or past, is always assumed. The minerals that are included in the meaning of weatherable minerals are as follows:

1. Clay minerals: All 2:1 lattice clays, except for one that is currently considered to be an aluminum-interlayered chlorite. Sepiolite, talc, and glauconite are also included in this group of weatherable clay minerals, although they are not everywhere of clay size.

2. Silt- and sand-sized minerals (0.02 to 0.2 mm in diameter): Feldspars, feldspathoids, ferromagnesian minerals, glass, micas, zeolites, and apatite.

Obviously, this definition of the term “weatherable minerals” is restrictive. The intent is to include, in the definitions of diagnostic horizons and various taxa, only those weatherable minerals that are unstable in a humid climate compared to other minerals, such as quartz and 1:1 lattice clays, but that are more resistant to weathering than calcite.

Characteristics Diagnostic for Organic Soils

Following is a description of the characteristics that are used only with organic soils.

Kinds of Organic Soil Materials

Three different kinds of organic soil materials are distinguished in this taxonomy, based on the degree of decomposition of the plant materials from which the organic materials are derived. The three kinds are (1) fibric, (2) hemic, and (3) sapric. Because of the importance of fiber content in the definitions of these materials, fibers are defined before the kinds of organic soil materials.

Fibers

Fibers are pieces of plant tissue in organic soil materials (excluding live roots) that:

1. Are large enough to be retained on a 100-mesh sieve (openings 0.15 mm across) when the materials are screened; *and*
2. Show evidence of the cellular structure of the plants from which they are derived; *and*
3. Either are 2 cm or less in their smallest dimension or are decomposed enough to be crushed and shredded with the fingers.

Pieces of wood that are larger than 2 cm in cross section and are so undecomposed that they cannot be crushed and shredded with the fingers, such as large branches, logs, and stumps, are not considered fibers but are considered coarse fragments (comparable to gravel, stones, and boulders in mineral soils).

Fibric Soil Materials

Fibric soil materials are organic soil materials that *either*:

1. Contain three-fourths or more (by volume) fibers after rubbing, excluding coarse fragments; *or*
2. Contain two-fifths or more (by volume) fibers after rubbing, excluding coarse fragments, and yield color values and chromas of 7/1, 7/2, 8/1, 8/2, or 8/3 (fig. 2) on white chromatographic or filter paper that is inserted into a paste made of the soil materials in a saturated sodium-pyrophosphate solution.

Hemic Soil Materials

Hemic soil materials (Gr. *hemi*, half; implying intermediate decomposition) are intermediate in their degree of decomposition between the less decomposed fibric and more decomposed sapric materials. Their morphological features give intermediate values for fiber content, bulk density, and water content. Hemic soil materials are partly altered both physically and biochemically.

Sapric Soil Materials

Sapric soil materials (Gr. *sapros*, rotten) are the most highly decomposed of the three kinds of organic soil materials. They have the smallest amount of plant fiber, the highest bulk density, and the lowest water content on a dry-weight basis at saturation. Sapric soil materials are commonly very dark gray to black. They are relatively stable; i.e., they change very little physically and chemically with time in comparison to other organic soil materials.

Sapric materials have the following characteristics:

1. The fiber content, after rubbing, is less than one-sixth (by volume), excluding coarse fragments; *and*
2. The color of the sodium-pyrophosphate extract on white chromatographic or filter paper is below or to the right of a line drawn to exclude blocks 5/1, 6/2, and 7/3 (Munsell designations, fig. 2). If few or no fibers can be detected and the color of the pyrophosphate extract is to the left of or above this line, the possibility that the material is limnic must be considered.

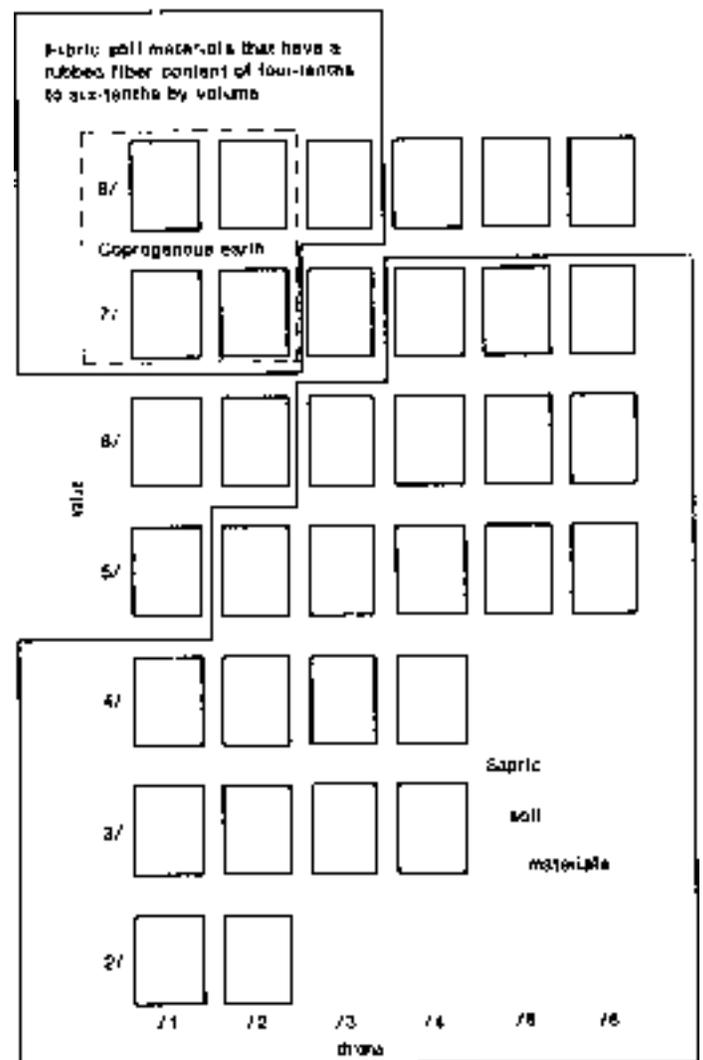
Humillic Material

Humillic material, i.e., illuvial humus, accumulates in the lower parts of some organic soils that are acid and have been drained and cultivated. The humillic material has a C^{14} age that is not older than the overlying organic materials. It has very high solubility in sodium pyrophosphate and rewets very slowly after drying. Most commonly, it accumulates near a contact with a sandy mineral horizon.

To be recognized as a differentia in classification, the humillic material must constitute one-half or more (by volume) of a layer 2 cm or more thick.

Limnic Materials

The presence or absence of limnic deposits is taken into account in the higher categories of Histosols but not Histels. The nature of such deposits is considered in the lower categories of Histosols. Limnic materials include both organic and inorganic materials that were either (1) deposited in water by precipitation or through the action of aquatic organisms,



drying, forming clods that are difficult to rewet and often tend to crack along horizontal planes; *and*

4. Either yields a saturated sodium-pyrophosphate extract on white chromatographic or filter paper that has a color value of 7 or more and chroma of 2 or less (fig. 2) or has a cation-exchange capacity of less than 240 cmol(+) per kg organic matter (measured by loss on ignition), or both.

Diatomaceous Earth

A layer of diatomaceous earth is a limnic layer that:

1. If not previously dried, has a matrix color value of 3, 4, or 5, which changes irreversibly on drying as a result of the irreversible shrinkage of organic-matter coatings on diatoms (identifiable by microscopic, 440 X, examination of dry samples); *and*
2. Either yields a saturated sodium-pyrophosphate extract on white chromatographic or filter paper that has a color value of 8 or more and chroma of 2 or less or has a cation-exchange capacity of less than 240 cmol(+) per kg organic matter (by loss on ignition), or both.

Marl

A layer of marl is a limnic layer that:

1. Has a color value, moist, of 5 or more; *and*
2. Reacts with dilute HCl to evolve CO₂.

The color of marl usually does not change irreversibly on drying because a layer of marl contains too little organic matter, even before it has been shrunk by drying, to coat the carbonate particles.

Thickness of Organic Soil Materials (Control Section of Histosols and Histels)

The thickness of organic materials over limnic materials, mineral materials, water, or permafrost is used to define the Histosols and Histels.

For practical reasons, an arbitrary control section has been established for the classification of Histosols and Histels. Depending on the kinds of soil material in the surface layer, the control section has a thickness of either 130 cm or 160 cm from the soil surface if there is no densic, lithic, or paralithic contact, thick layer of water, or permafrost within the respective limit. The thicker control section is used if the surface layer to a depth of 60 cm either contains three-fourths or more fibers derived from *Sphagnum*, *Hypnum*, or other mosses or has a bulk density of less than 0.1. Layers of water, which may be between a few centimeters and many meters thick in these soils, are considered to be the lower boundary of

the control section only if the water extends below a depth of 130 or 160 cm, respectively. A densic, lithic, or paralithic contact, if shallower than 130 or 160 cm, constitutes the lower boundary of the control section. In some soils the lower boundary is 25 cm below the upper limit of permafrost. An unconsolidated mineral substratum shallower than those limits does not change the lower boundary of the control section.

The control section of Histosols and Histels is divided somewhat arbitrarily into three tiers—surface, subsurface, and bottom tiers.

Surface Tier

The surface tier of a Histosol or Histel extends from the soil surface to a depth of 60 cm if either (1) the materials within that depth are fibric and three-fourths or more of the fiber volume is derived from *Sphagnum* or other mosses or (2) the materials have a bulk density of less than 0.1. Otherwise, the surface tier extends from the soil surface to a depth of 30 cm.

Some organic soils have a mineral surface layer less than 40 cm thick as a result of flooding, volcanic eruptions, additions of mineral materials to increase soil strength or reduce the hazard of frost, or other causes. If such a mineral layer is less than 30 cm thick, it constitutes the upper part of the surface tier; if it is 30 to 40 cm thick, it constitutes the whole surface tier and part of the subsurface tier.

Subsurface Tier

The subsurface tier is normally 60 cm thick. If the control section ends at a shallower depth (at a densic, lithic, or paralithic contact or a water layer or in permafrost), however, the subsurface tier extends from the lower boundary of the surface tier to the lower boundary of the control section. It includes any unconsolidated mineral layers that may be present within those depths.

Bottom Tier

The bottom tier is 40 cm thick unless the control section has its lower boundary at a shallower depth (at a densic, lithic, or paralithic contact or a water layer or in permafrost).

Thus, if the organic materials are thick, there are two possible thicknesses of the control section, depending on the presence or absence and the thickness of a surface mantle of fibric moss or other organic material that has a low bulk density (less than 0.1). If the fibric moss extends to a depth of 60 cm and is the dominant material within this depth (three-fourths or more of the volume), the control section is 160 cm thick. If the fibric moss is thin or absent, the control section extends to a depth of 130 cm.

Horizons and Characteristics Diagnostic for Both Mineral and Organic Soils

Following are descriptions of the horizons and characteristics that are diagnostic for both mineral and organic soils.

Aquic Conditions²

Soils with aquic (*L. aqua*, water) conditions are those that currently undergo continuous or periodic saturation and reduction. The presence of these conditions is indicated by redoximorphic features, except in Histosols and Histels, and can be verified by measuring saturation and reduction, except in artificially drained soils. Artificial drainage is defined here as the removal of free water from soils having aquic conditions by surface mounding, ditches, or subsurface tiles to the extent that water table levels are changed significantly in connection with specific types of land use. In the keys, artificially drained soils are included with soils that have aquic conditions.

Elements of aquic conditions are as follows:

1. Saturation is characterized by zero or positive pressure in the soil water and can generally be determined by observing free water in an unlined auger hole. Problems may arise, however, in clayey soils with peds, where an unlined auger hole may fill with water flowing along faces of peds while the soil matrix is and remains unsaturated (bypass flow). Such free water may incorrectly suggest the presence of a water table, while the actual water table occurs at greater depth. Use of well sealed piezometers or tensiometers is therefore recommended for measuring saturation. Problems may still occur, however, if water runs into piezometer slits near the bottom of the piezometer hole or if tensiometers with slowly reacting manometers are used. The first problem can be overcome by using piezometers with smaller slits and the second by using transducer tensiometry, which reacts faster than manometers. Soils are considered wet if they have pressure heads greater than -1 kPa. Only macropores, such as cracks between peds or channels, are then filled with air, while the soil matrix is usually still saturated. Obviously, exact measurements of the wet state can be obtained only with tensiometers. For operational purposes, the use of piezometers is recommended as a standard method.

The duration of saturation required for creating aquic conditions varies, depending on the soil environment, and is not specified.

Three types of saturation are defined:

a. *Endosaturation*.—The soil is saturated with water in all layers from the upper boundary of saturation to a depth of 200 cm or more from the mineral soil surface.

b. *Episaturation*.—The soil is saturated with water in one or more layers within 200 cm of the mineral soil surface and also has one or more unsaturated layers, with an upper boundary above a depth of 200 cm, below the saturated layer. The zone of saturation, i.e., the water table, is perched on top of a relatively impermeable layer.

c. *Anthric saturation*.—This term refers to a special kind of aquic conditions that occur in soils that are cultivated and irrigated (flood irrigation). Soils with anthraquic conditions must meet the requirements for aquic conditions and in addition have *both* of the following:

(1) A tilled surface layer and a directly underlying slowly permeable layer that has, for 3 months or more in normal years, *both*:

(a) Saturation and reduction; *and*

(b) Chroma of 2 or less in the matrix; *and*

(2) A subsurface horizon with *one or more* of the following:

(a) Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less in macropores; *or*

(b) Redox concentrations of iron; *or*

(c) 2 times or more the amount of iron (by dithionite citrate) contained in the tilled surface layer.

2. The degree of reduction in a soil can be characterized by the direct measurement of redox potentials. Direct measurements should take into account chemical equilibria as expressed by stability diagrams in standard soil textbooks. Reduction and oxidation processes are also a function of soil pH. Obtaining accurate measurements of the degree of reduction in a soil is difficult. In the context of this taxonomy, however, only a degree of reduction that results in reduced iron is considered, because it produces the visible redoximorphic features that are identified in the keys. A simple field test is available to determine if reduced iron ions are present. A freshly broken surface of a field-wet soil sample is treated with alpha,alpha-dipyridyl in neutral, 1-normal ammonium-acetate solution. The appearance of a strong red color on the freshly broken surface indicates the presence of reduced iron ions. A positive reaction to the alpha,alpha-dipyridyl field test for ferrous iron (Childs, 1981) may be used to confirm the existence of reducing conditions and is especially useful in situations where, despite saturation, normal morphological indicators of such conditions are either absent or obscured (as by the dark colors characteristic of melanic great groups). A negative reaction, however, does not imply that reducing conditions are always absent. It may only mean that the level of

² In 1992, the term "aquic conditions" was introduced and other changes were made throughout this taxonomy as a result of recommendations submitted to NRCS by the International Committee on Aquic Moisture Regime (ICOMAQ), which was established in 1982 and was chaired initially by Dr. Frank Moormann, then by Dr. Johan Bouma.

free iron in the soil is below the sensitivity limit of the test or that the soil is in an oxidized phase at the time of testing. Use of alpha,alpha-dipyridyl in a 10 percent acetic-acid solution is not recommended because the acid is likely to change soil conditions, for example, by dissolving CaCO_3 .

The duration of reduction required for creating aquic conditions is not specified.

3. Redoximorphic features associated with wetness result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. The reduced iron and manganese ions are mobile and may be transported by water as it moves through the soil. Certain redox patterns occur as a function of the patterns in which the ion-carrying water moves through the soil and as a function of the location of aerated zones in the soil. Redox patterns are also affected by the fact that manganese is reduced more rapidly than iron, while iron oxidizes more rapidly upon aeration. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese are oxidized and precipitated, they form either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redox processes in a soil may result in redoximorphic features that are defined as follows:

- a. *Redox concentrations.*—These are zones of apparent accumulation of Fe-Mn oxides, including:
 - (1) Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure. Boundaries commonly are diffuse if formed *in situ* and sharp after pedoturbation. Sharp boundaries may be relict features in some soils; *and*
 - (2) Masses, which are noncemented concentrations of substances within the soil matrix; *and*
 - (3) Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.
- b. *Redox depletions.*—These are zones of low chroma (chromas less than those in the matrix) where either Fe-Mn oxides alone or both Fe-Mn oxides and clay have been stripped out, including:
 - (1) Iron depletions, i.e., zones that contain low amounts of Fe and Mn oxides but have a clay content similar to

that of the adjacent matrix (often referred to as albans or neobans); *and*

- (2) Clay depletions, i.e., zones that contain low amounts of Fe, Mn, and clay (often referred to as silt coatings or skeletones).

c. *Reduced matrix.*—This is a soil matrix that has low chroma *in situ* but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

d. In soils that have no visible redoximorphic features, a reaction to an alpha,alpha-dipyridyl solution satisfies the requirement for redoximorphic features.

Field experience indicates that it is not possible to define a specific set of redoximorphic features that is uniquely characteristic of all of the taxa in one particular category. Therefore, color patterns that are unique to specific taxa are referenced in the keys.

Antraquic conditions are a variant of episaturation and are associated with controlled flooding (for such crops as wetland rice and cranberries), which causes reduction processes in the saturated, puddled surface soil and oxidation of reduced and mobilized iron and manganese in the unsaturated subsoil.

Cryoturbation

Cryoturbation (frost churning) is the mixing of the soil matrix within the pedon that results in irregular or broken horizons, involutions, accumulation of organic matter on the permafrost table, oriented rock fragments, and silt caps on rock fragments.

Densic Contact

A densic contact (*L. densus*, thick) is a contact between soil and densic materials (defined below). It has no cracks, or the spacing of cracks that roots can enter is 10 cm or more.

Densic Materials

Densic materials are relatively unaltered materials (do not meet the requirements for any other named diagnostic horizons or any other diagnostic soil characteristic) that have a noncemented rupture-resistance class. The bulk density or the organization is such that roots cannot enter, except in cracks. These are mostly earthy materials, such as till, volcanic mudflows, and some mechanically compacted materials, for example, mine spoils. Some noncemented rocks can be densic materials if they are dense or resistant enough to keep roots from entering, except in cracks.

Densic materials are noncemented and thus differ from

paralithic materials and the material below a lithic contact, both of which are cemented.

Densic materials have, at their upper boundary, a densic contact if they have no cracks or if the spacing of cracks that roots can enter is 10 cm or more. These materials can be used to differentiate soil series if the materials are within the series control section.

Gelic Materials

Gelic materials are mineral or organic soil materials that show evidence of cryoturbation (frost churning) and/or ice segregation in the active layer (seasonal thaw layer) and/or the upper part of the permafrost. Cryoturbation is manifested by irregular and broken horizons, involutions, accumulation of organic matter on top of and within the permafrost, oriented rock fragments, and silt-enriched layers. The characteristic structures associated with gelic materials include platy, blocky, or granular macrostructures; the structural results of sorting; and orbicular, conglomeric, banded, or vesicular microfabrics. Ice segregation is manifested by ice lenses, vein ice, segregated ice crystals, and ice wedges. Cryopedogenic processes that lead to gelic materials are driven by the physical volume change of water to ice, moisture migration along a thermal gradient in the frozen system, or thermal contraction of the frozen material by continued rapid cooling.

Glacic Layer

A glacic layer is massive ice or ground ice in the form of ice lenses or wedges. The layer is 30 cm or more thick and contains 75 percent or more visible ice.

Lithic Contact

A lithic contact is the boundary between soil and a coherent underlying material. Except in Ruptic-Lithic subgroups, the underlying material must be virtually continuous within the limits of a pedon. Cracks that can be penetrated by roots are few, and their horizontal spacing is 10 cm or more. The underlying material must be sufficiently coherent when moist to make hand-digging with a spade impractical, although the material may be chipped or scraped with a spade. The material below a lithic contact must be in a strongly cemented or more cemented rupture-resistance class. Commonly, the material is indurated. The underlying material considered here does not include diagnostic soil horizons, such as a duripan or a petrocalcic horizon.

A lithic contact is diagnostic at the subgroup level if it is within 125 cm of the mineral soil surface in Oxisols and within 50 cm of the mineral soil surface in all other mineral soils. In organic soils the lithic contact must be within the control section to be recognized at the subgroup level.

Paralithic Contact

A paralithic (lithiclike) contact is a contact between soil and paralithic materials (defined below) where the paralithic materials have no cracks or the spacing of cracks that roots can enter is 10 cm or more.

Paralithic Materials

Paralithic materials are relatively unaltered materials (do not meet the requirements for any other named diagnostic horizons or any other diagnostic soil characteristic) that have an extremely weakly cemented to moderately cemented rupture-resistance class. Cementation, bulk density, and the organization are such that roots cannot enter, except in cracks. Paralithic materials have, at their upper boundary, a paralithic contact if they have no cracks or if the spacing of cracks that roots can enter is 10 cm or more. Commonly, these materials are partially weathered bedrock or weakly consolidated bedrock, such as sandstone, siltstone, or shale. Paralithic materials can be used to differentiate soil series if the materials are within the series control section. Fragments of paralithic materials 2.0 mm or more in diameter are referred to as pararock fragments.

Permafrost

Permafrost is defined as a thermal condition in which a material (including soil material) remains below 0 °C for 2 or more years in succession. Those gelic materials having permafrost contain the unfrozen soil solution that drives cryopedogenic processes. Permafrost may be cemented by ice or, in the case of insufficient interstitial water, may be dry. The frozen layer has a variety of ice lenses, vein ice, segregated ice crystals, and ice wedges. The permafrost table is in dynamic equilibrium with the environment.

Soil Moisture Regimes

The term “soil moisture regime” refers to the presence or absence either of ground water or of water held at a tension of less than 1500 kPa in the soil or in specific horizons during periods of the year. Water held at a tension of 1500 kPa or more is not available to keep most mesophytic plants alive. The availability of water is also affected by dissolved salts. If a soil is saturated with water that is too salty to be available to most plants, it is considered salty rather than dry. Consequently, a horizon is considered dry when the moisture tension is 1500 kPa or more and is considered moist if water is held at a tension of less than 1500 kPa but more than zero. A soil may be continuously moist in some or all horizons either throughout the year or for some part of the year. It may be either moist in winter and dry in summer or the reverse. In the Northern

Hemisphere, summer refers to June, July, and August and winter refers to December, January, and February.

Normal Years

In the discussions that follow and throughout the keys, the term “normal years” is used. A normal year is defined as a year that has plus or minus one standard deviation of the long-term mean annual precipitation. (Long-term refers to 30 years or more.) Also, the mean monthly precipitation during a normal year must be plus or minus one standard deviation of the long-term monthly precipitation for 8 of the 12 months. For the most part, normal years can be calculated from the mean annual precipitation. When catastrophic events occur during a year, however, the standard deviations of the monthly means should also be calculated. The term “normal years” replaces the terms “most years” and “6 out of 10 years,” which were used in the 1975 edition of *Soil Taxonomy* (USDA, SCS, 1975).

Soil Moisture Control Section

The intent in defining the soil moisture control section is to facilitate estimation of soil moisture regimes from climatic data. The upper boundary of this control section is the depth to which a dry (tension of more than 1500 kPa, but not air-dry) soil will be moistened by 2.5 cm of water within 24 hours. The lower boundary is the depth to which a dry soil will be moistened by 7.5 cm of water within 48 hours. These depths do not include the depth of moistening along any cracks or animal burrows that are open to the surface.

If 7.5 cm of water moistens the soil to a densic, lithic, paralithic, or petroferric contact or to a petrocalcic or petrogypsic horizon or a duripan, the contact or the upper boundary of the cemented horizon constitutes the lower boundary of the soil moisture control section. If a soil is moistened to one of these contacts or horizons by 2.5 cm of water, the soil moisture control section is the boundary or the contact itself. The control section of such a soil is considered moist if the contact or upper boundary of the cemented horizon has a thin film of water. If that upper boundary is dry, the control section is considered dry.

The moisture control section of a soil extends approximately (1) from 10 to 30 cm below the soil surface if the particle-size class of the soil is fine-loamy, coarse-silty, fine-silty, or clayey; (2) from 20 to 60 cm if the particle-size class is coarse-loamy; and (3) from 30 to 90 cm if the particle-size class is sandy. If the soil contains rock and pararock fragments that do not absorb and release water, the limits of the moisture control section are deeper. The limits of the soil moisture control section are affected not only by the particle-size class but also by differences in soil structure or pore-size distribution or by other factors that influence the movement and retention of water in the soil.

Classes of Soil Moisture Regimes

The soil moisture regimes are defined in terms of the level of ground water and in terms of the seasonal presence or absence of water held at a tension of less than 1500 kPa in the moisture control section. It is assumed in the definitions that the soil supports whatever vegetation it is capable of supporting, i.e., crops, grass, or native vegetation, and that the amount of stored moisture is not being increased by irrigation or fallowing. These cultural practices affect the soil moisture conditions as long as they are continued.

Aquic moisture regime.—The aquic (*L. aqua*, water) moisture regime is a reducing regime in a soil that is virtually free of dissolved oxygen because it is saturated by water. Some soils are saturated with water at times while dissolved oxygen is present, either because the water is moving or because the environment is unfavorable for micro-organisms (e.g., if the temperature is less than 1 °C); such a regime is not considered aquic.

It is not known how long a soil must be saturated before it is said to have an aquic moisture regime, but the duration must be at least a few days, because it is implicit in the concept that dissolved oxygen is virtually absent. Because dissolved oxygen is removed from ground water by respiration of micro-organisms, roots, and soil fauna, it is also implicit in the concept that the soil temperature is above biologic zero for some time while the soil is saturated. Biologic zero is defined as 5 °C in this taxonomy. In some of the very cold regions of the world, however, biological activity occurs at temperatures below 5 °C.

Very commonly, the level of ground water fluctuates with the seasons; it is highest in the rainy season or in fall, winter, or spring if cold weather virtually stops evapotranspiration. There are soils, however, in which the ground water is always at or very close to the surface. Examples are soils in tidal marshes or in closed, landlocked depressions fed by perennial streams. Such soils are considered to have a peraquic moisture regime.

Aridic and torric (*L. aridus*, dry, and *L. torridus*, hot and dry) moisture regimes.—These terms are used for the same moisture regime but in different categories of the taxonomy.

In the aridic (torric) moisture regime, the moisture control section is, in normal years:

1. Dry in all parts for more than half of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is above 5 °C; *and*
2. Moist in some or all parts for less than 90 consecutive days when the soil temperature at a depth of 50 cm is above 8 °C.

Soils that have an aridic (torric) moisture regime normally occur in areas of arid climates. A few are in areas of semiarid climates and either have physical properties that keep them

dry, such as a crusty surface that virtually precludes the infiltration of water, or are on steep slopes where runoff is high. There is little or no leaching in this moisture regime, and soluble salts accumulate in the soils if there is a source.

The limits set for soil temperature exclude from these moisture regimes soils in the very cold and dry polar regions and in areas at high elevations. Such soils are considered to have anhydrous conditions (defined earlier).

Udic moisture regime.—The udic (*L. udus*, humid) moisture regime is one in which the soil moisture control section is not dry in any part for as long as 90 cumulative days in normal years. If the mean annual soil temperature is lower than 22 °C and if the mean winter and mean summer soil temperatures at a depth of 50 cm from the soil surface differ by 5 °C or more, the soil moisture control section, in normal years, is dry in all parts for less than 45 consecutive days in the 4 months following the summer solstice. In addition, the udic moisture regime requires, except for short periods, a three-phase system, solid-liquid-gas, in part or all of the soil moisture control section when the soil temperature is above 5 °C.

The udic moisture regime is common to the soils of humid climates that have well distributed rainfall; have enough rain in summer so that the amount of stored moisture plus rainfall is approximately equal to, or exceeds, the amount of evapotranspiration; or have adequate winter rains to recharge the soils and cool, foggy summers, as in coastal areas. Water moves downward through the soils at some time in normal years.

In climates where precipitation exceeds evapotranspiration in all months of normal years, the moisture tension rarely reaches 100 kPa in the soil moisture control section, although there are occasional brief periods when some stored moisture is used. The water moves through the soil in all months when it is not frozen. Such an extremely wet moisture regime is called perudic (*L. per*, throughout in time, and *L. udus*, humid). In the names of most taxa, the formative element “ud” is used to indicate either a udic or a perudic regime; the formative element “per” is used in selected taxa.

Ustic moisture regime.—The ustic (*L. ustus*, burnt; implying dryness) moisture regime is intermediate between the aridic regime and the udic regime. Its concept is one of moisture that is limited but is present at a time when conditions are suitable for plant growth. The concept of the ustic moisture regime is not applied to soils that have permafrost or a cryic soil temperature regime (defined below).

If the mean annual soil temperature is 22 °C or higher or if the mean summer and winter soil temperatures differ by less than 6 °C at a depth of 50 cm below the soil surface, the soil moisture control section in areas of the ustic moisture regime is dry in some or all parts for 90 or more cumulative days in normal years. It is moist, however, in some part either for more than 180 cumulative days per year or for 90 or more consecutive days.

If the mean annual soil temperature is lower than 22 °C and if the mean summer and winter soil temperatures differ by 6 °C or more at a depth of 50 cm from the soil surface, the soil moisture control section in areas of the ustic moisture regime is dry in some or all parts for 90 or more cumulative days in normal years, but it is not dry in all parts for more than half of the cumulative days when the soil temperature at a depth of 50 cm is higher than 6 °C. If in normal years the moisture control section is moist in all parts for 45 or more consecutive days in the 4 months following the winter solstice, the moisture control section is dry in all parts for less than 45 consecutive days in the 4 months following the summer solstice.

In tropical and subtropical regions that have a monsoon climate with either one or two dry seasons, summer and winter seasons have little meaning. In those regions the moisture regime is ustic if there is at least one rainy season of 3 months or more. In temperate regions of subhumid or semiarid climates, the rainy seasons are usually spring and summer or spring and fall, but never winter. Native plants are mostly annuals or plants that have a dormant period while the soil is dry.

Xeric moisture regime.—The xeric (*Gr. xeros*, dry) moisture regime is the typical moisture regime in areas of Mediterranean climates, where winters are moist and cool and summers are warm and dry. The moisture, which falls during the winter, when potential evapotranspiration is at a minimum, is particularly effective for leaching. In areas of a xeric moisture regime, the soil moisture control section, in normal years, is dry in all parts for 45 or more consecutive days in the 4 months following the summer solstice and moist in all parts for 45 or more consecutive days in the 4 months following the winter solstice. Also, in normal years, the moisture control section is moist in some part for more than half of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is higher than 6 °C or for 90 or more consecutive days when the soil temperature at a depth of 50 cm is higher than 8 °C. The mean annual soil temperature is lower than 22 °C, and the mean summer and mean winter soil temperatures differ by 6 °C or more either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact if shallower.

Soil Temperature Regimes

Classes of Soil Temperature Regimes

Following is a description of the soil temperature regimes used in defining classes at various categoric levels in this taxonomy.

Cryic (Gr. *kryos*, coldness; meaning very cold soils).—Soils in this temperature regime have a mean annual temperature lower than 8 °C but do not have permafrost.

1. In mineral soils the mean summer soil temperature (June, July, and August in the Northern Hemisphere and December,

January, and February in the Southern Hemisphere) either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower, is as follows:

- a. If the soil is not saturated with water during some part of the summer and
 - (1) If there is no O horizon: lower than 15 °C; *or*
 - (2) If there is an O horizon: lower than 8 °C; *or*
 - b. If the soil is saturated with water during some part of the summer and
 - (1) If there is no O horizon: lower than 13 °C; *or*
 - (2) If there is an O horizon or a histic epipedon: lower than 6 °C.
2. In organic soils the mean annual soil temperature is lower than 6 °C.

Cryic soils that have an aquic moisture regime commonly are churned by frost.

Isofrigid soils could also have a cryic temperature regime. A few with organic materials in the upper part are exceptions.

The concepts of the soil temperature regimes described below are used in defining classes of soils in the low categories.

Frigid.—A soil with a frigid temperature regime is warmer in summer than a soil with a cryic regime, but its mean annual temperature is lower than 8 °C and the difference between mean summer (June, July, and August) and mean winter (December, January, and February) soil temperatures is more than 6 °C either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower.

Mesic.—The mean annual soil temperature is 8 °C or higher but lower than 15 °C, and the difference between mean summer and mean winter soil temperatures is more than 6 °C either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower.

Thermic.—The mean annual soil temperature is 15 °C or higher but lower than 22 °C, and the difference between mean summer and mean winter soil temperatures is more than 6 °C either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower.

Hyperthermic.—The mean annual soil temperature is 22 °C or higher, and the difference between mean summer and mean winter soil temperatures is more than 6 °C either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower.

If the name of a soil temperature regime has the prefix *iso*, the mean summer and mean winter soil temperatures differ by less than 6 °C at a depth of 50 cm or at a densic, lithic, or paralithic contact, whichever is shallower.

Isofrigid.—The mean annual soil temperature is lower than 8 °C.

Isomesic.—The mean annual soil temperature is 8 °C or higher but lower than 15 °C.

Isothermic.—The mean annual soil temperature is 15 °C or higher but lower than 22 °C.

Isohyperthermic.—The mean annual soil temperature is 22 °C or higher.

Sulfidic Materials

Sulfidic materials contain oxidizable sulfur compounds. They are mineral or organic soil materials that have a pH value of more than 3.5 and that, if incubated as a layer 1 cm thick under moist aerobic conditions (field capacity) at room temperature, show a drop in pH of 0.5 or more units to a pH value of 4.0 or less (1:1 by weight in water or in a minimum of water to permit measurement) within 8 weeks.

Sulfidic materials accumulate as a soil or sediment that is permanently saturated, generally with brackish water. The sulfates in the water are biologically reduced to sulfides as the materials accumulate. Sulfidic materials most commonly accumulate in coastal marshes near the mouth of rivers that carry noncalcareous sediments, but they may occur in freshwater marshes if there is sulfur in the water. Upland sulfidic materials may have accumulated in a similar manner in the geologic past.

If a soil containing sulfidic materials is drained or if sulfidic materials are otherwise exposed to aerobic conditions, the sulfides oxidize and form sulfuric acid. The pH value, which normally is near neutrality before drainage or exposure, may drop below 3. The acid may induce the formation of iron and aluminum sulfates. The iron sulfate, jarosite, may segregate, forming the yellow redoximorphic concentrations that commonly characterize a sulfuric horizon. The transition from sulfidic materials to a sulfuric horizon normally requires very few years and may occur within a few weeks. A sample of sulfidic materials, if air-dried slowly in shade for about 2 months with occasional remoistening, becomes extremely acid.

Sulfuric Horizon

Required Characteristics

The sulfuric (*L. sulfur*) horizon is 15 cm or more thick and is composed of either mineral or organic soil material that has a pH value of 3.5 or less (1:1 by weight in water or in a minimum of water to permit measurement) and shows evidence that the low pH value is caused by sulfuric acid. The evidence is *one or more* of the following:

1. Jarosite concentrations; *or*
2. Directly underlying sulfidic materials (defined above); *or*
3. 0.05 percent or more water-soluble sulfate.

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CHAPTER 4

Identification of the Taxonomic Class of a Soil

The taxonomic class of a specific soil can be determined by using the keys that follow in this and other chapters. It is assumed that the reader is familiar with the definitions of diagnostic horizons and properties that are given in chapters 2 and 3 of this publication and with the meanings of the terms used for describing soils given in the *Soil Survey Manual*. The Index at the back of this publication indicates the pages on which definitions of terms are given.

Standard rounding conventions should be used to determine numerical values.

Soil colors (hue, value, and chroma) are used in many of the criteria that follow. Soil colors typically change value and some change hue and chroma, depending on the water state. In many of the criteria of the keys, the water state is specified. If no water state is specified, the soil is considered to meet the criterion if it does so when moist or dry or both moist and dry.

All of the keys in this taxonomy are designed in such a way that the user can determine the correct classification of a soil by going through the keys systematically. The user must start at the beginning of the “Key to Soil Orders” and eliminate, one by one, all classes that include criteria that do not fit the soil in question. The soil belongs to the first class listed for which it meets all the required criteria.

In classifying a specific soil, the user of soil taxonomy begins by checking through the “Key to Soil Orders” to determine the name of the first order that, according to the criteria listed, includes the soil in question. The next step is to go to the page indicated to find the “Key to Suborders” of that particular order. Then the user systematically goes through the key to identify the suborder that includes the soil, i.e., the first in the list for which it meets all the required criteria. The same procedure is used to find the great group class of the soil in the “Key to Great Groups” of the identified suborder. Likewise, going through the “Key to Subgroups” of that great group, the user selects as the correct subgroup name the name of the first taxon for which the soil meets all of the required criteria.

The family level is determined, in a similar manner, after the subgroup has been determined. Chapter 17 can be used, as one would use other keys in this taxonomy, to determine which components are part of the family. The family, however, typically has more than one component, and therefore the entire chapter must be used. The keys to control

sections for classes used as components of a family must be used to determine the control section before use of the keys to classes.

The descriptions and definitions of individual soil series are not included in this text. Definitions of the series and of the control section are given in chapter 17.

In the “Key to Soil Orders” and the other keys that follow, the diagnostic horizons and the properties mentioned do not include those below any densic, lithic, paralithic, or petroferic contact. The properties of buried soils and the properties of a surface mantle are considered on the basis of whether or not the soil meets the meaning of the term “buried soil” given in chapter 1.

If a soil has a surface mantle and is not a buried soil, the top of the original surface layer is considered the “soil surface” for determining depth to and thickness of diagnostic horizons and most other diagnostic soil characteristics. The only properties of the surface mantle that are considered are soil temperature, soil moisture (including aquic conditions), and any andic or vitrandic properties.

If a soil profile includes a buried soil, the present soil surface is used to determine soil moisture and temperature as well as depth to and thickness of diagnostic horizons and other diagnostic soil characteristics. Diagnostic horizons of the buried soil are not considered in selecting taxa unless the criteria in the keys specifically indicate buried horizons, such as in Thapto-Histic subgroups. Most other diagnostic soil characteristics of the buried soil are not considered, but organic carbon if of Holocene age, andic soil properties, base saturation, and all properties used to determine family and series placement are considered.

Key to Soil Orders

A. Soils that have:

1. Permafrost within 100 cm of the soil surface; *or*
2. Gelic materials within 100 cm of the soil surface and permafrost within 200 cm of the soil surface.

Gelisols, p. 149

B. Other soils that:

1. Do not have andic soil properties in 60 percent or more

of the thickness between the soil surface and either a depth of 60 cm or a densic, lithic, or paralithic contact or duripan if shallower; *and*

2. Have organic soil materials that meet *one or more* of the following:

a. Overlie cindery, fragmental, or pumiceous materials and/or fill their interstices¹ *and* directly below these materials, have a densic, lithic, or paralithic contact; *or*

b. When added with the underlying cindery, fragmental, or pumiceous materials, total 40 cm or more between the soil surface and a depth of 50 cm; *or*

c. Constitute two-thirds or more of the total thickness of the soil to a densic, lithic, or paralithic contact *and* have no mineral horizons or have mineral horizons with a total thickness of 10 cm or less; *or*

d. Are saturated with water for 30 days or more per year in normal years (or are artificially drained), have an upper boundary within 40 cm of the soil surface, and have a total thickness of *either*:

(1) 60 cm or more if three-fourths or more of their volume consists of moss fibers or if their bulk density, moist, is less than 0.1 g/cm³; *or*

(2) 40 cm or more if they consist either of sapric or hemic materials, or of fibric materials with less than three-fourths (by volume) moss fibers and a bulk density, moist, of 0.1 g/cm³ or more.

Histosols, p. 159

C. Other soils that do not have a plaggen epipedon or an argillic or kandic horizon above a spodic horizon, *and* have *one or more* of the following:

1. A spodic horizon, an albic horizon in 50 percent or more of each pedon, and a cryic soil temperature regime; *or*

2. An Ap horizon containing 85 percent or more spodic materials; *or*

3. A spodic horizon with *all* of the following characteristics:

a. *One or more* of the following:

(1) A thickness of 10 cm or more; *or*

(2) An overlying Ap horizon; *or*

(3) Cementation in 50 percent or more of each pedon; *or*

(4) A coarse-loamy, loamy-skeletal, or finer particle-size class and a frigid temperature regime in the soil; *or*

(5) A cryic temperature regime in the soil; *and*

b. An upper boundary within the following depths from the mineral soil surface: *either*

(1) Less than 50 cm; *or*

(2) Less than 200 cm if the soil has a sandy particle-size class in at least some part between the mineral soil surface and the spodic horizon; *and*

c. A lower boundary as follows:

(1) *Either* at a depth of 25 cm or more below the mineral soil surface or at the top of a duripan or fragipan or at a densic, lithic, paralithic, or petroferic contact, whichever is shallowest; *or*

(2) At any depth,

(a) If the spodic horizon has a coarse-loamy, loamy-skeletal, or finer particle-size class and the soil has a frigid temperature regime; *or*

(b) If the soil has a cryic temperature regime; *and*

d. *Either*:

(1) A directly overlying albic horizon in 50 percent or more of each pedon; *or*

(2) No andic soil properties in 60 percent or more of the thickness *either*:

(a) Within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

(b) Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon.

Spodosols, p. 249

D. Other soils that have andic soil properties in 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is

¹ Materials that meet the definition of cindery, fragmental, or pumiceous but have more than 10 percent, by volume, voids that are filled with organic soil materials are considered to be organic soil materials.

shallower, and a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon.

Andisols, p. 83

E. Other soils that have *either*:

1. An oxic horizon that has its upper boundary within 150 cm of the mineral soil surface and no kandic horizon that has its upper boundary within that depth; *or*
2. 40 percent or more (by weight) clay in the fine-earth fraction between the mineral soil surface and a depth of 18 cm (after mixing) *and* a kandic horizon that has the weatherable-mineral properties of an oxic horizon and has its upper boundary within 100 cm of the mineral soil surface.

Oxisols, p. 233

F. Other soils that have:

1. A layer 25 cm or more thick, with an upper boundary within 100 cm of the mineral soil surface, that has *either* slickensides *or* wedge-shaped peds that have their long axes tilted 10 to 60 degrees from the horizontal; *and*
2. A weighted average of 30 percent or more clay in the fine-earth fraction either between the mineral soil surface and a depth of 18 cm or in an Ap horizon, whichever is thicker, *and* 30 percent or more clay in the fine-earth fraction of all horizons between a depth of 18 cm and either a depth of 50 cm or a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon if shallower; *and*
3. Cracks² that open and close periodically.

Vertisols, p. 281

G. Other soils that:

1. Have:
 - a. An aridic soil moisture regime; *and*
 - b. An ochric or anthropic epipedon; *and*
 - c. *One or more* of the following with the upper boundary within 100 cm of the soil surface: a cambic horizon with a lower depth of 25 cm or more; a cryic temperature regime and a cambic horizon; a calcic, gypsic, petrocalcic, petrogypsic, or salic horizon; or a duripan; *or*
 - d. An argillic or natric horizon; *or*
2. Have a salic horizon; *and*

- a. Saturation with water in one or more layers within 100 cm of the soil surface for 1 month or more during a normal year; *and*
- b. A moisture control section that is dry in some or all parts at some time during normal years; *and*
- c. No sulfuric horizon that has its upper boundary within 150 cm of the mineral soil surface.

Aridisols, p. 103

H. Other soils that have *either*:

1. An argillic or kandic horizon, but no fragipan, and a base saturation (by sum of cations) of less than 35 percent at one of the following depths:
 - a. If the epipedon has a sandy or sandy-skeletal particle-size class throughout, *either*:
 - (1) 125 cm below the upper boundary of the argillic horizon (but no deeper than 200 cm below the mineral soil surface) or 180 cm below the mineral soil surface, whichever is deeper; *or*
 - (2) At a densic, lithic, paralithic, or petroferic contact if shallower; *or*
 - b. The shallowest of the following depths:
 - (1) 125 cm below the upper boundary of the argillic or kandic horizon; *or*
 - (2) 180 cm below the mineral soil surface; *or*
 - (3) At a densic, lithic, paralithic, or petroferic contact; *or*
2. A fragipan and *both* of the following:
 - a. Either an argillic or a kandic horizon above, within, or below it or clay films 1 mm or more thick in one or more of its subhorizons; *and*
 - b. A base saturation (by sum of cations) of less than 35 percent at the shallowest of the following depths:
 - (1) 75 cm below the upper boundary of the fragipan; *or*
 - (2) 200 cm below the mineral soil surface; *or*
 - (3) At a densic, lithic, paralithic, or petroferic contact.

Ultisols, p. 259

I. Other soils that have *both* of the following:

1. *Either*:
 - a. A mollic epipedon; *or*
 - b. *Both* a surface horizon that meets all the requirements for a mollic epipedon except thickness after

² A crack is a separation between gross polyhedrons. If the surface is strongly self-mulching, i.e., a mass of granules, or if the soil is cultivated while cracks are open, the cracks may be filled mainly by granular materials from the surface, but they are open in the sense that the polyhedrons are separated. A crack is regarded as open if it controls the infiltration and percolation of water in a dry, clayey soil.

the soil has been mixed to a depth of 18 cm *and* a subhorizon more than 7.5 cm thick, within the upper part of an argillic, kandic, or natric horizon, that meets the color, organic-carbon content, base saturation, and structure requirements of a mollic epipedon but is separated from the surface horizon by an albic horizon; *and*

2. A base saturation of 50 percent or more (by NH_4OAc) in all horizons *either* between the upper boundary of any argillic, kandic, or natric horizon and a depth of 125 cm below that boundary, *or* between the mineral soil surface and a depth of 180 cm, *or* between the mineral soil surface and a densic, lithic, or paralithic contact, whichever depth is shallowest.

Mollisols, p. 191

J. Other soils that do not have a plaggen epipedon and that have *either*:

1. An argillic, kandic, or natric horizon; *or*
2. A fragipan that has clay films 1 mm or more thick in some part.

Alfisols, p. 41

K. Other soils that have *either*:

1. *One or more* of the following:
 - a. A cambic horizon with 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*
 - b. A calcic, petrocalcic, gypsic, petrogypsic, or placic horizon or a duripan with an upper boundary

within a depth of 100 cm of the mineral soil surface; *or*

- c. A fragipan or an oxic, sombric, or spodic horizon with an upper boundary within 200 cm of the mineral soil surface; *or*
- d. A sulfuric horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*
- e. A cryic temperature regime and a cambic horizon; *or*

2. No sulfidic materials within 50 cm of the mineral soil surface; *and both*:

- a. In one or more horizons between 20 and 50 cm below the mineral soil surface, either an n value of 0.7 or less or less than 8 percent clay in the fine-earth fraction; *and*

- b. *One or both* of the following:

- (1) A salic horizon or a histic, mollic, plaggen, or umbric epipedon; *or*
- (2) In 50 percent or more of the layers between the mineral soil surface and a depth of 50 cm, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more), which decreases with increasing depth below 50 cm, *and* also ground water within 100 cm of the mineral soil surface at some time during the year when the soil is not frozen in any part.

Inceptisols, p. 165

L. Other soils.

Entisols, p. 129

CHAPTER 5

Alfisols

Key to Suborders

JA. Alfisols that have, in one or more horizons within 50 cm of the mineral soil surface, aquic conditions (other than anthraquic conditions) for some time in normal years (or artificial drainage) *and* have *one or both* of the following:

1. Redoximorphic features in all layers between either the lower boundary of an Ap horizon or a depth of 25 cm below the mineral soil surface, whichever is deeper, and a depth of 40 cm; *and one* of the following within the upper 12.5 cm of the argillic, natric, glossic, or kandic horizon:
 - a. 50 percent or more redox depletions with chroma of 2 or less on faces of peds and redox concentrations within peds; *or*
 - b. Redox concentrations and 50 percent or more redox depletions with chroma of 2 or less in the matrix; *or*
 - c. 50 percent or more redox depletions with chroma of 1 or less on faces of peds or in the matrix, or both; *or*
2. In the horizons that have aquic conditions, enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

[Aqualfs](#), p. 41

JB. Other Alfisols that have a cryic or isofrigid temperature regime.

[Cryalfs](#), p. 50

JC. Other Alfisols that have an ustic moisture regime.

[Ustalfs](#), p. 65

JD. Other Alfisols that have a xeric moisture regime.

[Xeralfs](#), p. 76

JE. Other Alfisols.

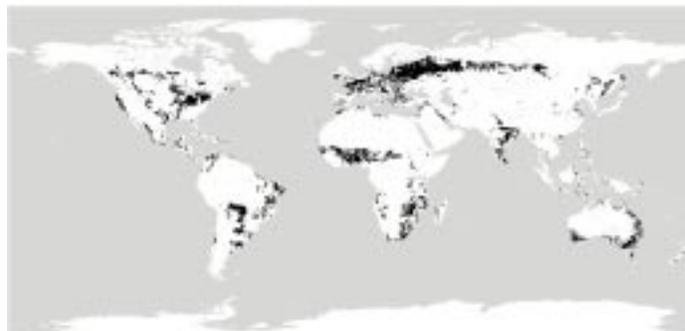
[Udalfs](#), p. 54

Aqualfs

Key to Great Groups

JAA. Aqualfs that have a cryic temperature regime.

[Cryaqualfs](#), p. 43



A
L
F

JAB. Other Aqualfs that have one or more horizons, at a depth between 30 and 150 cm from the mineral soil surface, in which plinthite either forms a continuous phase or constitutes one-half or more of the volume.

[Plinthaqualfs](#), p. 50

JAC. Other Aqualfs that have a duripan.

[Duraqualfs](#), p. 43

JAD. Other Aqualfs that have a natric horizon.

[Natraqualfs](#), p. 49

JAE. Other Aqualfs that have a fragipan with an upper boundary within 100 cm of the mineral soil surface.

[Fragiaqualfs](#), p. 47

JAF. Other Aqualfs that have a kandic horizon.

[Kandiaqualfs](#), p. 48

JAG. Other Aqualfs that have one or more layers, at least 25 cm thick (cumulative) within 100 cm of the mineral soil surface, that have 50 percent or more (by volume) recognizable bioturbation, such as filled animal burrows, wormholes, or casts.

[Vermaqualfs](#), p. 50

JAH. Other Aqualfs that have an abrupt textural change between the ochric epipedon or the albic horizon and the argillic horizon and have a moderately low or lower saturated hydraulic conductivity in the argillic horizon.

[Albaqualfs](#), p. 42

JAI. Other Aqualfs that have a glossic horizon.
[Glossaqualfs](#), p. 48

JAJ. Other Aqualfs that have episaturation.
[Epiqualfs](#), p. 45

JAK. Other Aqualfs.
[Endoqualfs](#), p. 43

Albaqualfs

Key to Subgroups

JAHA. Albaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more below the mineral soil surface.

Arenic Albaqualfs

JAHB. Other Albaqualfs that have *both* of the following:

1. *One or both*:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. Chroma of 3 or more in 40 percent or more of the matrix between the lower boundary of the A or Ap horizon and a depth of 75 cm from the mineral soil surface.

Aeric Vertic Albaqualfs

JAHC. Other Albaqualfs that have *both* of the following:

1. *One or both*:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. An Ap horizon or materials between the mineral soil surface and a depth of 18 cm that, after mixing, have *one or more* of the following:

- a. A color value, moist, of 4 or more; *or*
- b. A color value, dry, of 6 or more; *or*
- c. Chroma of 4 or more.

Chromic Vertic Albaqualfs

JAHD. Other Albaqualfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Albaqualfs

JAHE. Other Albaqualfs that have *both*:

1. Chroma of 3 or more in 40 percent or more of the matrix between the lower boundary of the A or Ap horizon and a depth of 75 cm from the mineral soil surface; *and*
2. A mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Udolic Albaqualfs

JAHF. Other Albaqualfs that have chroma of 3 or more in 40 percent or more of the matrix between the lower boundary of the A or Ap horizon and a depth of 75 cm from the mineral soil surface.

Aeric Albaqualfs

JAHG. Other Albaqualfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium

oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Albaqualfs

JAHH. Other Albaqualfs that have a mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Albaqualfs

JAHI. Other Albaqualfs that have an umbric epipedon, an Ap horizon that meets all of the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Umbric Albaqualfs

JAHJ. Other Albaqualfs.

Typic Albaqualfs

Cryaqualfs

Key to Subgroups

JAAA. All Cryaqualfs (provisionally).

Typic Cryaqualfs

Duraqualfs

Key to Subgroups

JACA. All Duraqualfs (provisionally).

Typic Duraqualfs

Endoaqualfs

Key to Subgroups

JAKA. Endoaqualfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Endoaqualfs

JAKB. Other Endoaqualfs that have *both* of the following:

1. *One or both*:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. An Ap horizon or materials between the mineral soil surface and a depth of 18 cm that, after mixing, have *one or more* of the following:

- a. A color value, moist, of 4 or more; *or*
- b. A color value, dry, of 6 or more; *or*
- c. Chroma of 4 or more.

Chromic Vertic Endoaqualfs

JAKC. Other Endoaqualfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Endoaqualfs

JAKD. Other Endoaqualfs that have:

1. Fragic soil properties:

a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one or a combination of the following colors:

a. Hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

(1) If peds are present, chroma of 2 or more on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less in ped interiors; *or*

(2) If peds are absent, chroma of 2 or more in 50 percent or more of the matrix; *or*

b. In 50 percent or more of the matrix, hue of 10YR or yellower *and either*:

(1) Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*

(2) Chroma of 2 or more if there are no redox concentrations.

Aeric Fragic Endoaqualfs

JAKE. Other Endoaqualfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Endoaqualfs

JAKF. Other Endoaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm below the mineral soil surface.

Arenic Endoaqualfs

JAKG. Other Endoaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more below the mineral soil surface.

Grossarenic Endoaqualfs

JAKH. Other Endoaqualfs that have *both*:

1. A mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one or a combination of the following colors:

a. Hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

(1) If peds are present, chroma of 2 or more on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less in ped interiors; *or*

(2) If peds are absent, chroma of 2 or more in 50 percent or more of the matrix; *or*

b. In 50 percent or more of the matrix, hue of 10YR or yellower *and either*:

(1) Both a color value of 3 or more (moist) and chroma of 3 or more; *or*

(2) Chroma of 2 or more if there are no redox concentrations.

Udolic Endoaqualfs

JAKI. Other Endoaqualfs that have *both*:

1. An umbric epipedon, an Ap horizon that meets all of the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one or a combination of the following colors:

a. Hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

(1) If peds are present, chroma of 2 or more on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less in ped interiors; *or*

(2) If peds are absent, chroma of 2 or more in 50 percent or more of the matrix; *or*

b. In 50 percent or more of the matrix, hue of 10YR or yellower *and either*:

(1) Both a color value of 3 or more (moist) and chroma of 3 or more; *or*

(2) Chroma of 2 or more if there are no redox concentrations.

Aeric Umbric Endoaqualfs

JAKJ. Other Endoaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:

1. Hue of 7.5YR or redder; *and*

a. If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*

- b. If peds are absent, chroma of 2 or more (both moist and dry); *or*
- 2. Hue of 10YR or yellower *and either*:
 - a. Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*
 - b. Chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Endoaqualfs

JAKK. Other Endoaqualfs that have a mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Endoaqualfs

JAKL. Other Endoaqualfs that have an umbric epipedon, an Ap horizon that meets all of the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Umbric Endoaqualfs

JAKM. Other Endoaqualfs.

Typic Endoaqualfs

Epiaqualfs

Key to Subgroups

JAJA. Epiaqualfs that have *all* of the following:

1. *One or both*:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:
 - a. Hue of 7.5YR or redder; *and*
 - (1) If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors

or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*

(2) If peds are absent, chroma of 2 or more (both moist and dry); *or*

b. Hue of 10YR or yellower *and either*:

(1) Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*

(2) Chroma of 2 or more (both moist and dry) and no redox concentrations; *and*

3. An Ap horizon or materials between the mineral soil surface and a depth of 18 cm that, after mixing, have *one or more* of the following:

- a. A color value, moist, of 4 or more; *or*
- b. A color value, dry, of 6 or more; *or*
- c. Chroma of 4 or more.

Aeric Chromic Vertic Epiaqualfs

JAJB. Other Epiaqualfs that have *both* of the following:

1. *One or both*:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:
 - a. Hue of 7.5YR or redder; *and*
 - (1) If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*
 - (2) If peds are absent, chroma of 2 or more (both moist and dry); *or*
- b. Hue of 10YR or yellower *and either*:
 - (1) Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*

- (2) Chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Vertic Epiaqualfs

JAJC. Other Epiaqualfs that have *both* of the following:

1. *One or both*:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. An Ap horizon or materials between the mineral soil surface and a depth of 18 cm that, after mixing, have *one or more* of the following:
 - a. A color value, moist, of 4 or more; *or*
 - b. A color value, dry, of 6 or more; *or*
 - c. Chroma of 4 or more.

Chromic Vertic Epiaqualfs

JAJD. Other Epiaqualfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Epiaqualfs

JAJE. Other Epiaqualfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

- a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
- b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Epiaqualfs

JAJF. Other Epiaqualfs that have:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:
 - a. Hue of 7.5YR or redder; *and*
 - (1) If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*
 - (2) If peds are absent, chroma of 2 or more (both moist and dry); *or*
 - b. Hue of 10YR or yellower *and either*:
 - (1) Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*
 - (2) Chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Fragic Epiaqualfs

JAJG. Other Epiaqualfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Epiaqualfs

JAJH. Other Epiaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm below the mineral soil surface.

Arenic Epiaqualfs

JAJI. Other Epiaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more below the mineral soil surface.

Grossarenic Epiaqualfs

JAJJ. Other Epiaqualfs that have:

1. An umbric epipedon, an Ap horizon that meets all of the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing; *and*
2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:
 - a. Hue of 7.5YR or redder; *and*
 - (1) If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*
 - (2) If peds are absent, chroma of 2 or more (both moist and dry); *or*
 - b. Hue of 10YR or yellower *and either*:
 - (1) Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*
 - (2) Chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Umbric Epiaqualfs

JAJK. Other Epiaqualfs that have *both*:

1. A mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing; *and*
2. In 50 percent or more of the matrix in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one or a combination of the following colors:
 - a. Hue of 7.5YR or redder; *and*
 - (1) If peds are present, chroma of 2 or more on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less in ped interiors; *or*
 - (2) If peds are absent, chroma of 2 or more in 50 percent or more of the matrix; *or*
 - b. Hue of 10YR or yellower *and either*:
 - (1) Both a color value of 3 or more (moist) and chroma of 3 or more; *or*

- (2) Chroma of 2 or more if there are no redox concentrations.

Udolic Epiaqualfs

JAJL. Other Epiaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:

1. Hue of 7.5YR or redder; *and*
 - a. If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*
 - b. If peds are absent, chroma of 2 or more (both moist and dry); *or*
2. Hue of 10YR or yellower *and either*:
 - a. Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*
 - b. Chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Epiaqualfs

JAJM. Other Epiaqualfs that have a mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Epiaqualfs

JAJN. Other Epiaqualfs that have an umbric epipedon, an Ap horizon that meets all of the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Umbric Epiaqualfs

JAJO. Other Epiaqualfs.

Typic Epiaqualfs

Fragiaqualfs

Key to Subgroups

JAEA. Fragiaqualfs that have one or more layers, at least 25 cm thick (cumulative) within 100 cm of the mineral soil surface, that have 25 percent or more (by volume) recognizable bioturbation, such as filled animal burrows, wormholes, or casts.

Vermic Fragiaqualfs

JAEB. Other Fragiaqualfs that have, between the A or Ap horizon and a fragipan, a horizon with 50 percent or more

chroma of 3 or more if hue is 10YR or redder or of 4 or more if hue is 2.5Y or yellower.

Aeric Fraguaqualfs

JAEC. Other Fraguaqualfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Fraguaqualfs

JAED. Other Fraguaqualfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing.

Humic Fraguaqualfs

JAEE. Other Fraguaqualfs.

Typic Fraguaqualfs

Glossaqualfs

Key to Subgroups

JAIA. Glossaqualfs that have a histic epipedon.

Histic Glossaqualfs

JAIB. Other Glossaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more below the mineral soil surface.

Arenic Glossaqualfs

JAIC. Other Glossaqualfs that have:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one or a combination of the following colors:
 - a. Hue of 7.5YR or redder in 50 percent or more of the matrix; *and*
 - (1) If peds are present, chroma of 2 or more on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less in ped interiors; *or*
 - (2) If peds are absent, chroma of 2 or more in 50 percent or more of the matrix; *or*
 - b. In 50 percent or more of the matrix, hue of 10YR or yellower *and either*:

- (1) Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*
- (2) Chroma of 2 or more if there are no redox concentrations.

Aeric Fragic Glossaqualfs

JAID. Other Glossaqualfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Glossaqualfs

JAIE. Other Glossaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:

1. Hue of 7.5YR or redder; *and*
 - a. If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*
 - b. If peds are absent, chroma of 2 or more (both moist and dry); *or*
2. Hue of 10YR or yellower *and either*:
 - a. Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*
 - b. Chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Glossaqualfs

JAIF. Other Glossaqualfs that have a mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Glossaqualfs

JAIG. Other Glossaqualfs.

Typic Glossaqualfs

Kandiaqualfs

Key to Subgroups

JAJA. Kandiaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm below the mineral soil surface.

Arenic Kandiaqualfs

JAFB. Other Kandiaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 100 cm or more below the mineral soil surface.

Grossarenic Kandiaqualfs

J AFC. Other Kandiaqualfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiaqualfs

JAFD. Other Kandiaqualfs that have *both*:

1. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:
 - a. Hue of 7.5YR or redder; *and*
 - (1) If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*
 - (2) If peds are absent, chroma of 2 or more (both moist and dry); *or*
 - b. Hue of 10YR or yellower *and either*:
 - (1) Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*
 - (2) Chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Umbric Kandiaqualfs

JAFE. Other Kandiaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one or a combination of the following colors:

1. Hue of 7.5YR or redder; *and*
 - a. If peds are present, chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less (both moist and dry) in ped interiors; *or*
 - b. If peds are absent, chroma of 2 or more (both moist and dry); *or*
2. Hue of 10YR or yellower *and either*:
 - a. Both a color value of 3 or more (moist) and chroma of 3 or more (moist and dry); *or*

- b. Chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Kandiaqualfs

JAFF. Other Kandiaqualfs that have an umbric epipedon, an Ap horizon that meets all of the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Umbric Kandiaqualfs

JAFG. Other Kandiaqualfs.

Typic Kandiaqualfs

Natraqualfs

Key to Subgroups

JADA. Natraqualfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natraqualfs

JADB. Other Natraqualfs that have one or more layers, at least 25 cm thick (cumulative) within 100 cm of the mineral soil surface, that have 25 percent or more (by volume) recognizable bioturbation, such as filled animal burrows, wormholes, or casts.

Vermic Natraqualfs

JADC. Other Natraqualfs that have *both*:

1. A glossic horizon or interfingering of albic materials into the natric horizon; *and*
2. An exchangeable sodium percentage of less than 15 and less magnesium plus sodium than calcium plus extractable acidity either throughout the upper 15 cm of the natric horizon or in all horizons within 40 cm of the mineral soil surface, whichever is deeper.

Albic Glossic Natraqualfs

JADD. Other Natraqualfs that have an exchangeable sodium percentage of less than 15 and less magnesium plus sodium than calcium plus extractable acidity either throughout the upper 15 cm of the natric horizon or in all horizons within 40 cm of the mineral soil surface, whichever is deeper.

Albic Natraqualfs

JADE. Other Natraqualfs that have a glossic horizon or interfingering of albic materials into the natric horizon.

Glossic Natraqualfs

JADF. Other Natraqualfs that have a mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Natraqualfs

JADG. Other Natraqualfs.

Typic Natraqualfs

Plinthaqualfs

Key to Subgroups

JABA. All Plinthaqualfs (provisionally).

Typic Plinthaqualfs

Vermaqualfs

Key to Subgroups

JAGA. Vermaqualfs that have an exchangeable sodium percentage of 7 or more (or a sodium adsorption ratio of 6 or more) *either or both*:

1. Throughout the upper 15 cm of the argillic horizon; *and/or*
2. Throughout all horizons within 40 cm of the mineral soil surface.

Natric Vermaqualfs

JAGB. Other Vermaqualfs.

Typic Vermaqualfs

Cryalfs

Key to Great Groups

JBA. Cryalfs that have *all* of the following:

1. An argillic, kandic, or natric horizon that has its upper boundary 60 cm or more below *both*:
 - a. The mineral soil surface; *and*
 - b. The lower boundary of any surface mantle containing 30 percent or more vitric volcanic ash, cinders, or other vitric pyroclastic materials; *and*
2. A texture (in the fine-earth fraction) finer than loamy fine sand in one or more horizons above the argillic, kandic, or natric horizon; *and*

3. Either a glossic horizon or interfingering of albic materials into the argillic, kandic, or natric horizon.

[Palecryalfs](#), p. 53

JBB. Other Cryalfs that have a glossic horizon.

[Glossocryalfs](#), p. 50

JBC. Other Cryalfs.

[Haplocryalfs](#), p. 52

Glossocryalfs

Key to Subgroups

JBBA. Glossocryalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Glossocryalfs

JBBA. Other Glossocryalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Glossocryalfs

JBBC. Other Glossocryalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Glossocryalfs

JBBD. Other Glossocryalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

- b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Glossocryalfs

JBBE. Other Glossocryalfs that have, in one or more subhorizons within the upper 25 cm of the argillic, kandic, or natric horizon, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Glossocryalfs

JBBF. Other Glossocryalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Glossocryalfs

JBBG. Other Glossocryalfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Glossocryalfs

JBBH. Other Glossocryalfs that have:

1. A xeric moisture regime; *and*
2. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
3. A base saturation of 50 percent or more (by NH_4OAc) in all parts from the mineral soil surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Xerollic Glossocryalfs

JBBI. Other Glossocryalfs that have:

1. A xeric moisture regime; *and*
2. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing.

Umbric Xeric Glossocryalfs

JBBJ. Other Glossocryalfs that:

1. Are dry in some part of the moisture control section for 45 or more days (cumulative) in normal years; *and*
2. Have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
3. Have a base saturation of 50 percent or more (by NH_4OAc) in all parts from the mineral soil surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Ustollic Glossocryalfs

JBBK. Other Glossocryalfs that have a xeric moisture regime.

Xeric Glossocryalfs

JBBL. Other Glossocryalfs that are dry in some part of the moisture control section for 45 or more days (cumulative) in normal years.

Ustic Glossocryalfs

JBBM. Other Glossocryalfs that:

1. Have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
2. Have a base saturation of 50 percent or more (by NH_4OAc) in all parts from the mineral soil surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Mollic Glossocryalfs

JBBN. Other Glossocryalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing.

Umbric Glossocryalfs

JBBO. Other Glossocryalfs that have a base saturation of 50 percent or more (by NH_4OAc) in all parts from the mineral soil surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Eutric Glossocryalfs

JBBP. Other Glossocryalfs.

Typic Glossocryalfs

Haplocryalfs

Key to Subgroups

JBCA. Haplocryalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplocryalfs

JBCB. Other Haplocryalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplocryalfs

JBCC. Other Haplocryalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplocryalfs

JBCD. Other Haplocryalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haplocryalfs

JBCE. Other Haplocryalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplocryalfs

JBCF. Other Haplocryalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haplocryalfs

JBCG. Other Haplocryalfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*
2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*
3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:
 - a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*
 - b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Haplocryalfs

JBCH. Other Haplocryalfs that have a sandy or sandy-skeletal particle-size class throughout the upper 75 cm of the argillic, kandic, or natric horizon or throughout the entire argillic, kandic, or natric horizon if it is less than 75 cm thick.

Psammentic Haplocryalfs

JBCI. Other Haplocryalfs that have:

1. An argillic, kandic, or natric horizon that is 35 cm or less thick; *and*
2. No densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Inceptic Haplocryalfs

JBCJ. Other Haplocryalfs that have:

1. A xeric moisture regime; *and*
2. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
3. A base saturation of 50 percent or more (by NH₄OAc) in all parts from the mineral soil surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Xerollic Haplocryalfs

JBCK. Other Haplocryalfs that have:

1. A xeric moisture regime; *and*
2. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing.

Umbric Xeric Haplocryalfs

JBCL. Other Haplocryalfs that:

1. Are dry in some part of the moisture control section for 45 or more days (cumulative) in normal years; *and*
2. Have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
3. Have a base saturation of 50 percent or more (by NH_4OAc) in all parts from the mineral soil surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Ustollic Haplocryalfs

JBCM. Other Haplocryalfs that have a xeric moisture regime.

Xeric Haplocryalfs

JBCN. Other Haplocryalfs that are dry in some part of the moisture control section for 45 or more days (cumulative) in normal years.

Ustic Haplocryalfs

JBCO. Other Haplocryalfs that:

1. Have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
2. Have a base saturation of 50 percent or more (by NH_4OAc) in all parts from the mineral soil surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Mollic Haplocryalfs

JBCP. Other Haplocryalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing.

Umbric Haplocryalfs

JBCQ. Other Haplocryalfs that have a base saturation of 50 percent or more (by NH_4OAc) in all parts from the mineral soil

surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Eutric Haplocryalfs

JBCR. Other Haplocryalfs.

Typic Haplocryalfs

Palecryalfs

Key to Subgroups

JBAA. Palecryalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Palecryalfs

JBAB. Other Palecryalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Palecryalfs

JBAC. Other Palecryalfs that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Palecryalfs

JBAD. Other Palecryalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Palecryalfs

JBAE. Other Palecryalfs that have a xeric moisture regime.

Xeric Palecryalfs

JBAF. Other Palecryalfs that are dry in some part of the

moisture control section for 45 or more days (cumulative) in normal years.

Ustic Palecryalfs

JBAG. Other Palecryalfs that:

1. Have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
2. Have a base saturation of 50 percent or more (by NH₄OAc) in all parts from the mineral soil surface to a depth of 180 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

Mollic Palecryalfs

JBAH. Other Palecryalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing.

Umbric Palecryalfs

JBAI. Other Palecryalfs.

Typic Palecryalfs

Udalfs

Key to Great Groups

JEA. Udalfs that have a natric horizon.

[Natrudalfs](#), p. 62

JEB. Other Udalfs that have:

1. A glossic horizon; *and*
2. In the argillic or kandic horizon, discrete nodules, 2.5 to 30 cm in diameter, that:
 - a. Are enriched with iron and extremely weakly cemented to indurated; *and*
 - b. Have exteriors with either a redder hue or a higher chroma than the interiors.

[Ferrudalfs](#), p. 55

JEC. Other Udalfs that have *both*:

1. A glossic horizon; *and*
2. A fragipan with an upper boundary within 100 cm of the mineral soil surface.

[Fraglossudalfs](#), p. 55

JED. Other Udalfs that have a fragipan with an upper boundary within 100 cm of the mineral soil surface.

[Fragiudalfs](#), p. 55

JEE. Other Udalfs that:

1. Do not have a densic, lithic, paralithic, or petroferic contact within 150 cm of the mineral soil surface; *and*
2. Have a kandic horizon; *and*
3. Within 150 cm of the mineral soil surface, *either*:
 - a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content [Clay is measured noncarbonate clay or based on the following formula: Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon), whichever value is greater, but no more than 100]; *or*
 - b. Have 5 percent or more (by volume) skeletal faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Kandiudalfs](#), p. 61

JEF. Other Udalfs that have a kandic horizon.

[Kanhapludalfs](#), p. 62

JEG. Other Udalfs that:

1. Do not have a densic, lithic, or paralithic contact within 150 cm of the mineral soil surface; *and*
2. Within 150 cm of the mineral soil surface, *either*:
 - a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content [Clay is measured noncarbonate clay or based on the following formula: Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon), whichever value is greater, but no more than 100]; *or*
 - b. Have 5 percent or more (by volume) skeletal faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction; *and*
3. Have an argillic horizon with *one or more* of the following:
 - a. In 50 percent or more of the matrix of one or more subhorizons in its lower one-half, hue of 7.5YR or redder and chroma of 5 or more; *or*
 - b. In 50 percent or more of the matrix of horizons that total more than one-half the total thickness, hue of

2.5YR or redder, value, moist, of 3 or less, and value, dry, of 4 or less; *or*

c. Many coarse redox concentrations with hue of 5YR or redder or chroma of 6 or more, or both, in one or more subhorizons; *or*

4. Have a frigid temperature regime and *all* of the following:

a. An argillic horizon that has its upper boundary 60 cm or more below *both*:

- (1) The mineral soil surface; *and*
- (2) The lower boundary of any surface mantle containing 30 percent or more vitric volcanic ash, cinders, or other vitric pyroclastic materials; *and*

b. A texture (in the fine-earth fraction) finer than loamy fine sand in one or more horizons above the argillic horizon; *and*

c. Either a glossic horizon or interfingering of albic materials into the argillic horizon.

[Paleudalfs](#), p. 63

JEH. Other Udalfs that have, in *all* subhorizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*
3. Dry value no more than 1 unit higher than the moist value.

[Rhodudalfs](#), p. 65

JEI. Other Udalfs that have a glossic horizon.

[Glossudalfs](#), p. 56

JEJ. Other Udalfs.

[Hapludalfs](#), p. 58

Ferrudalfs

Key to Subgroups

JEBA. Ferrudalfs that have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Ferrudalfs

JEJB. Other Ferrudalfs.

Typic Ferrudalfs

Fragiudalfs

Key to Subgroups

JEDA. Fragiudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragiudalfs

JEDB. Other Fragiudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Fragiudalfs

JEDC. Other Fragiudalfs that have, in one or more horizons within 40 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Fragiudalfs

JEDD. Other Fragiudalfs that are saturated with water in one or more layers above the fragipan in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Fragiudalfs

JEDE. Other Fragiudalfs.

Typic Fragiudalfs

Fraglossudalfs

Key to Subgroups

JECA. Fraglossudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water

retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fraglossudalfs

JECB. Other Fraglossudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Fraglossudalfs

JECC. Other Fraglossudalfs that have, in one or more subhorizons within the upper 25 cm of the argillic or kandic horizon, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Fraglossudalfs

JECD. Other Fraglossudalfs that are saturated with water in one or more layers above the fragipan in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Fraglossudalfs

JECE. Other Fraglossudalfs.

Typic Fraglossudalfs

Glossudalfs

Key to Subgroups

JEIA. Glossudalfs that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a

densic, lithic, or paralithic contact, whichever is shallower; *and*

2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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.

Aquertic Glossudalfs

JEIB. Other Glossudalfs that have *both*:

1. Saturation with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Oxyaquic Vertic Glossudalfs

JEIC. Other Glossudalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Glossudalfs

JEID. Other Glossudalfs that have *both*:

1. In one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with chroma of 2 or

less and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Glossudalfs

JEIE. Other Glossudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Glossudalfs

JEIF. Other Glossudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Glossudalfs

JEIG. Other Glossudalfs that have *both*:

1. Fragic soil properties:

a. In 30 percent or more of the volume of a layer 15 cm

or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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.

Fragiaquic Glossudalfs

JEIH. Other Glossudalfs that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Glossudalfs

JEII. Other Glossudalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*

2. 30 or more cumulative days.

Oxyaquic Glossudalfs

JEIJ. Other Glossudalfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Glossudalfs

JEIK. Other Glossudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more below the mineral soil surface.

Arenic Glossudalfs

JEIL. Other Glossudalfs that have a glossic horizon less than 50 cm in total thickness.

Haplic Glossudalfs

JEIM. Other Glossudalfs.

Typic Glossudalfs

Hapludalfs

Key to Subgroups

JEJA. Hapludalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapludalfs

JEJB. Other Hapludalfs that have *all* of the following:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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; *and*
3. An Ap horizon or materials between the mineral soil surface and a depth of 18 cm that, after mixing, have *one or more* of the following:
 - a. A color value, moist, of 4 or more; *or*
 - b. A color value, dry, of 6 or more; *or*
 - c. Chroma of 4 or more.

Aquertic Chromic Hapludalfs

JEJC. Other Hapludalfs that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a

densic, lithic, or paralithic contact, whichever is shallower; *and*

2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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.

Aquertic Hapludalfs

JEJD. Other Hapludalfs that have *both*:

1. Saturation with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Oxyaquic Vertic Hapludalfs

JEJE. Other Hapludalfs that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. An Ap horizon or materials between the mineral soil surface and a depth of 18 cm that, after mixing, have *one or more* of the following:

- a. A color value, moist, of 4 or more; *or*
- b. A color value, dry, of 6 or more; *or*
- c. Chroma of 4 or more.

Chromic Vertic Hapludalfs

JEJF. Other Hapludalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Hapludalfs

JEJG. Other Hapludalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Hapludalfs

JEJH. Other Hapludalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Hapludalfs

JEJI. Other Hapludalfs that have *both*:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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.

Fragiaquic Hapludalfs

JEJJ. Other Hapludalfs that have *both*:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. Saturation with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Fragic Oxyaquic Hapludalfs

JEJK. Other Hapludalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Aquic Arenic Hapludalfs

JEJL. Other Hapludalfs that have:

1. An abrupt textural change; *and*
2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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; *and*

3. A base saturation (by sum of cations) of less than 60 percent at a depth of 125 cm from the top of the argillic horizon, at a depth of 180 cm from the mineral soil surface, or directly above a densic, lithic, or paralithic contact, whichever is shallowest.

Albaquiltic Hapludalfs

JEJM. Other Hapludalfs that have *both*:

1. An abrupt textural change; *and*
2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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.

Albaquic Hapludalfs

JEJN. Other Hapludalfs that have *both*:

1. Interfingering of albic materials in the upper part of the argillic horizon; *and*
2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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.

Glossaquic Hapludalfs

JEJO. Other Hapludalfs that have *both*:

1. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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; *and*
2. A base saturation (by sum of cations) of less than 60 percent at a depth of 125 cm from the top of the argillic horizon, at a depth of 180 cm from the mineral soil surface,

or directly above a densic, lithic, or paralithic contact, whichever is shallowest.

Aquiltic Hapludalfs

JEJP. Other Hapludalfs that have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing; *and*
2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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.

Aquollic Hapludalfs

JEJQ. Other Hapludalfs that have redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *either*:

1. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*
2. 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.

Aquic Hapludalfs

JEJR. Other Hapludalfs that have anthraquic conditions.

Anthraquic Hapludalfs

JEJS. Other Hapludalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Hapludalfs

JEJT. Other Hapludalfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Hapludalfs

JEJU. Other Hapludalfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*
2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*
3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:
 - a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*
 - b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Hapludalfs

JEJV. Other Hapludalfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Hapludalfs

JEJW. Other Hapludalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Hapludalfs

JEJX. Other Hapludalfs that have interfingering of albic materials in one or more subhorizons of the argillic horizon.

Glossic Hapludalfs

JEJY. Other Hapludalfs that have:

1. An argillic, kandic, or natric horizon that is 35 cm or less thick; *and*
2. No densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Inceptic Hapludalfs

JEJZ. Other Hapludalfs that have a base saturation (by sum of cations) of less than 60 percent at a depth of 125 cm below the top of the argillic horizon, at a depth of 180 cm below the mineral soil surface, or directly above a densic, lithic, or paralithic contact, whichever is shallowest.

Ultic Hapludalfs

JEJZa. Other Hapludalfs that have a mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil

surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Hapludalfs

JEJZb. Other Hapludalfs.

Typic Hapludalfs

Kandiudalfs

Key to Subgroups

JEEA. Kandiudalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthaquic Kandiudalfs

JEEB. Other Kandiudalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Kandiudalfs

JEEC. Other Kandiudalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Kandiudalfs

JEED. Other Kandiudalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kandiudalfs

JEEE. Other Kandiudalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 100 cm or more; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Kandiudalfs

JEEF. Other Kandiudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the

mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm.

Arenic Kandiudalfs

JEEG. Other Kandiudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 100 cm or more.

Grossarenic Kandiudalfs

JEEH. Other Kandiudalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiudalfs

JEEI. Other Kandiudalfs that have, in *all* subhorizons in the upper 100 cm of the kandic horizon or throughout the entire kandic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*
3. Dry value no more than 1 unit higher than the moist value.

Rhodic Kandiudalfs

JEEJ. Other Kandiudalfs that have a mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Kandiudalfs

JEEK. Other Kandiudalfs.

Typic Kandiudalfs

Kanhapludalfs

Key to Subgroups

JEFA. Kanhapludalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhapludalfs

JEFB. Other Kanhapludalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Kanhapludalfs

JEFC. Other Kanhapludalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Kanhapludalfs

JEFD. Other Kanhapludalfs that have, in *all* subhorizons in the upper 100 cm of the kandic horizon or throughout the entire kandic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*
3. Dry value no more than 1 unit higher than the moist value.

Rhodic Kanhapludalfs

JEFE. Other Kanhapludalfs.

Typic Kanhapludalfs

Natrudalfs

Key to Subgroups

JEAA. Natrudalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrudalfs

JEAB. Other Natrudalfs that have:

1. Either a glossic horizon or interfingering of albic materials into the natric horizon; *and*
2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *either*:
 - a. Within the upper 25 cm of the natric 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 natric horizon is 50 cm or more below the mineral soil surface.

Glossaquic Natrudalfs

JEAC. Other Natrudalfs that have redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *either*:

1. Within the upper 25 cm of the natric horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*
2. Within 75 cm of the mineral soil surface if the upper boundary of the natric horizon is 50 cm or more below the mineral soil surface.

Aquic Natrudalfs

JEAD. Other Natrudalfs.

Typic Natrudalfs**Paleudalfs****Key to Subgroups**JEGA. Paleudalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a dense, lithic, or paralithic contact, whichever is shallower.

Vertic PaleudalfsJEGB. Other Paleudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.**Andic Paleudalfs**JEGC. Other Paleudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic PaleudalfsJEGD. Other Paleudalfs that have *both*:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *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.

Fragiaquic PaleudalfsJEGE. Other Paleudalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthaquic PaleudalfsJEGF. Other Paleudalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A glossic horizon or, in the upper part of the argillic horizon, one or more subhorizons that have 5 percent or more (by volume) clay depletions with chroma of 2 or less.

Glossaquic PaleudalfsJEGG. Other Paleudalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A clay increase of 15 percent or more (absolute) in the fine-earth fraction within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon.

Albaquic Paleudalfs

JEGH. Other Paleudalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with

chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Paleudalfs

JEGI. Other Paleudalfs that have anthraquic conditions.

Anthraquic Paleudalfs

JEGJ. Other Paleudalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Paleudalfs

JEGK. Other Paleudalfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Paleudalfs

JEGL. Other Paleudalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Paleudalfs

JEGM. Other Paleudalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Paleudalfs

JEGN. Other Paleudalfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*
2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*
3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:
 - a. Two or more lamellae with a combined thickness of

5 cm or more (that may or may not be part of the argillic horizon); *or*

- b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Paleudalfs

JEGO. Other Paleudalfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Paleudalfs

JEGP. Other Paleudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleudalfs

JEQ. Other Paleudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleudalfs

JEGR. Other Paleudalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleudalfs

JEGS. Other Paleudalfs that have *either*:

1. A glossic horizon; *or*
2. In the upper part of the argillic horizon, one or more subhorizons that have 5 percent or more (by volume) skeletalans with chroma of 2 or less; *or*
3. 5 percent or more (by volume) albic materials in some subhorizon of the argillic horizon.

Glossic Paleudalfs

JEGT. Other Paleudalfs that have, in *all* subhorizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*
3. Dry value no more than 1 unit higher than the moist value.

Rhodic Paleudalfs

JEGU. Other Paleudalfs that have a mollic epipedon, an Ap horizon that meets all of the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Paleudalfs

JEGV. Other Paleudalfs.

Typic Paleudalfs

Rhodudalfs

Key to Subgroups

JEHA. All Rhodudalfs (provisionally).

Typic Rhodudalfs

Ustalfs

Key to Great Groups

JCA. Ustalfs that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

[Durustalfs](#), p. 66

JCB. Other Ustalfs that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one-half or more of the volume.

[Plinthustalfs](#), p. 76

JCC. Other Ustalfs that have a natric horizon.

[Natrustalfs](#), p. 71

JCD. Other Ustalfs that:

1. Have a kandic horizon; *and*
2. Do not have a densic, lithic, paralithic, or petroferic contact within 150 cm of the mineral soil surface; *and*
3. Within 150 cm of the mineral soil surface, *either*:
 - a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content [Clay is measured noncarbonate clay or based on the following formula: Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon), whichever value is greater, but no more than 100]; *or*
 - b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Kandiustalfs](#), p. 69

JCE. Other Ustalfs that have a kandic horizon.

[Kanhaplustalfs](#), p. 70

JCF. Other Ustalfs that have *one or more* of the following:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*
2. No densic, lithic, or paralithic contact within 150 cm of the mineral soil surface *and* an argillic horizon that has *both*:

a. Within 150 cm of the mineral soil surface, *either*:

- (1) With increasing depth, no clay decrease of 20 percent or more (relative) from the maximum clay content [Clay is measured noncarbonate clay or based on the following formula: Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon), whichever value is greater, but no more than 100]; *or*
- (2) 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction; *and*

b. In the lower one-half of the argillic horizon, one or more subhorizons with *either or both*:

- (1) Hue of 7.5YR or redder and chroma of 5 or more in 50 percent or more of the matrix; *or*
- (2) Common or many coarse redox concentrations with hue of 7.5YR or redder or chroma of 6 or more, or both; *or*

3. No densic, lithic, or paralithic contact within 50 cm of the mineral soil surface *and* an argillic horizon that has *both*:

a. A clayey or clayey-skeletal particle-size class throughout one or more subhorizons in its upper part; *and*

b. At its upper boundary, a clay increase (in the fine-earth fraction) of *either* 20 percent or more (absolute) within a vertical distance of 7.5 cm *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm.

[Paleustalfs](#), p. 73

JCG. Other Ustalfs that have, in *all* subhorizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*

3. Dry value no more than 1 unit higher than the moist value.

[Rhodustalfs](#), p. 76

JCH. Other Ustalfs.

[Haplustalfs](#), p. 66

Durustalfs

Key to Subgroups

JCAA. All Durustalfs (provisionally).

Typic Durustalfs

Haplustalfs

Key to Subgroups

JCHA. Haplustalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplustalfs

JCHB. Other Haplustalfs that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquertic Haplustalfs

JCHC. Other Haplustalfs that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. Saturation with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

- a. 20 or more consecutive days; *or*
- b. 30 or more cumulative days.

Oxyaquic Vertic Haplustalfs

JCHD. Other Haplustalfs that have *both* of the following:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C;

2. *One or both* of the following:

- a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
- b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Haplustalfs

JCHE. Other Haplustalfs that have *both*:

1. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in

some part for four-tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Udertic Haplustalfs

JCHF. Other Haplustalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplustalfs

JCHG. Other Haplustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Haplustalfs

JCHH. Other Haplustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. An argillic horizon that has a base saturation (by sum of cations) of less than 75 percent throughout.

Aquatic Haplustalfs

JCHI. Other Haplustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplustalfs

JCHJ. Other Haplustalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*

2. 30 or more cumulative days.

Oxyaquic Haplustalfs

JCHK. Other Haplustalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haplustalfs

JCHL. Other Haplustalfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:

a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Haplustalfs

JCHM. Other Haplustalfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Haplustalfs

JCHN. Other Haplustalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Arenic Aridic Haplustalfs

JCHO. Other Haplustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Haplustalfs

JCHP. Other Haplustalfs that have *both*:

1. A calcic horizon with its upper boundary within 100 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-

tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

- b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
- c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Calcic Haplustalfs

JCHQ. Other Haplustalfs that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - a. Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Haplustalfs

JCHR. Other Haplustalfs that have a CEC of less than 24 cmol(+)/kg clay (by 1N NH₄OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick *or* of its upper 100 cm.

Kanhaplic Haplustalfs

JCHS. Other Haplustalfs that have:

1. An argillic, kandic, or natric horizon that is 35 cm or less thick; *and*
2. No densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Inceptic Haplustalfs

JCHT. Other Haplustalfs that have *both*:

1. A calcic horizon with its upper boundary within 100 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 105 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Calcic Udic Haplustalfs

JCHU. Other Haplustalfs that have an argillic horizon with a base saturation (by sum of cations) of less than 75 percent throughout.

Udic Haplustalfs

JCHV. Other Haplustalfs that have a calcic horizon with its upper boundary within 100 cm of the mineral soil surface.

Calcic Haplustalfs

JCHW. Other Haplustalfs that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 105 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Haplustalfs

JCHX. Other Haplustalfs.

Typic Haplustalfs

Kandiustalfs

Key to Subgroups

JCDA. Kandiustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 100 cm or more.

Grossarenic Kandiustalfs

JCDB. Other Kandiustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm.

Aquic Arenic Kandiustalfs

JCDC. Other Kandiustalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiustalfs

JCDD. Other Kandiustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Kandiustalfs

JCDE. Other Kandiustalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm; *and*
2. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:

- (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
- (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Arenic Aridic Kandiestalfts

JCDF. Other Kandiestalfts that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm.

Arenic Kandiestalfts

JCDG. Other Kandiestalfts that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - a. Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Kandiestalfts

JCDH. Other Kandiestalfts that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 120

cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Kandiestalfts

JCDI. Other Kandiestalfts that have, in *all* subhorizons in the upper 100 cm of the kandic horizon or throughout the entire kandic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*
3. Dry value no more than 1 unit higher than the moist value.

Rhodic Kandiestalfts

JCDJ. Other Kandiestalfts.

Typic Kandiestalfts

Kanhaplustalfts

Key to Subgroups

JCEA. Kanhaplustalfts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplustalfts

JCEB. Other Kanhaplustalfts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Kanhaplustalfts

JCEC. Other Kanhaplustalfts that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - a. Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Kanhaplustalfts

JCED. Other Kanhaplustalfs that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Kanhaplustalfs

JCEE. Other Kanhaplustalfs that have, in *all* subhorizons in the upper 100 cm of the kandic horizon or throughout the entire kandic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*
3. Dry value no more than 1 unit higher than the moist value.

Rhodic Kanhaplustalfs

JCEF. Other Kanhaplustalfs.

Typic Kanhaplustalfs

Natrustalfs

Key to Subgroups

JCCA. Natrustalfs that have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

Salidic Natrustalfs

JCCB. Other Natrustalfs that have *all* of the following:

1. Visible crystals of gypsum or other salts more soluble than gypsum, or both, within 40 cm of the soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:

- (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
- (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*

3. *One or both* of the following:

- a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
- b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Leptic Torrertic Natrustalfs

JCCC. Other Natrustalfs that have *both* of the following:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*

2. *One or both* of the following:

- a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
- b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Natrustalfs

JCCD. Other Natrustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquertic Natrustalfs

JCCE. Other Natrustalfs that have *both* of the following:

1. Visible crystals of gypsum or other salts more soluble than gypsum, or both, within 40 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:

- (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
- (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Leptic Natrustalfs

JCCF. Other Natrustalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrustalfs

JCCG. Other Natrustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Aquic Arenic Natrustalfs

JCCH. Other Natrustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Natrustalfs

JCCI. Other Natrustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Natrustalfs

JCCJ. Other Natrustalfts that have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Natrustalfts

JCCK. Other Natrustalfts that have visible crystals of gypsum or other salts more soluble than gypsum, or both, within 40 cm of the mineral soil surface.

Leptic Natrustalfts

JCCL. Other Natrustalfts that have *both* of the following:

1. An exchangeable sodium percentage of less than 15 (or a sodium adsorption ratio of less than 13) in 50 percent or more of the natric horizon; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Haplargidic Natrustalfts

JCCM. Other Natrustalfts that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some

part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:

- a. Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
- b. Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Natrustalfts

JCCN. Other Natrustalfts that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing.

Mollic Natrustalfts

JCCO. Other Natrustalfts.

Typic Natrustalfts

Paleustalfts

Key to Subgroups

JCFA. Paleustalfts that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a dense, lithic, or paralithic contact, whichever is shallower; *and*
2. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquertic Paleustalfts

JCFB. Other Paleustalfts that have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. Saturation with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

a. 20 or more consecutive days; *or*

b. 30 or more cumulative days.

Oxyaquic Vertic Paleustalfs

JCFC. Other Paleustalfs that have *both*:

1. When neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for four-tenths or less of the time (cumulative) per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Udertic Paleustalfs

JCFD. Other Paleustalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick

that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Paleustalfs

JCFE. Other Paleustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Paleustalfs

JCFF. Other Paleustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Paleustalfs

JCFG. Other Paleustalfs that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*

2. 30 or more cumulative days.

Oxyaquic Paleustalfs

JCFH. Other Paleustalfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:

a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Paleustalfs

JCFI. Other Paleustalfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or

throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Paleustalfs

JCFJ. Other Paleustalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the time (cumulative) per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the time (cumulative) per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Arenic Aridic Paleustalfs

JCFK. Other Paleustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleustalfs

JCFL. Other Paleustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleustalfs

JCFM. Other Paleustalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleustalfs

JCFN. Other Paleustalfs that have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Paleustalfs

JCFO. Other Paleustalfs that have *both*:

1. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the time (cumulative) per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the time (cumulative) per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:
 - (1) Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*
2. A calcic horizon *either* within 100 cm of the mineral soil surface if the weighted average particle-size class of the upper 50 cm of the argillic horizon is sandy, *or* within 60 cm if it is loamy, *or* within 50 cm if it is clayey, *and* carbonates in all horizons above the calcic horizon.

Calcic Paleustalfs

JCFP. Other Paleustalfs that, when neither irrigated nor fallowed to store moisture, have:

1. A frigid temperature regime *and* a moisture control section that in normal years is dry in all parts for four-tenths or more of the time (cumulative) per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for six-tenths or more of the time (cumulative) per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years:

- a. Is moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
- b. Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Paleustalfs

JCFQ. Other Paleustalfs that have a CEC of less than 24 cmol(+)/kg clay (by 1N NH₄OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick *or* of its upper 100 cm.

Kandic Paleustalfs

JCFR. Other Paleustalfs that have, in *all* subhorizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*
3. Dry value no more than 1 unit higher than the moist value.

Rhodic Paleustalfs

JCFS. Other Paleustalfs that have an argillic horizon with a base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Paleustalfs

JCFT. Other Paleustalfs that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for four-tenths or less of the time (cumulative) per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Paleustalfs

JCFU. Other Paleustalfs.

Typic Paleustalfs

Plinthustalfs

Key to Subgroups

JCBA. All Plinthustalfs (provisionally).

Typic Plinthustalfs

Rhodustalfs

Key to Subgroups

JCGA. Rhodustalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodustalfs

JCGB. Other Rhodustalfs that have a CEC of less than 24 cmol(+)/kg clay (by 1N NH₄OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick *or* of its upper 100 cm.

Kanhaplic Rhodustalfs

JCGC. Other Rhodustalfs that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime *and* a moisture control section that in normal years is dry in some part for four-tenths or less of the time (cumulative) per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime *and* a moisture control section that in normal years is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Rhodustalfs

JCGD. Other Rhodustalfs.

Typic Rhodustalfs

Xeralfs

Key to Great Groups

JDA. Xeralfs that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

[Durixeralfs](#), p. 77

JDB. Other Xeralfs that have a natric horizon.

[Natrixeralfs](#), p. 80

JDC. Other Xeralfs that have a fragipan with an upper boundary within 100 cm of the mineral soil surface.

[Fragixeralfs](#), p. 78

JDD. Other Xeralfs that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one-half or more of the volume.

[Plinthoxeralfs](#), p. 82

JDE. Other Xeralfs that have, in *all* subhorizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. Value, moist, of 3 or less; *and*
3. Dry value no more than 1 unit higher than the moist value.

[Rhodoxeralfs](#), p. 82

JDF. Other Xeralfs that have *one or more* of the following:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*
2. No densic, lithic, or paralithic contact within 150 cm of the mineral soil surface *and* an argillic or kandic horizon that has *both*:
 - a. Within 150 cm of the mineral soil surface, *either*:
 - (1) With increasing depth, no clay decrease of 20 percent or more (relative) from the maximum clay content [Clay is measured noncarbonate clay or based on the following formula: Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon), whichever value is greater, but no more than 100]; *or*
 - (2) 5 percent or more (by volume) skeletons on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction; *and*
 - b. A base at a depth of 150 cm or more; *or*
3. No densic, lithic, or paralithic contact within 50 cm of the mineral soil surface *and* an argillic or kandic horizon that has within 15 cm of its upper boundary *both*:
 - a. A clayey, clayey-skeletal, fine, or very-fine particle-size class; *and*
 - b. A clay increase, in the fine-earth fraction, of *either* 20 percent or more (absolute) within a vertical distance of 7.5 cm *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm.

[Palexeralfs](#), p. 80

JDG. Other Xeralfs.

[Haploxeralfs](#), p. 78

Durixeralfs

Key to Subgroups

JDAA. Durixeralfs that have a natric horizon.

Natric Durixeralfs

JDAB. Other Durixeralfs that have, above the duripan, *one or both* of the following:

1. Cracks that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick; *or*
2. A linear extensibility of 6.0 cm or more.

Vertic Durixeralfs

JDAC. Other Durixeralfs that have, in one or more subhorizons within the argillic horizon, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Durixeralfs

JDAD. Other Durixeralfs that have *both*:

1. An argillic horizon that has *both*:
 - a. A clayey particle-size class throughout some subhorizon 7.5 cm or more thick; *and*
 - b. At its upper boundary or within some part, a clay increase *either* of 20 percent or more (absolute) within a vertical distance of 7.5 cm *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction; *and*
2. A duripan that is strongly cemented or less cemented in all subhorizons.

Abruptic Haplic Durixeralfs

JDAE. Other Durixeralfs that have an argillic horizon that has *both*:

1. A clayey particle-size class throughout some subhorizon 7.5 cm or more thick; *and*
2. At its upper boundary or within some part, a clay increase *either* of 20 percent or more (absolute) within a vertical distance of 7.5 cm *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.

Abruptic Durixeralfs

JDAF. Other Durixeralfs that have a duripan that is strongly cemented or less cemented in all subhorizons.

Haplic Durixeralfs

JDAG. Other Durixeralfs.

Typic Durixeralfs

Fragixeralfs

Key to Subgroups

JDCA. Fragixeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragixeralfs

JDCB. Other Fragixeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Fragixeralfs

JDCC. Other Fragixeralfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) or materials between the soil surface and a depth of 18 cm that have these color values after mixing.

Mollic Fragixeralfs

JDCD. Other Fragixeralfs that have, in one or more horizons within 40 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Fragixeralfs

JDCE. Other Fragixeralfs that, above the fragipan, do not have an argillic or kandic horizon with clay films on both vertical and horizontal faces of any ped.

Inceptic Fragixeralfs

JDCF. Other Fragixeralfs.

Typic Fragixeralfs

Haploxeralfs

Key to Subgroups

JDGA. Haploxeralfs that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. A color value, moist, of 3 or less and 0.7 percent or more organic carbon either throughout an Ap horizon or throughout the upper 10 cm of an A horizon.

Lithic Mollic Haploxeralfs

JDGB. Other Haploxeralfs that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. An argillic or kandic horizon that is discontinuous horizontally in each pedon.

Lithic Ruptic-Inceptic Haploxeralfs

JDGC. Other Haploxeralfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxeralfs

JDGD. Other Haploxeralfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haploxeralfs

JDGE. Other Haploxeralfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:
 - a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Haploxeralfs

JDGF. Other Haploxeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploxeralfs

JDGG. Other Haploxeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haploxeralfs

JDGH. Other Haploxeralfs that have *both*:

1. Fragic soil properties:

a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *either*:

a. Within the upper 25 cm of the argillic or kandic 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 or kandic horizon is 50 cm or more below the mineral soil surface.

Fragiaquic Haploxeralfs

JDGI. Other Haploxeralfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. An argillic or kandic horizon that has a base saturation (by sum of cations) of less than 75 percent in one or more subhorizons within its upper 75 cm or above a densic, lithic, or paralithic contact, whichever is shallower.

Aquiltic Haploxeralfs

JDGJ. Other Haploxeralfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haploxeralfs

JDGK. Other Haploxeralfs that have an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) in one or more subhorizons of the argillic or kandic horizon.

Natric Haploxeralfs

JDGL. Other Haploxeralfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Haploxeralfs

JDGM. Other Haploxeralfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:

a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the

argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Haploxeralfs

JDGN. Other Haploxeralfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Haploxeralfs

JDGO. Other Haploxeralfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Haploxeralfs

JDGP. Other Haploxeralfs that have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calcic Haploxeralfs

JDGQ. Other Haploxeralfs that have:

1. An argillic, kandic, or natric horizon that is 35 cm or less thick; *and*
2. No densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Inceptic Haploxeralfs

JDGR. Other Haploxeralfs that have an argillic or kandic horizon that has a base saturation (by sum of cations) of less than 75 percent in one or more subhorizons within its upper 75 cm or above a densic, lithic, or paralithic contact, whichever is shallower.

Ultic Haploxeralfs

JDGS. Other Haploxeralfs that have a color value, moist, of 3 or less and 0.7 percent or more organic carbon either throughout an Ap horizon or throughout the upper 10 cm of an A horizon.

Mollic Haploxeralfs

JDGT. Other Haploxeralfs.

Typic Haploxeralfs

Natrixeralfs

Key to Subgroups

JDBA. Natrixeralfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or

more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrixeralfs

JDBB. Other Natrixeralfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Natrixeralfs

JDBC. Other Natrixeralfs.

Typic Natrixeralfs

Palexeralfs

Key to Subgroups

JDFA. Palexeralfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Palexeralfs

JDFB. Other Palexeralfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:
 - a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
 - b. More than 35 percent (by volume) fragments coarser

than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Palexeralfs

JDFC. Other Palexeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Palexeralfs

JDFD. Other Palexeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Palexeralfs

JDFE. Other Palexeralfs that have *both*:

1. Fragic soil properties:

a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with chroma of 2 or less in layers that also have aquic conditions in normal years (or artificial drainage) *either*:

a. Within the upper 25 cm of the argillic or kandic 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 or kandic horizon is 50 cm or more below the mineral soil surface.

Fragiaquic Palexeralfs

JDFF. Other Palexeralfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Palexeralfs

JDFG. Other Palexeralfs that have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Palexeralfs

JDFH. Other Palexeralfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:

a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Palexeralfs

JDFI. Other Palexeralfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Palexeralfs

JDFJ. Other Palexeralfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 cm or more.

Arenic Palexeralfs

JDFK. Other Palexeralfs that have an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) in one or more horizons within 100 cm of the mineral soil surface.

Natric Palexeralfs

JDFL. Other Palexeralfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Palexeralfs

JDFM. Other Palexeralfs that have a calcic horizon within 150 cm of the mineral soil surface.

Calcic Palexeralfs

JDFN. Other Palexeralfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Palexeralfs

JDFO. Other Palexeralfs that have an argillic or kandic horizon that has a base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Palexeralfs

JDFP. Other Palexeralfs with an argillic or kandic horizon that has, in the fine-earth fraction, *either or both*:

1. Less than 35 percent clay throughout all subhorizons within 15 cm of its upper boundary; *or*
2. At its upper boundary, a clay increase of less than 20 percent (absolute) within a vertical distance of 7.5 cm and of less than 15 percent (absolute) within a vertical distance of 2.5 cm.

Haplic Palexeralfs

JDFQ. Other Palexeralfs that have a color value, moist, of 3 or less and 0.7 percent or more organic carbon either throughout an Ap horizon or throughout the upper 10 cm of an A horizon.

Mollic Palexeralfs

JDFR. Other Palexeralfs.

Typic Palexeralfs

Plinthoxeralfs

Key to Subgroups

JDDA. All Plinthoxeralfs (provisionally).

Typic Plinthoxeralfs

Rhodoxeralfs

Key to Subgroups

JDEA. Rhodoxeralfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodoxeralfs

JDEB. Other Rhodoxeralfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Rhodoxeralfs

JDEC. Other Rhodoxeralfs that have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Rhodoxeralfs

JDED. Other Rhodoxeralfs that have a calcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Calcic Rhodoxeralfs

JDEE. Other Rhodoxeralfs that have an argillic or kandic horizon that is either less than 15 cm thick or is discontinuous horizontally in each pedon.

Inceptic Rhodoxeralfs

JDEF. Other Rhodoxeralfs.

Typic Rhodoxeralfs

CHAPTER 6

*Andisols*¹

Key to Suborders

DA. Andisols that have *either*:

1. A histic epipedon; *or*
2. In a layer above a densic, lithic, or paralithic contact or in a layer at a depth between 40 and 50 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallowest, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:
 - a. 2 percent or more redox concentrations; *or*
 - b. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
 - c. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

[Aquands](#), p. 83

DB. Other Andisols that have a cryic soil temperature regime.

[Cryands](#), p. 86

DC. Other Andisols that have an aridic moisture regime.

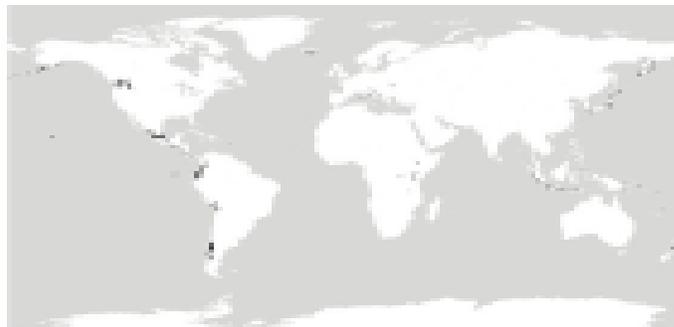
[Torrands](#), p. 89

DD. Other Andisols that have a xeric moisture regime.

[Xerands](#), p. 100

DE. Other Andisols that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic



contact, duripan, or petrocalcic horizon within that depth; *or*

2. Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon.

[Vitrand](#)s, p. 99

DF. Other Andisols that have an ustic moisture regime.

[Ustands](#), p. 97

DG. Other Andisols.

[Udands](#), p. 90

Aquands

Key to Great Groups

DAA. Aquands that have a cryic soil temperature regime.

[Cryaquands](#), p. 84

DAB. Other Aquands that have, in half or more of each pedon, a placic horizon within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

[Placaquands](#), p. 86

DAC. Other Aquands that have, in 75 percent or more of each pedon, a cemented horizon that has its upper boundary within 100 cm either of the mineral soil surface or of the top of

¹This chapter builds on the preliminary Andisol Proposal (1978) by Guy D. Smith (New Zealand Soil Bureau Record 96) and represents the work of the International Committee on the Classification of Andisols (ICOMAND), chaired by Michael L. Leamy, New Zealand Soil Bureau.

an organic layer with andic soil properties, whichever is shallower.

[Duraquands](#), p. 84

DAD. Other Aquands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact within that depth; *or*
2. Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact.

[Vitraqquands](#), p. 86

DAE. Other Aquands that have a melanic epipedon.

[Melanaquands](#), p. 85

DAF. Other Aquands that have episaturation.

[Epiquands](#), p. 85

DAG. Other Aquands.

[Endoquands](#), p. 84

Cryaquands

Key to Subgroups

DAAA. Cryaquands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Cryaquands

DAAB. Other Cryaquands that have a histic epipedon.

Histic Cryaquands

DAAC. Other Cryaquands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Cryaquands

DAAD. Other Cryaquands.

Typic Cryaquands

Duraquands

Key to Subgroups

DACA. Duraquands that have a histic epipedon.

Histic Duraquands

DACB. Other Duraquands that have extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 $\text{cmol}(+)/\text{kg}$ in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Acraquoxic Duraquands

DACC. Other Duraquands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Duraquands

DACD. Other Duraquands.

Typic Duraquands

Endoquands

Key to Subgroups

DAGA. Endoquands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Endoquands

DAGB. Other Endoquands that have a horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Endoquands

DAGC. Other Endoquands that have a histic epipedon.

Histic Endoquands

DAGD. Other Endoquands that have more than 2.0 $\text{cmol}(+)/\text{kg}$ Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more at a depth between 25 and 50 cm either from the mineral soil

surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Endoaquands

DAGE. Other Endoaquands that have, on undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Endoaquands

DAGF. Other Endoaquands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Endoaquands

DAGG. Other Endoaquands.

Typic Endoaquands

Epiaquands

Key to Subgroups

DAFA. Epiaquands that have a horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Epiaquands

DAFB. Other Epiaquands that have a histic epipedon.

Histic Epiaquands

DAFC. Other Epiaquands that have more than 2.0 cmol(+)/kg Al³⁺ (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more at a depth between 25 and 50 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Epiaquands

DAFD. Other Epiaquands that have, on undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Epiaquands

DAFE. Other Epiaquands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Epiaquands

DAFF. Other Epiaquands.

Typic Epiaquands

Melanaquands

Key to Subgroups

DAEA. Melanaquands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Melanaquands

DAEB. Other Melanaquands that have extractable bases (by NH₄OAc) plus 1N KCl-extractable Al³⁺ totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Acraquoxic Melanaquands

DAEC. Other Melanaquands that have *both*:

1. On undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. More than 6.0 percent organic carbon and the colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Pachic Melanaquands

DAED. Other Melanaquands that have, on undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Melanaquands

DAEE. Other Melanaquands that have more than 6.0 percent organic carbon and the colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Melanaquands

DAEF. Other Melanaquands that have, at a depth between 40 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Melanaquands

DAEG. Other Melanaquands.

Typic Melanaquands

Placaquands

Key to Subgroups

DABA. Placaquands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Placaquands

DABB. Other Placaquands that have *both*:

1. A histic epipedon; *and*
2. A horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Histic Placaquands

DABC. Other Placaquands that have a horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Placaquands

DABD. Other Placaquands that have a histic epipedon.

Histic Placaquands

DABE. Other Placaquands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0

percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Placaquands

DABF. Other Placaquands.

Typic Placaquands

Vitraqquands

Key to Subgroups

DADA. Vitraqquands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Vitraqquands

DADB. Other Vitraqquands that have a horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Vitraqquands

DADC. Other Vitraqquands that have a histic epipedon.

Histic Vitraqquands

DADD. Other Vitraqquands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Vitraqquands

DADE. Other Vitraqquands.

Typic Vitraqquands

Cryands

Key to Great Groups

DBA. Cryands that have, in 75 percent or more of each pedon, a cemented horizon that has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

[Duricryands](#), p. 87

DBB. Other Cryands that have, on undried samples, a 1500 kPa water retention of 100 percent or more, by weighted average, throughout *either*:

1. One or more layers with a total thickness of 35 cm between the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and 100 cm from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth;
or

2. 60 percent or more of the horizon thickness between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon.

[Hydrocryands](#), p. 88

DBC. Other Cryands that have a melanic epipedon.

[Melanocryands](#), p. 89

DBD. Other Cryands that have a layer that meets the depth, thickness, and organic-carbon requirements for a melanic epipedon.

[Fulvicryands](#), p. 87

DBE. Other Cryands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth;
or

2. Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon.

[Vitricryands](#), p. 89

DBF. Other Cryands.

[Haplocryands](#), p. 87

Duricryands

Key to Subgroups

DBAA. Duricryands that have, in some subhorizon at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in

normal years (or artificial drainage) and *one or more* of the following:

- 2 percent or more redox concentrations; *or*
- A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
- Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Duricryands

DBAB. Other Duricryands.

Typic Duricryands

Fulvicryands

Key to Subgroups

DBDA. Fulvicryands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Fulvicryands

DBDB. Other Fulvicryands that have, throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower:

- More than 6.0 percent organic carbon, by weighted average; *and*
- More than 4.0 percent organic carbon in all parts.

Pachic Fulvicryands

DBDC. Other Fulvicryands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Fulvicryands

DBDD. Other Fulvicryands.

Typic Fulvicryands

Haplocryands

Key to Subgroups

DBFA. Haplocryands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Haplocryands

DBFB. Other Haplocryands that have more than 2.0 cmol(+)/kg Al³⁺ (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more at a depth between 25 and 50 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Haplocryands

DBFC. Other Haplocryands that have, in some subhorizon at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Haplocryands

DBFD. Other Haplocryands that have extractable bases (by NH₄OAc) plus 1N KCl-extractable Al³⁺ totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrodoxic Haplocryands

DBFE. Other Haplocryands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Haplocryands

DBFF. Other Haplocryands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haplocryands

DBFG. Other Haplocryands that have a xeric moisture regime.

Xeric Haplocryands

DBFH. Other Haplocryands.

Typic Haplocryands

Hydrocryands

Key to Subgroups

DBBA. Hydrocryands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Hydrocryands

DBBB. Other Hydrocryands that have a placic horizon within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Placic Hydrocryands

DBBC. Other Hydrocryands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Hydrocryands

DBBD. Other Hydrocryands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Hydrocryands

DBBE. Other Hydrocryands.

Typic Hydrocryands

Melanocryands

Key to Subgroups

DBCA. Melanocryands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer that has andic soil properties, whichever is shallower.

Lithic Melanocryands

DBCB. Other Melanocryands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Melanocryands

DBCC. Other Melanocryands.

Typic Melanocryands

Vitricryands

Key to Subgroups

DBEA. Vitricryands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer that has andic soil properties, whichever is shallower.

Lithic Vitricryands

DBEB. Other Vitricryands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Vitricryands

DBEC. Other Vitricryands that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Vitricryands

DBED. Other Vitricryands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Vitricryands

DBEE. Other Vitricryands that have a xeric moisture regime and a mollic or umbric epipedon.

Humic Xeric Vitricryands

DBEF. Other Vitricryands that have a xeric moisture regime.

Xeric Vitricryands

DBEG. Other Vitricryands that have an argillic or kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm or throughout the entire argillic or kandic horizon if it is less than 50 cm thick.

Ultic Vitricryands

DBEH. Other Vitricryands that have an argillic or kandic horizon that has its upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Vitricryands

DBEI. Other Vitricryands that have a mollic or umbric epipedon.

Humic Vitricryands

DBEJ. Other Vitricryands.

Typic Vitricryands

Torrands

Key to Great Groups

DCA. Torrands that have, in 75 percent or more of each pedon, a cemented horizon that has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

[Duritorrands](#), p. 90

DCB. Other Torrands that have, on air-dried samples, a 1500 kPa water retention of less than 15 percent throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*
2. Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon.

[Vitritorrands](#), p. 90

DCC. Other Torrands.

[Haplotorrands](#), p. 90

Duritorrands

Key to Subgroups

DCAA. Duritorrands that have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Duritorrands

DCAB. Other Duritorrands that have, on air-dried samples, a 1500 kPa water retention of less than 15 percent throughout 60 percent or more of the thickness *either*:

1. Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, if there is no paralithic contact or duripan within that depth, and a point 60 cm below that depth; *or*
2. Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a paralithic contact or a duripan.

Vitric Duritorrands

DCAC. Other Duritorrands.

Typic Duritorrands

Haplotorrands

Key to Subgroups

DCCA. Haplotorrands that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplotorrands

DCCB. Other Haplotorrands that have a horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm of the mineral soil surface.

Duric Haplotorrands

DCCC. Other Haplotorrands that have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Calcic Haplotorrands

DCCD. Other Haplotorrands.

Typic Haplotorrands

Vitritorrands

Key to Subgroups

DCBA. Vitritorrands that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vitritorrands

DCBB. Other Vitritorrands that have a horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm of the mineral soil surface.

Duric Vitritorrands

DCBC. Other Vitritorrands that have, in one or more horizons at a depth between 50 and 100 cm from the mineral soil surface, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Vitritorrands

DCBD. Other Vitritorrands that have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Calcic Vitritorrands

DCBE. Other Vitritorrands.

Typic Vitritorrands

Udands

Key to Great Groups

DGA. Udands that have, in half or more of each pedon, a placic horizon within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

[Placudands](#), p. 97

DGB. Other Udands that have, in 75 percent or more of each pedon, a cemented horizon that has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

[Durudands](#), p. 91

DGC. Other Udands that have a melanic epipedon.

[Melanudands](#), p. 95

DGD. Other Udands that have, on undried samples, a 1500 kPa water retention of 100 percent or more, by weighted average, throughout *either*:

1. One or more layers with a total thickness of 35 cm between the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and 100 cm from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. 60 percent or more of the horizon thickness between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon.

[Hydrudands](#), p. 94

DGE. Other Udands that have a layer that meets the depth, thickness, and organic-carbon requirements for a melanic epipedon.

[Fulvudands](#), p. 91

DGF. Other Udands.

[Hapludands](#), p. 92

Durudands

Key to Subgroups

DGBA. Durudands that have, in one or more horizons above the cemented horizon, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Durudands

DGBB. Other Durudands that have extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 $\text{cmol}(+)/\text{kg}$ in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, and the cemented horizon.

Acrodoxic Durudands

DGBC. Other Durudands that have, on undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick above the cemented horizon.

Hydric Durudands

DGBD. Other Durudands that have more than 6.0 percent organic carbon and the colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Durudands

DGBE. Other Durudands.

Typic Durudands

Fulvudands

Key to Subgroups

DGEA. Fulvudands that have *both*:

1. A lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. No horizons with more than 2.0 $\text{cmol}(+)/\text{kg}$ Al^{3+} (by 1N KCl) in the fine-earth fraction and with a total thickness of 10 cm or more at a depth between 25 cm from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, and the lithic contact.

Eutric Lithic Fulvudands

DGEB. Other Fulvudands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Fulvudands

DGEC. Other Fulvudands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or

more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Fulvudands

DGED. Other Fulvudands that have, on undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Fulvudands

DGEE. Other Fulvudands that have extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Acruoxic Fulvudands

DGEF. Other Fulvudands that have an argillic or kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Fulvudands

DGEG. Other Fulvudands that have *both*:

1. No horizons with more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction and with a total thickness of 10 cm or more at a depth between 25 and 50 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. Throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower:
 - a. More than 6.0 percent organic carbon, by weighted average; *and*
 - b. More than 4.0 percent organic carbon in all parts.

Eutric Pachic Fulvudands

DGEH. Other Fulvudands that have no horizons with more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction and with a total thickness of 10 cm or more at a depth between 25 and 50 cm either from the mineral soil surface or from the

top of an organic layer with andic soil properties, whichever is shallower.

Eutric Fulvudands

DGEI. Other Fulvudands that have, throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower:

1. More than 6.0 percent organic carbon, by weighted average; *and*
2. More than 4.0 percent organic carbon in all parts.

Pachic Fulvudands

DGEJ. Other Fulvudands that have, at a depth between 40 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Fulvudands

DGEK. Other Fulvudands.

Typic Fulvudands

Hapludands

Key to Subgroups

DGFA. Hapludands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Hapludands

DGFB. Other Hapludands that have anthraquic conditions.

Anthraquic Hapludands

DGFC. Other Hapludands that have *both*:

1. A horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. In one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

- a. 2 percent or more redox concentrations; *or*
- b. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
- c. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Duric Hapludands

DGFD. Other Hapludands that have a horizon 15 cm or more thick that has 20 percent or more (by volume) cemented soil material and has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Hapludands

DGFE. Other Hapludands that have more than 2.0 cmol(+)/kg Al³⁺ (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more at a depth between 25 and 50 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Hapludands

DGFF. Other Hapludands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Hapludands

DGFG. Other Hapludands that have *both*:

1. Extractable bases (by NH₄OAc) plus 1N KCl-extractable Al³⁺ totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. On undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top

of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hydric Hapludands

DGFH. Other Hapludands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, *both*:

1. Extractable bases (by NH₄OAc) plus 1N KCl-extractable Al³⁺ totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more; *and*
2. A layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Acrudoxic Thaptic Hapludands

DGFI. Other Hapludands that have *both*:

1. Extractable bases (by NH₄OAc) plus 1N KCl-extractable Al³⁺ totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. An argillic or kandic horizon that has *both*:
 - a. An upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
 - b. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Acrudoxic Ultic Hapludands

DGFJ. Other Hapludands that have extractable bases (by NH₄OAc) plus 1N KCl-extractable Al³⁺ totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hapludands

DGFK. Other Hapludands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more within 100 cm either of the mineral soil

surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Hapludands

DGFL. Other Hapludands that have *both*:

1. On undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. At a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Hydric Thaptic Hapludands

DGFM. Other Hapludands that have, on undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Hapludands

DGFN. Other Hapludands that have *both*:

1. A sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more at a depth between 25 and 75 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. At a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Eutric Thaptic Hapludands

DGFO. Other Hapludands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total

thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Hapludands

DGFP. Other Hapludands that have a sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more at a depth between 25 and 75 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Hapludands

DGFQ. Other Hapludands that have an oxic horizon that has its upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Oxic Hapludands

DGFR. Other Hapludands that have an argillic or kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Hapludands

DGFS. Other Hapludands that have an argillic or kandic horizon that has its upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Hapludands

DGFT. Other Hapludands.

Typic Hapludands

Hydrudands

Key to Subgroups

DGDA. Hydrudands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Hydrudands

DGDB. Other Hydrudands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Hydrudands

DGDC. Other Hydrudands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, *both*:

1. Extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more; *and*
2. A layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Acrudoxic Thaptic Hydrudands

DGDD. Other Hydrudands that have extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hydrudands

DGDE. Other Hydrudands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Hydrudands

DGDF. Other Hydrudands that have a sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more at a depth between 25 and 75 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Hydrudands

DGDG. Other Hydrudands that have an argillic or kandic

horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Hydrudands

DGDH. Other Hydrudands.

Typic Hydrudands

Melanudands

Key to Subgroups

DGCA. Melanudands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer that has andic soil properties, whichever is shallower.

Lithic Melanudands

DGCB. Other Melanudands that have anthraquic conditions.

Anthraquic Melanudands

DGCC. Other Melanudands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Melanudands

DGCD. Other Melanudands that have *both*:

1. Extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more

within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Vitric Melanudands

DGCE. Other Melanudands that have *both*:

1. Extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 $\text{cmol}(+)/\text{kg}$ in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. On undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hydric Melanudands

DGCF. Other Melanudands that have extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 $\text{cmol}(+)/\text{kg}$ in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Melanudands

DGCG. Other Melanudands that have *both*:

1. More than 6.0 percent organic carbon and the colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Vitric Melanudands

DGCH. Other Melanudands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Melanudands

DGCI. Other Melanudands that have *both*:

1. On undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and the colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Pachic Melanudands

DGCJ. Other Melanudands that have more than 6.0 percent organic carbon and the colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Melanudands

DGCK. Other Melanudands that have, on undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Melanudands

DGCL. Other Melanudands that have, at a depth between 40 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Melanudands

DGCM. Other Melanudands that have an argillic or kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Melanudands

DGCN. Other Melanudands that have a sum of extractable bases of more than 25.0 $\text{cmol}(+)/\text{kg}$ in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more at a depth between 25 and 75 cm either from the

mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Melanudands

DGCO. Other Melanudands.

Typic Melanudands

Placudands

Key to Subgroups

DGAA. Placudands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer that has andic soil properties, whichever is shallower.

Lithic Placudands

DGAB. Other Placudands that have, in one or more horizons at a depth between 50 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, and the placic horizon, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Placudands

DGAC. Other Placudands that have extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more at a depth between 25 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, and the placic horizon.

Acrudoxic Placudands

DGAD. Other Placudands that have, on undried samples, a 1500 kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Placudands

DGAE. Other Placudands.

Typic Placudands

Ustands

Key to Great Groups

DFA. Ustands that have, in 75 percent or more of each pedon, a cemented horizon that has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

[Durustands](#), p. 97

DFB. Other Ustands.

[Haplustands](#), p. 98

Durustands

Key to Subgroups

DFAA. Durustands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Durustands

DFAB. Other Durustands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Durustands

DFAC. Other Durustands that have a melanic, mollic, or umbric epipedon.

Humic Durustands

DFAD. Other Durustands.

Typic Durustands

Haplustands

Key to Subgroups

DFBA. Haplustands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Haplustands

DFBB. Other Haplustands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Haplustands

DFBC. Other Haplustands that have *both*:

1. Extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 15.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 60 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Dystric Vitric Haplustands

DFBD. Other Haplustands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout one or more layers that have andic soil properties and have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Haplustands

DFBE. Other Haplustands that have more than 6.0 percent organic carbon and the colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral

soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Haplustands

DFBF. Other Haplustands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haplustands

DFBG. Other Haplustands that have a calcic horizon that has its upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Calcic Haplustands

DFBH. Other Haplustands that have extractable bases (by NH_4OAc) plus 1N KCl-extractable Al^{3+} totaling less than 15.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 60 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Dystric Haplustands

DFBI. Other Haplustands that have an oxic horizon that has its upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Oxic Haplustands

DFBJ. Other Haplustands that have an argillic or kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm or throughout the entire argillic or kandic horizon if it is less than 50 cm thick.

Ultic Haplustands

DFBK. Other Haplustands that have an argillic or kandic horizon that has its upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Haplustands

DFBL. Other Haplustands that have a melanic, mollic, or umbric epipedon.

Humic Haplustands

DFBM. Other Haplustands.

Typic Haplustands

Vitrands

Key to Great Groups

DEA. Vitrands that have an ustic moisture regime.
[Ustivitrands](#), p. 99

DEB. Other Vitrands.
[Udivitrands](#), p. 99

Udivitrands

Key to Subgroups

DEBA. Udivitrands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.
Lithic Udivitrands

DEBB. Other Udivitrands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Udivitrands

DEBC. Other Udivitrands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Udivitrands

DEBD. Other Udivitrands that have *both*:

1. An argillic or kandic horizon that has its upper boundary within 125 cm of the mineral soil surface or of the

upper boundary of an organic layer with andic soil properties, whichever is shallower; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of the argillic or kandic horizon.

Ultic Udivitrands

DEBE. Other Udivitrands that have an argillic or kandic horizon that has its upper boundary within 125 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Alfic Udivitrands

DEBF. Other Udivitrands that have a melanic, mollic, or umbric epipedon.

Humic Udivitrands

DEBG. Other Udivitrands.

Typic Udivitrands

Ustivitrands

Key to Subgroups

DEAA. Ustivitrands that have a lithic contact within 50 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Ustivitrands

DEAB. Other Ustivitrands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Ustivitrands

DEAC. Other Ustivitrands that have, at a depth between 25 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1

unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Ustivitrands

DEAD. Other Ustivitrands that have a calcic horizon that has its upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Calcic Ustivitrands

DEAE. Other Ustivitrands that have a melanic, mollic, or umbric epipedon.

Humic Ustivitrands

DEAF. Other Ustivitrands.

Typic Ustivitrands

Xerands

Key to Great Groups

DDA. Xerands that have a 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*
2. Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, a duripan, or a petrocalcic horizon.

[Vitrixerands](#), p. 101

DDB. Other Xerands that have a melanic epipedon.

[Melanoxerands](#), p. 101

DDC. Other Xerands.

[Haploxerands](#), p. 100

Haploxerands

Key to Subgroups

DDCA. Haploxerands that have a lithic contact within 50 cm of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Haploxerands

DDCB. Other Haploxerands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with

andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Haploxerands

DDCC. Other Haploxerands that have, at a depth between 25 and 100 cm from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haploxerands

DDCD. Other Haploxerands that have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Calcic Haploxerands

DDCE. Other Haploxerands that have an argillic or kandic horizon that has *both*:

1. An upper boundary within 125 cm of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Haploxerands

DDCF. Other Haploxerands that have *both*:

1. A mollic or umbric epipedon; *and*
2. An argillic or kandic horizon that has its upper boundary within 125 cm of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Humic Haploxerands

DDCG. Other Haploxerands that have an argillic or kandic horizon that has its upper boundary within 125 cm of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Haploxerands

DDCH. Other Haploxerands that have a mollic or umbric epipedon.

Humic Haploxerands

DDCI. Other Haploxerands.

Typic Haploxerands

Melanoxerands

Key to Subgroups

DDBA. Melanoxerands that have more than 6.0 percent organic carbon and the colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Melanoxerands

DDBB. Other Melanoxerands.

Typic Melanoxerands

Vitrixerands

Key to Subgroups

DDAA. Vitrixerands that have a lithic contact within 50 cm of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Vitrixerands

DDAB. Other Vitrixerands that have, in one or more horizons at a depth between 50 and 100 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. 2 percent or more redox concentrations; *or*
2. A color value, moist, of 4 or more and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds or in the matrix if peds are absent; *or*
3. Enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Vitrixerands

DDAC. Other Vitrixerands that have, at a depth between 25 and 100 cm from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and the colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Vitrixerands

DDAD. Other Vitrixerands that have *both*:

1. A melanic, mollic, or umbric epipedon; *and*
2. An argillic or kandic horizon that has its upper boundary within 125 cm of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Humic Vitrixerands

DDAE. Other Vitrixerands that have an argillic or kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower; *and*
2. A base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm or throughout the entire argillic or kandic horizon if it is less than 50 cm thick.

Ultic Vitrixerands

DDAF. Other Vitrixerands that have an argillic or kandic horizon that has its upper boundary within 125 cm of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Vitrixerands

DDAG. Other Vitrixerands that have a melanic, mollic, or umbric epipedon.

Humic Vitrixerands

DDAH. Other Vitrixerands.

Typic Vitrixerands

CHAPTER 7

Aridisols¹

Key to Suborders

FA. Aridisols that have a cryic soil temperature regime.
[Cryids](#), p. 118

FB. Other Aridisols that have a salic horizon that has its upper boundary within 100 cm of the soil surface.
[Salids](#), p. 128

FC. Other Aridisols that have a duripan that has its upper boundary within 100 cm of the soil surface.
[Durids](#), p. 121

FD. Other Aridisols that have a gypsic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface and do not have a petrocalcic horizon overlying these horizons.
[Gypsids](#), p. 124

FE. Other Aridisols that have an argillic or natric horizon that has its upper boundary within 100 cm of the soil surface and do not have a petrocalcic horizon that has an upper boundary within 100 cm of the soil surface.
[Argids](#), p. 103

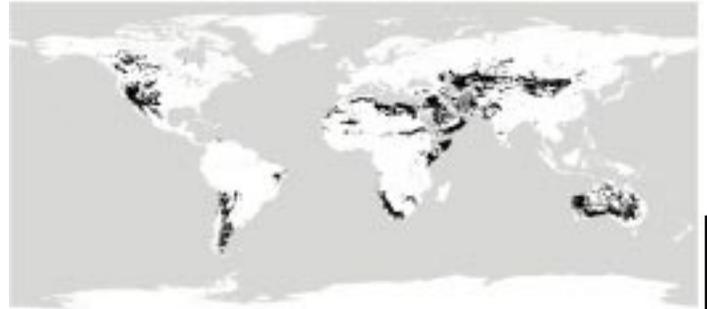
FF. Other Aridisols that have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.
[Calcids](#), p. 111

FG. Other Aridisols.
[Cambids](#), p. 114

Argids

Key to Great Groups

FEA. Argids that have a duripan or a petrocalcic or petrogypsic horizon that has its upper boundary within 150 cm of the soil surface.
[Petroargids](#), p. 111



A
R
I

FEB. Other Argids that have a natric horizon.
[Natrargids](#), p. 108

FEC. Other Argids that do not have a densic, lithic, or paralithic contact within 50 cm of the soil surface and have *either*:

1. A clay increase of 15 percent or more (absolute) within a vertical distance of 2.5 cm either within the argillic horizon or at its upper boundary; *or*
2. An argillic horizon that extends to 150 cm or more from the soil surface, that does not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content, and that has, in 50 percent or more of the matrix in some part between 100 and 150 cm, *either*:
 - a. Hue of 7.5YR or redder and chroma of 5 or more; *or*
 - b. Hue of 7.5YR or redder and value, moist, of 3 or less and value, dry, of 4 or less.

[Paleargids](#), p. 109

FED. Other Argids that have a gypsic horizon that has its upper boundary within 150 cm of the soil surface.
[Gypsiargids](#), p. 105

FEE. Other Argids that have a calcic horizon that has its upper boundary within 150 cm of the soil surface.
[Calciargids](#), p. 104

FEF. Other Argids.
[Haplargids](#), p. 106

¹ This chapter was rewritten in 1994 following recommendations of the International Committee on Aridisols (ICOMID), chaired by Dr. A. Osman. Major contributions were made by Dr. H. Eswaran and J. Nichols.

Calciargids

Key to Subgroups

FEEA. Calciargids that have a lithic contact within 50 cm of the soil surface.

Lithic Calciargids

FEEB. Other Calciargids that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Xerertic Calciargids

FEEC. Other Calciargids that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Ustertic Calciargids

FEED. Other Calciargids that have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the

soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower.

Vertic Calciargids

FEEE. Other Calciargids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Calciargids

FEEF. Other Calciargids that have:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the soil surface to the top of an argillic horizon at a depth of 50 cm or more; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and a soil moisture regime that borders on ustic.

Arenic Ustic Calciargids

FEEG. Other Calciargids that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Calciargids

FEEH. Other Calciargids that have the following combination of characteristics:

1. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Durinodic Xeric Calciargids

FEEI. Other Calciargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Durinodic Calciargids

FEEJ. Other Calciargids that:

1. Are dry in all parts of the moisture control section

for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric; *and*

2. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Xeric Calciargids

FEEK. Other Calciargids that:

1. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic; *and*

2. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Ustic Calciargids

FEEL. Other Calciargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Calciargids

FEEM. Other Calciargids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Calciargids

FEEN. Other Calciargids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser

than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Calciargids

FEEO. Other Calciargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Calciargids

FEEP. Other Calciargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Calciargids

FEEQ. Other Calciargids.

Typic Calciargid

Gypsiargids

Key to Subgroups

FEDA. Gypsiargids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
2. Are saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Gypsiargids

FEDB. Other Gypsiargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that either contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Durinodic Gypsiargids

FEDC. Other Gypsiargids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness

of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

- a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
- b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Gypsiargids

FEDD. Other Gypsiargids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Gypsiargids

FEDE. Other Gypsiargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Gypsiargids

FEDF. Other Gypsiargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Gypsiargids

FEDG. Other Gypsiargids.

Typic Gypsiargids

Haplargids

Key to Subgroups

FEFA. Haplargids that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. An argillic horizon that is discontinuous throughout each pedon.

Lithic Ruptic-Entic Haplargids

FEFB. Other Haplargids that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Lithic Xeric Haplargids

FEFC. Other Haplargids that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Lithic Ustic Haplargids

FEFD. Other Haplargids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplargids

FEFE. Other Haplargids that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Xerertic Haplargids

FEFF. Other Haplargids that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Ustertic Haplargids

FEFG. Other Haplargids that have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower.

Vertic Haplargids

FEFH. Other Haplargids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Haplargids

FEFI. Other Haplargids that have:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the soil surface to the top of an argillic horizon at a depth of 50 cm or more; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and a soil moisture regime that borders on ustic.

Arenic Ustic Haplargids

FEFJ. Other Haplargids that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Haplargids

FEFK. Other Haplargids that have:

1. One or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the

soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Durinodic Xeric Haplargids

FEFL. Other Haplargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Durinodic Haplargids

FEFM. Other Haplargids that:

1. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Petronodic Ustic Haplargids

FEFN. Other Haplargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Haplargids

FEFO. Other Haplargids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Haplargids

FEFP. Other Haplargids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser

than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Haplargids

FEFQ. Other Haplargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Haplargids

FEFR. Other Haplargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Haplargids

FEFS. Other Haplargids.

Typic Haplargids

Natrargids

Key to Subgroups

FEBA. Natrargids that have *both* of the following:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Lithic Xeric Natrargids

FEBB. Other Natrargids that have *both* of the following:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Lithic Ustic Natrargids

FEBC. Other Natrargids that have a lithic contact within 50 cm of the soil surface.

Lithic Natrargids

FEBD. Other Natrargids that have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrargids

FEBE. Other Natrargids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*

2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Natrargids

FEBF. Other Natrargids that meet *both* of the following:

1. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist; *and*

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Durinodic Xeric Natrargids

FEBG. Other Natrargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Durinodic Natrargids

FEBH. Other Natrargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Natrargids

FEBI. Other Natrargids that have:

1. Skeletans covering 10 percent or more of the surfaces of peds at a depth 2.5 cm or more below the upper boundary of the natric horizon; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the

soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Glossic Ustic Natrargids

FEBJ. Other Natrargids that have:

1. An exchangeable sodium percentage of less than 15 (or an SAR of less than 13) in 50 percent or more of the natric horizon; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Haplic Ustic Natrargids

FEBK. Other Natrargids that have:

1. An exchangeable sodium percentage of less than 15 (or an SAR of less than 13) in 50 percent or more of the natric horizon; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Haploxeralfic Natrargids

FEBL. Other Natrargids that have an exchangeable sodium percentage of less than 15 (or an SAR of less than 13) in 50 percent or more of the natric horizon.

Haplic Natrargids

FEBM. Other Natrargids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Natrargids

FEBN. Other Natrargids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Natrargids

FEBO. Other Natrargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Natrargids

FEBP. Other Natrargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Natrargids

FEBQ. Other Natrargids that have skeletalans covering 10 percent or more of the surfaces of peds at a depth 2.5 cm or more below the upper boundary of the natric horizon.

Glossic Natrargids

FEBR. Other Natrargids.

Typic Natrargids

Paleargids

Key to Subgroups

FECA. Paleargids that have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Paleargids

FECB. Other Paleargids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*

2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Paleargids

FECC. Other Paleargids that have:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Arenic Ustic Paleargids

FECD. Other Paleargids that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Paleargids

FECE. Other Paleargids that have a calcic horizon that has its upper boundary within 150 cm of the soil surface.

Calcic Paleargids

FECF. Other Paleargids that have:

1. One or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Durinodic Xeric Paleargids

FECG. Other Paleargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Durinodic Paleargids

FECH. Other Paleargids that:

1. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the

soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Petronodic Ustic Paleargids

FECI. Other Paleargids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Paleargids

FECJ. Other Paleargids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Paleargids

FECK. Other Paleargids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Paleargids

FECL. Other Paleargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Paleargids

FECM. Other Paleargids that are dry in all parts of the moisture control section for less than three-fourths of the time

(cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Paleargids

FECN. Other Paleargids.

Typic Paleargids

Petroargids

Key to Subgroups

FEAA. Petroargids that meet *both* of the following:

1. Have a petrogypsic horizon that has its upper boundary within 150 cm of the soil surface; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Petrogypsic Ustic Petroargids

FEAB. Other Petroargids that have a petrogypsic horizon that has its upper boundary within 150 cm of the soil surface.

Petrogypsic Petroargids

FEAC. Other Petroargids that have:

1. A duripan that has its upper boundary within 150 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Duric Xeric Petroargids

FEAD. Other Petroargids that have a duripan that has its upper boundary within 150 cm of the soil surface.

Duric Petroargids

FEAE. Other Petroargids that have a natric horizon.

Natric Petroargids

FEAF. Other Petroargids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Petroargids

FEAG. Other Petroargids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Petroargids

FEAH. Other Petroargids.

Typic Petroargids

Calcids

Key to Great Groups

FFA. Calcids that have a petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

[Petrocalcids](#), p. 113

FFB. Other Calcids.

[Haplocalcids](#), p. 111

Haplocalcids

Key to Subgroups

FFBA. Haplocalcids that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Lithic Xeric Haplocalcids

FFBB. Other Haplocalcids that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Lithic Ustic Haplocalcids

FFBC. Other Haplocalcids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplocalcids

FFBD. Other Haplocalcids that have:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplocalcids

FFBE. Other Haplocalcids that:

1. Are *either*:

a. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*

b. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years; *and*

2. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Aquic Durinodic Haplocalcids

FFBF. Other Haplocalcids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*

2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Haplocalcids

FFBG. Other Haplocalcids that have:

1. A duripan that has its upper boundary within 150 cm of the surface; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Duric Xeric Haplocalcids

FFBH. Other Haplocalcids that have a duripan that has its upper boundary within 150 cm of the surface.

Duric Haplocalcids

FFBI. Other Haplocalcids that have:

1. One or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Durinodic Xeric Haplocalcids

FFBJ. Other Haplocalcids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more

(by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Durinodic Haplocalcids

FFBK. Other Haplocalcids that have:

1. One or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Petronodic Xeric Haplocalcids

FEBL. Other Haplocalcids that:

1. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions; *and*

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Petronodic Ustic Haplocalcids

FFBM. Other Haplocalcids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Haplocalcids

FFBN. Other Haplocalcids that have *both*:

1. A horizon at least 25 cm thick within 100 cm of the soil surface that has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and a soil moisture regime that borders on xeric.

Sodic Xeric Haplocalcids

FFBO. Other Haplocalcids that meet *both* of the following:

1. Have, in a horizon at least 25 cm thick within 100 cm of the soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years; *and*

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Sodic Ustic Haplocalcids

FFBP. Other Haplocalcids that have, in a horizon at least 25 cm thick within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years.

Sodic Haplocalcids

FFBQ. Other Haplocalcids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Haplocalcids

FFBR. Other Haplocalcids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandidic Haplocalcids

FFBS. Other Haplocalcids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Haplocalcids

FFBT. Other Haplocalcids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Haplocalcids

FFBU. Other Haplocalcids.

Typic Haplocalcids

Petrocalcids

Key to Subgroups

FFAA. Petrocalcids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Petrocalcids

FFAB. Other Petrocalcids that have a natric horizon.

Natric Petrocalcids

FFAC. Other Petrocalcids that have *both* of the following:

1. An argillic horizon that has its upper boundary within 100 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Xeralfic Petrocalcids

FFAD. Other Petrocalcids that have *both* of the following:

1. An argillic horizon that has its upper boundary within 100 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Ustalfic Petrocalcids

FFAE. Other Petrocalcids that have an argillic horizon that has its upper boundary within 100 cm of the soil surface.

Argic Petrocalcids

FFAF. Other Petrocalcids that have:

1. A calcic horizon overlying the petrocalcic horizon; *and*

2. A lithic contact within 50 cm of the soil surface.

Calcic Lithic Petrocalcids

FFAG. Other Petrocalcids that have a calcic horizon overlying the petrocalcic horizon.

Calcic Petrocalcids

FFAH. Other Petrocalcids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Petrocalcids

FFAI. Other Petrocalcids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Petrocalcids

FFAJ. Other Petrocalcids.

Typic Petrocalcids

Cambids

Key to Great Groups

FGA. Cambids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
 2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.
- [Aquicambids](#), p. 114

FGB. Other Cambids that have a duripan or a petrocalcic or petrogypsic horizon that has its upper boundary within 150 cm of the soil surface.

[Petrocambids](#), p. 117

FGC. Other Cambids that have an anthropic epipedon.

[Anthracambids](#), p. 114

FGD. Other Cambids.

[Haplocambids](#), p. 115

Anthracambids

Key to Subgroups

FGCA. All Anthracambids.

Typic Anthracambids

Aquicambids

Key to Subgroups

FGAA. Aquicambids that have, in a horizon at least 25 cm thick within 100 cm of the soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years.

Sodic Aquicambids

FGAB. Other Aquicambids that:

1. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Durinodic Xeric Aquicambids

FGAC. Other Aquicambids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Durinodic Aquicambids

FGAD. Other Aquicambids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Aquicambids

FGAE. Other Aquicambids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Aquicambids

FGAF. Other Aquicambids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrantic Aquicambids

FGAG. Other Aquicambids that have an irregular decrease in content of organic carbon from a depth of 25 cm either to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluventic Aquicambids

FGAH. Other Aquicambids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Aquicambids

FGAI. Other Aquicambids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Aquicambids

FGAJ. Other Aquicambids.

Typic Aquicambids

Haplocambids

Key to Subgroups

FGDA. Haplocambids that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Lithic Xeric Haplocambids

FGDB. Other Haplocambids that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that is dry in all parts for

less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Lithic Ustic Haplocambids

FGDC. Other Haplocambids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplocambids

FGDD. Other Haplocambids that have:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Xerertic Haplocambids

FGDE. Other Haplocambids that have:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on ustic.

Ustertic Haplocambids

FGDF. Other Haplocambids that have *at least one* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a dense, lithic, or paralithic contact, whichever is shallower.

Vertic Haplocambids

FGDG. Other Haplocambids that have *both* of the following:

1. One or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and a soil moisture regime that borders on xeric.

Durinodic Xeric Haplocambids

FGDH. Other Haplocambids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture-resistance class when moist.

Durinodic Haplocambids

FGDI. Other Haplocambids that have:

1. One or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and a soil moisture regime that borders on xeric.

Petronodic Xeric Haplocambids

FEDJ. Other Haplocambids that:

1. Have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Petronodic Ustic Haplocambids

FGDK. Other Haplocambids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Haplocambids

FGDL. Other Haplocambids that have *both*:

1. A horizon at least 25 cm thick within 100 cm of the soil surface that has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and a soil moisture regime that borders on xeric.

Sodic Xeric Haplocambids

FGDM. Other Haplocambids that meet *both* of the following:

1. Have, in a horizon at least 25 cm thick within 100 cm of the soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Sodic Ustic Haplocambids

FGDN. Other Haplocambids that have, in a horizon at least 25 cm thick within 100 cm of the soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years.

Sodic Haplocambids

FGDO. Other Haplocambids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Haplocambids

FGDP. Other Haplocambids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Haplocambids

FGDQ. Other Haplocambids that:

1. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric; *and*
2. Have an irregular decrease in content of organic carbon from a depth of 25 cm either to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Xerofluventic Haplocambids

FGDR. Other Haplocambids that:

1. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic; *and*
2. Have an irregular decrease in content of organic carbon from a depth of 25 cm either to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Ustifluventic Haplocambids

FGDS. Other Haplocambids that have an irregular decrease in content of organic carbon from a depth of 25 cm either to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluventic Haplocambids

FGDT. Other Haplocambids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Haplocambids

FGDU. Other Haplocambids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Haplocambids

FGDV. Other Haplocambids.

Typic Haplocambids

Petrocambids

Key to Subgroups

FGBA. Petrocambids that have, in a horizon at least 25 cm thick within 100 cm of the soil surface, an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years.

Sodic Petrocambids

FGBB. Other Petrocambids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Petrocambids

FGBC. Other Petrocambids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Petrocambids

FGBD. Other Petrocambids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Petrocambids

FGBE. Other Petrocambids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Petrocambids

FGBF. Other Petrocambids.

Typic Petrocambids

Cryids

Key to Great Groups

FAA. Cryids that have a salic horizon that has its upper boundary within 100 cm of the soil surface.

[Salicryids](#), p. 121

FAB. Other Cryids that have a duripan or a petrocalcic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

[Petrocryids](#), p. 120

FAC. Other Cryids that have a gypsic horizon that has its upper boundary within 100 cm of the soil surface.

[Gypsicryids](#), p. 119

FAD. Other Cryids that have an argillic or natric horizon.

[Argicryids](#), p. 118

FAE. Other Cryids that have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

[Calcicryids](#), p. 119

FAF. Other Cryids.

[Haplocryids](#), p. 120

Argicryids

Key to Subgroups

FADA. Argicryids that have a lithic contact within 50 cm of the soil surface.

Lithic Argicryids

FADB. Other Argicryids that have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide throughout a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argicryids

FADC. Other Argicryids that have a natric horizon that has its upper boundary within 100 cm of the soil surface.

Natric Argicryids

FADD. Other Argicryids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

- a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

- b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Argicryids

FADE. Other Argicryids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Argicryids

FADF. Other Argicryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Argicryids

FADG. Other Argicryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a

depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Argicryids

FADH. Other Argicryids.

Typic Argicryids

Calcicryids

Key to Subgroups

FAEA. Calcicryids that have a lithic contact within 50 cm of the soil surface.

Lithic Calcicryids

FAEB. Other Calcicryids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Calcicryids

FAEC. Other Calcicryids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Calcicryids

FAED. Other Calcicryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Calcicryids

FAEE. Other Calcicryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Calcicryids

FAEF. Other Calcicryids.

Typic Calcicryids

Gypsicryids

Key to Subgroups

FACA. Gypsicryids that have a calcic horizon.

Calcic Gypsicryids

FACB. Other Gypsicryids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Gypsicryids

FACC. Other Gypsicryids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Gypsicryids

FACD. Other Gypsicryids.

Typic Gypsicryids

Haplocryids

Key to Subgroups

FAFA. Haplocryids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplocryids

FAFB. Other Haplocryids that have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide throughout a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplocryids

FAFC. Other Haplocryids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Haplocryids

FAFD. Other Haplocryids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Haplocryids

FAFE. Other Haplocryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Haplocryids

FAFF. Other Haplocryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Haplocryids

FAFG. Other Haplocryids.

Typic Haplocryids

Petrocryids

Key to Subgroups

FABA. Petrocryids that:

1. Have a duripan that is strongly cemented or less cemented in all subhorizons and has its upper boundary within 100 cm of the soil surface; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xereptic Petrocryids

FABB. Other Petrocryids that:

1. Have a duripan that has its upper boundary within 100 cm of the soil surface; *and*
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Duric Xeric Petrocryids

FABC. Other Petrocryids that have a duripan that has its upper boundary within 100 cm of the soil surface.

Duric Petrocryids

FABD. Other Petrocryids that have a petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

Petrogypsic Petrocryids

FABE. Other Petrocryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a

depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Petrocryids

FABF. Other Petrocryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on ustic.

Ustic Petrocryids

FABG. Other Petrocryids.

Typic Petrocryids

Salicyrids

Key to Subgroups

FAAA. Salicyrids that are saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Salicyrids

FAAB. Other Salicyrids.

Typic Salicyrids

Durids

Key to Great Groups

FCA. Durids that have a natric horizon above the duripan.

[Natridurids](#), p. 123

FCB. Other Durids that have an argillic horizon above the duripan.

[Argidurids](#), p. 121

FCC. Other Durids.

[Haplodurids](#), p. 122

Argidurids

Key to Subgroups

FCBA. Argidurids that have, above the duripan, *one or both* of the following:

1. Cracks between the soil surface and the top of the duripan that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary above the duripan;
or

2. A linear extensibility of 6.0 cm or more between the soil surface and the top of the duripan.

Vertic Argidurids

FCBB. Other Argidurids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Argidurids

FCBC. Other Argidurids that have the following combination of characteristics:

1. An argillic horizon that has 35 percent or more clay in the fine-earth fraction of some part; *and either*
 - a. A clay increase of 15 percent or more (absolute) within a vertical distance of 2.5 cm either within the argillic horizon or at its upper boundary; *or*
 - b. If there is an Ap horizon directly above the argillic horizon, a clay increase of 10 percent or more (absolute) at the upper boundary of the argillic horizon; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Abruptic Xeric Argidurids

FCBD. Other Argidurids that have an argillic horizon that has 35 percent or more clay in the fine-earth fraction of some part; *and either*

1. A clay increase of 15 percent or more (absolute) within a vertical distance of 2.5 cm within the argillic horizon or at its upper boundary; *or*
2. If there is an Ap horizon directly above the argillic horizon, a clay increase of 10 percent or more (absolute) at the upper boundary of the argillic horizon.

Abruptic Argidurids

FCBE. Other Argidurids that have:

1. A duripan that is strongly cemented or less cemented in all subhorizons; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Haploxeralf Argidurids

FCBF. Other Argidurids that have a duripan that is strongly cemented or less cemented in all subhorizons.

Argidic Argidurids

FCBG. Other Argidurids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Argidurids

FCBH. Other Argidurids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Argidurids

FCBI. Other Argidurids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Argidurids

FCBJ. Other Argidurids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Argidurids

FCBK. Other Argidurids.

Typic Argidurids

Haplodurids

Key to Subgroups

FCCA. Haplodurids that:

1. Have a duripan that is strongly cemented or less cemented in all subhorizons; *and*
2. Are *either*:
 - a. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
 - b. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquicambidic Haplodurids

FCCB. Other Haplodurids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Haplodurids

FCCC. Other Haplodurids that have:

1. A duripan that is strongly cemented or less cemented in all subhorizons; *and*
2. A mean annual soil temperature lower than 22 °C, a difference of 5 °C or more between mean summer and mean winter soil temperatures at a depth of 50 cm, and a soil moisture regime that borders on xeric.

Xereptic Haplodurids

FCCD. Other Haplodurids that have a duripan that is strongly cemented or less cemented in all subhorizons.

Cambidic Haplodurids

FCCE. Other Haplodurids that have:

1. A moisture control section that is dry in all parts for three-fourths of the time (cumulative) or less when the soil temperature at a depth of 50 cm is 5 °C or higher and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Haplodurids

FCCF. Other Haplodurids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Haplodurids

FCCG. Other Haplodurids that have a mean annual soil temperature lower than 22 °C, a difference of 5 °C or more between mean summer and mean winter soil temperatures at a depth of 50 cm, and a soil moisture regime that borders on xeric.

Xeric Haplodurids

FCCH. Other Haplodurids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Haplodurids

FCCI. Other Haplodurids.

Typic Haplodurids

Natridurids

Key to Subgroups

FCAA. Natridurids that have, above the duripan, *one or both* of the following:

1. Cracks between the soil surface and the top of the duripan that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary above the duripan; *or*
2. A linear extensibility of 6.0 cm or more between the soil surface and the top of the duripan.

Vertic Natridurids

FCAB. Other Natridurids that meet *both* of the following:

1. Have a duripan that is strongly cemented or less cemented in all subhorizons; *and*
2. Are *either*:
 - a. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
 - b. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Natrargidic Natridurids

FCAC. Other Natridurids that are *either*:

1. Irrigated and have aquic conditions for some time in normal years in one or more layers within 100 cm of the soil surface; *or*
2. Saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more in normal years.

Aquic Natridurids

FCAD. Other Natridurids that have the following combination of characteristics:

1. A duripan that is strongly cemented or less cemented in all subhorizons; *and*
2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric.

Natrixeralfic Natridurids

FCAE. Other Natridurids that have a duripan that is strongly cemented or less cemented in all subhorizons.

Natrargidic Natridurids

FCAF. Other Natridurids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent

extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Natridurids

FCAG. Other Natridurids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandid Natridurids

FCAH. Other Natridurids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and have a soil moisture regime that borders on xeric.

Xeric Natridurids

FCAI. Other Natridurids.

Typic Natridurids

Gypsids

Key to Great Groups

FDA. Gypsids that have a petrogypsic or petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

[Petrogypsids](#), p. 127

FDB. Other Gypsids that have a natric horizon that has its upper boundary within 100 cm of the soil surface.

[Natrigypsids](#), p. 126

FDC. Other Gypsids that have an argillic horizon that has its upper boundary within 100 cm of the soil surface.

[Argigypsids](#), p. 124

FDD. Other Gypsids that have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

[Calcigypsids](#), p. 125

FDE. Other Gypsids.

[Haplogypsids](#), p. 125

Argigypsids

Key to Subgroups

FDCA. Argigypsids that have a lithic contact within 50 cm of the soil surface.

Lithic Argigypsids

FDCB. Other Argigypsids that have:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argigypsids

FDCC. Other Argigypsids that have a calcic horizon overlying the gypsic horizon.

Calcic Argigypsids

FDCD. Other Argigypsids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Argigypsids

FDCE. Other Argigypsids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

- a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

- b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Argigypsids

FDCF. Other Argigypsids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 percent or more.

Vitrandid Argigypsid

FDCG. Other Argigypsid that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Argigypsid

FDCH. Other Argigypsid that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Argigypsid

FDCI. Other Argigypsid.

Typic Argigypsid

Calcigypsid

Key to Subgroups

FDDA. Calcigypsid that have a lithic contact within 50 cm of the soil surface.

Lithic Calcigypsid

FDDB. Other Calcigypsid that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Calcigypsid

FDDC. Other Calcigypsid that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

- b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Calcigypsid

FDDD. Other Calcigypsid that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandid Calcigypsid

FDDE. Other Calcigypsid that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Calcigypsid

FDDF. Other Calcigypsid that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Calcigypsid

FDDG. Other Calcigypsid.

Typic Calcigypsid

Haplogypsid

Key to Subgroups

FDEA. Haplogypsid that have a lithic contact within 50 cm of the soil surface.

Lithic Haplogypsid

FDEB. Other Haplogypsid that have a gypsic horizon that has its upper boundary within 18 cm of the soil surface.

Leptic Haplogypsid

FDEC. Other Haplogypsid that have, in a horizon at least 25 cm thick within 100 cm of the mineral soil surface, an

exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least 1 month in normal years.

Sodic Haplogypsids

FDED. Other Haplogypsids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Haplogypsids

FDEE. Other Haplogypsids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrikerandic Haplogypsids

FDEF. Other Haplogypsids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandidic Haplogypsids

FDEG. Other Haplogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Haplogypsids

FDEH. Other Haplogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Haplogypsids

FDEI. Other Haplogypsids.

Typic Haplogypsids

Natrigypsids

Key to Subgroups

FDDBA. Natrigypsids that have a lithic contact within 50 cm of the soil surface.

Lithic Natrigypsids

FDEBB. Other Natrigypsids that have:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrigypsids

FDEBC. Other Natrigypsids that have one or more horizons, within 100 cm of the soil surface and with a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Natrigypsids

FDEBD. Other Natrigypsids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more

particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Natrigypsids

FDBE. Other Natrigypsids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Natrigypsids

FDBF. Other Natrigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Natrigypsids

FDBG. Other Natrigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Natrigypsids

FDBH. Other Natrigypsids.

Typic Natrigypsids

Petrogypsids

Key to Subgroups

FDAA. Petrogypsids that have a petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

Petrocalcic Petrogypsids

FDAB. Other Petrogypsids that have a calcic horizon overlying the petrogypsic horizon.

Calcic Petrogypsids

FDAC. Other Petrogypsids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5 °C or higher at a depth of 50 cm and a soil moisture regime that borders on xeric; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Petrogypsids

FDAD. Other Petrogypsids that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Petrogypsids

FDAAE. Other Petrogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on xeric.

Xeric Petrogypsids

FDAAF. Other Petrogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5 °C or higher and have a soil moisture regime that borders on ustic.

Ustic Petrogypsids

FDAG. Other Petrogyptsids.

Typic Petrogyptsids

Salids

Key to Great Groups

FBA. Salids that are saturated with water in one or more layers within 100 cm of the mineral soil surface for 1 month or more in normal years.

[Aquisalids](#), p. 128

FBB. Other Salids.

[Haplosalids](#), p. 128

Aquisalids

Key to Subgroups

FBAA. Aquisalids that have a gypsic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

Gypsic Aquisalids

FBAB. Other Aquisalids that have a calcic or petrocalcic horizon that has an upper boundary within 100 cm of the soil surface.

Calcic Aquisalids

FBAC. Other Aquisalids.

Typic Aquisalids

Haplosalids

Key to Subgroups

FBBA. Haplosalids that have a duripan that has its upper boundary within 100 cm of the soil surface.

Duric Haplosalids

FBBB. Other Haplosalids that have a petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

Petrogyptic Haplosalids

FBBC. Other Haplosalids that have a gypsic horizon that has its upper boundary within 100 cm of the soil surface.

Gypsic Haplosalids

FBBD. Other Haplosalids that have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

Calcic Haplosalids

FBBE. Other Haplosalids.

Typic Haplosalids

CHAPTER 8

Entisols

Key to Suborders

LA. Entisols that have *one or more* of the following:

1. Aquic conditions and sulfidic materials within 50 cm of the mineral soil surface; *or*
2. Permanent saturation with water and a reduced matrix in all horizons below 25 cm from the mineral soil surface; *or*
3. In a layer above a densic, lithic, or paralithic contact or in a layer at a depth between 40 and 50 cm below the mineral soil surface, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

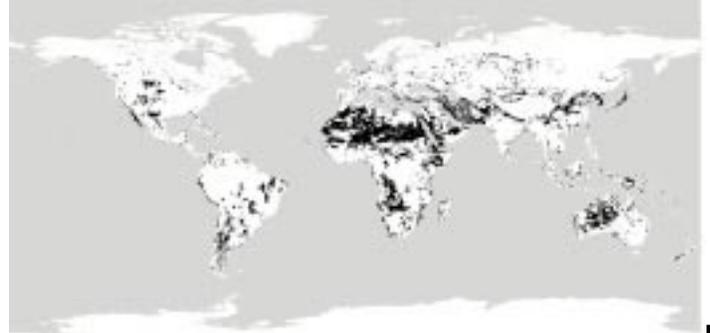
a. A texture finer than loamy fine sand and, in 50 percent or more of the matrix, *one or more* of the following:

- (1) Chroma of 0; *or*
- (2) Chroma of 1 or less and a color value, moist, of 4 or more; *or*
- (3) Chroma of 2 or less and redox concentrations; *or*

b. A texture of loamy fine sand or coarser and, in 50 percent or more of the matrix, *one or more* of the following:

- (1) Chroma of 0; *or*
- (2) Hue of 10YR or redder, a color value, moist, of 4 or more, and chroma of 1; *or*
- (3) Hue of 10YR or redder, chroma of 2 or less, and redox concentrations; *or*
- (4) Hue of 2.5Y or yellower, chroma of 3 or less, and distinct or prominent redox concentrations; *or*
- (5) Hue of 2.5Y or yellower and chroma of 1; *or*
- (6) Hue of 5GY, 5G, 5BG, or 5B; *or*
- (7) Any color if it results from uncoated sand grains; *or*

c. Enough active ferrous iron to give a positive reaction



to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

[Aquepts](#), p. 130

LB. Other Entisols that have, in one or more layers at a depth between 25 and 100 cm below the mineral soil surface, 3 percent or more (by volume) fragments of diagnostic horizons that are not arranged in any discernible order.

[Arents](#), p. 133

LC. Other Entisols that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers within the particle-size control section.

[Psamments](#), p. 144

LD. Other Entisols that do not have a densic, lithic, or paralithic contact within 25 cm of the mineral soil surface and have:

1. A slope of less than 25 percent; *and*
2. *Either* 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface *or* an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A soil temperature regime:
 - a. That is warmer than cryic; *or*
 - b. That is cryic and the soil has:
 - (1) No gelic material; *and*
 - (2) Either a slope of less than 5 percent or less than

15 percent volcanic glass in the 0.02 to 2.0 mm fraction in some part of the particle-size control section.

[Fluvents](#), p. 134

LE. Other Entisols.

[Orthents](#), p. 139

Aquents

Key to Great Groups

LAA. Aquents that have sulfidic materials within 50 cm of the mineral soil surface.

[Sulfaquents](#), p. 133

LAB. Other Aquents that have, in all horizons at a depth between 20 and 50 cm below the mineral soil surface, both an *n* value of more than 0.7 and 8 percent or more clay in the fine-earth fraction.

[Hydraquents](#), p. 132

LAC. Other Aquents that have a cryic soil temperature regime.

[Cryaquents](#), p. 130

LAD. Other Aquents that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers within the particle-size control section.

[Psammaquents](#), p. 132

LAE. Other Aquents that have *either* 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface *or* an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

[Fluvaquents](#), p. 131

LAF. Other Aquents that have episaturation.

[Epiquents](#), p. 131

LAG. Other Aquents.

[Endoaquents](#), p. 130

Cryaquents

Key to Subgroups

LACA. Cryaquents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al

plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

- a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

- b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Cryaquents

LACB. Other Cryaquents.

Typic Cryaquents

Endoaquents

Key to Subgroups

LAGA. Endoaquents that have, within 100 cm of the mineral soil surface, *one or both* of the following:

1. Sulfidic materials; *or*

2. A horizon 15 cm or more thick that has all of the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0.

Sulfic Endoaquents

LAGB. Other Endoaquents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Endoaquents

LAGC. Other Endoaquents that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Endoaquents

LAGD. Other Endoaquents that have, in one or more horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, colors in 50 percent or more of the matrix as follows:

1. Hue of 2.5Y or redder, a color value, moist, of 6 or more, and chroma of 3 or more; *or*

2. Hue of 2.5Y or redder, a color value, moist, of 5 or less, and chroma of 2 or more; *or*

3. Hue of 5Y and chroma of 3 or more; *or*

4. Hue of 5Y or redder and chroma of 2 or more if there are no redox concentrations.

Aeric Endoaquents

LAGE. Other Endoaquents that have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing; *and*
2. A base saturation (by NH₄OAc) of less than 50 percent in some part within 100 cm of the mineral soil surface.

Humaqueptic Endoaquents

LAGF. Other Endoaquents that have either an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing.

Mollic Endoaquents

LAGE. Other Endoaquents.

Typic Endoaquents

Epiaquents

Key to Subgroups

LAFB. Epiaquents that have, in one or more horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, colors in 50 percent or more of the matrix as follows:

1. Hue of 2.5Y or redder, a color value, moist, of 6 or more, and chroma of 3 or more; *or*
2. Hue of 2.5Y or redder, a color value, moist, of 5 or less, and chroma of 2 or more; *or*
3. Hue of 5Y and chroma of 3 or more; *or*
4. Chroma of 2 or more if there are no redox concentrations.

Aeric Epiaquents

LAFB. Other Epiaquents that have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing; *and*
2. A base saturation (by NH₄OAc) of less than 50 percent in some part within 100 cm of the mineral soil surface.

Humaqueptic Epiaquents

LAFB. Other Epiaquents that have either an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5

or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing.

Mollic Epiaquents

LAFD. Other Epiaquents.

Typic Epiaquents

Fluvaquents

Key to Subgroups

LAEA. Fluvaquents that have, within 100 cm of the mineral soil surface, *one or both* of the following:

1. Sulfidic materials; *or*
2. A horizon 15 cm or more thick that has all of the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0.

Sulfic Fluvaquents

LAEB. Other Fluvaquents that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Fluvaquents

LAEC. Other Fluvaquents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Fluvaquents

LAED. Other Fluvaquents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

- b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Fluvaquents

LAEE. Other Fluvaquents that have, in one or more horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, colors in 50 percent or more of the matrix as follows:

1. Hue of 2.5Y or redder, a color value, moist, of 6 or more, and chroma of 3 or more; *or*
2. Hue of 2.5Y or redder, a color value, moist, of 5 or less, and chroma of 2 or more; *or*
3. Hue of 5Y and chroma of 3 or more; *or*
4. Chroma of 2 or more if there are no redox concentrations.

Aeric Fluvaquents

LAEF. Other Fluvaquents that have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing; *and*
2. A base saturation (by NH_4OAc) of less than 50 percent in some part within 100 cm of the mineral soil surface.

Humaqueptic Fluvaquents

LAEG. Other Fluvaquents that have either an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing.

Mollic Fluvaquents

LAEH. Other Fluvaquents.

Typic Fluvaquents

Hydraquents

Key to Subgroups

LABA. Hydraquents that have, within 100 cm of the mineral soil surface, *one or both* of the following:

1. Sulfidic materials; *or*
2. A horizon 15 cm or more thick that has all of the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0.

Sulfic Hydraquents

LABB. Other Hydraquents that have, in one or more horizons within 100 cm of the mineral soil surface, an

exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Hydraquents

LABC. Other Hydraquents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Hydraquents

LABD. Other Hydraquents.

Typic Hydraquents

Psammaquents

Key to Subgroups

LADA. Psammaquents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Psammaquents

LADB. Other Psammaquents that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Psammaquents

LADC. Other Psammaquents that have a horizon, 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*
2. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*
3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Psammaquents

LADD. Other Psammaquents that have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing; *and*
2. A base saturation (by NH_4OAc) of less than 50 percent in some part within 100 cm of the mineral soil surface.

Humaqueptic Psammaquents

LADE. Other Psammaquents that have either an Ap horizon that has a color value, moist, of 3 or less and a color value, dry,

of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing.

Mollic Psammaquents

LADF. Other Psammaquents.

Typic Psammaquents

Sulfaquents

Key to Subgroups

LAAA. Sulfaquents that have, in some horizons at a depth between 20 and 50 cm below the mineral soil surface, *either or both*:

1. An *n* value of 0.7 or less; *or*
2. Less than 8 percent clay in the fine-earth fraction.

Haplic Sulfaquents

LAAB. Other Sulfaquents that have a histic epipedon.

Histic Sulfaquents

LAAC. Other Sulfaquents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Sulfaquents

LAAD. Other Sulfaquents.

Typic Sulfaquents

Arents

Key to Great Groups

LBA. Arents that have an ustic moisture regime.

[Ustarents](#), p. 133

LBB. Other Arents that have a xeric moisture regime.

[Xerarents](#), p. 133

LBC. Other Arents that have an aridic (or torric) moisture regime.

[Torriarents](#), p. 133

LBD. Other Arents.

[Udarents](#), p. 133

Torriarents

Key to Subgroups

LBCA. Torriarents that have, in one or more horizons within 100 cm of the mineral soil surface, 3 percent or more fragments of a natric horizon.

Sodic Torriarents

LBCB. Other Torriarents that have, within 100 cm of the mineral soil surface, 3 percent or more fragments of a duripan or a petrocalcic horizon;

Duric Torriarents

LBCC. Other Torriarents.

Haplic Torriarents

Udarents

Key to Subgroups

LBDA. Udarents that have 3 percent or more fragments of an argillic horizon in some horizon within 100 cm of the mineral soil surface and have a base saturation (by sum of cations) of 35 percent or more in all parts within 100 cm of the mineral soil surface.

Alfic Udarents

LBDB. Other Udarents that have 3 percent or more fragments of an argillic horizon in some horizon within 100 cm of the mineral soil surface.

Ultic Udarents

LBDC. Other Udarents that have 3 percent or more fragments of a mollic epipedon in some horizon within 100 cm of the mineral soil surface and have a base saturation (by sum of cations) of 35 percent or more in all parts within 100 cm of the mineral soil surface.

Mollic Udarents

LBDD. Other Udarents.

Haplic Udarents

Ustarents

Key to Subgroups

LBAA. All Ustarents.

Haplic Ustarents

Xerarents

Key to Subgroups

LBBA. Xerarents that have, in one or more horizons within 100 cm of the mineral soil surface, 3 percent or more fragments of a natric horizon.

Sodic Xerarents

LBBB. Other Xerarents that have, within 100 cm of the mineral soil surface, 3 percent or more fragments of a duripan or a petrocalcic horizon.

Duric Xerarents

LBBC. Other Xerarents that have fragments of an argillic horizon with a base saturation (by sum of cations) of 35 percent or more within 100 cm of the mineral soil surface.

Alfic Xerarents

LBBD. Other Xerarents.

Haplic Xerarents

Fluents

Key to Great Groups

LDA. Fluents that have a cryic soil temperature regime.
[Cryofluents](#), p. 134

LDB. Other Fluents that have a xeric moisture regime.
[Xerofluents](#), p. 138

LDC. Other Fluents that have an ustic moisture regime.
[Ustifluents](#), p. 137

LDD. Other Fluents that have an aridic (or torric) moisture regime.
[Torrifluents](#), p. 134

LDE. Other Fluents.
[Udifluents](#), p. 136

Cryofluents

Key to Subgroups

LDAA. Cryofluents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and percent aluminum plus 1/2 the iron percentage (by ammonium oxalate) totaling more than 1.0.

Andic Cryofluents

LDAB. Other Cryofluents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium

oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Cryofluents

LDAC. Other Cryofluents that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Cryofluents

LDAD. Other Cryofluents that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Cryofluents

LDAAE. Other Cryofluents that have either an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing.

Mollic Cryofluents

LDAF. Other Cryofluents.

Typic Cryofluents

Torrifluents

Key to Subgroups

LDDA. Torrifluents that have:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
3. An aridic (or torric) moisture regime that borders on ustic.

Ustertic Torrifluents

LDDB. Other Torrifuvents that have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Torrifuvents

LDDC. Other Torrifuvents that have:

1. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
2. A thermic, mesic, or frigid soil temperature regime and an aridic (or torric) moisture regime that borders on xeric; *and*
3. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrikerandic Torrifuvents

LDDD. Other Torrifuvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium

oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Torrifuvents

LDDE. Other Torrifuvents that have, in one or more horizons within 100 cm of the soil surface, both redox depletions with chroma of 2 or less and aquic conditions for some time in normal years (or artificial drainage).

Aquic Torrifuvents

LDDF. Other Torrifuvents that are saturated with water in one or more layers within 150 cm of the soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Torrifuvents

LDDG. Other Torrifuvents that have:

1. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist; *and*
2. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
3. A thermic, mesic, or frigid soil temperature regime and an aridic (or torric) moisture regime that borders on xeric.

Duric Xeric Torrifuvents

LDDH. Other Torrifuvents that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Torrifuvents

LDDI. Other Torrifuvents that have *both*:

1. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
2. An aridic (or torric) moisture regime that borders on ustic.

Ustic Torrifuvents

LDDJ. Other Torrifuvents that have *both*:

1. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*

2. A thermic, mesic, or frigid soil temperature regime and an aridic (or torric) moisture regime that borders on xeric.

Xeric Torrifuvents

LDDK. Other Torrifuvents that have an anthropic epipedon.

Anthropic Torrifuvents

LDDL. Other Torrifuvents.

Typic Torrifuvents

Udifuvents

Key to Subgroups

LDEA. Udifuvents that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. *Either or both* of the following:
 - a. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *or*
 - b. In one or more horizons within 100 cm of the mineral soil surface, a color value, moist, of 4 or more and either chroma of 0 or hue of 5GY, 5G, 5BG, or 5B and also aquic conditions for some time in normal years (or artificial drainage).

Aquertic Udifuvents

LDEB. Other Udifuvents that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Udifuvents

LDEC. Other Udifuvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Udifuvents

LDED. Other Udifuvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Udifuvents

LDEE. Other Udifuvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *or*
2. In one or more horizons within 100 cm of the mineral soil surface, a color value, moist, of 4 or more and either chroma of 0 or hue of 5GY, 5G, 5BG, or 5B and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Udifuvents

LDEF. Other Udifuvents that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Udifuvents

LDEG. Other Udifuvents that have either an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing.

Mollic Udifuvents

LDEH. Other Udifuvents.

Typic Udifuvents

Ustifluvents

Key to Subgroups

LDCA. Ustifluvents that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. *Either or both* of the following:
 - a. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *or*
 - b. In one or more horizons within 150 cm of the mineral soil surface, a color value, moist, of 4 or more and either chroma of 0 or hue of 5GY, 5G, 5BG, or 5B and also aquic conditions for some time in normal years (or artificial drainage).

Aquertic Ustifluvents

LDCB. Other Ustifluvents that have *both* of the following:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that, in normal years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that, in normal years, is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that

are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Ustifluvents

LDCC. Other Ustifluvents that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Ustifluvents

LDCD. Other Ustifluvents that have anthraquic conditions.

Anthraquic Ustifluvents

LDCE. Other Ustifluvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *or*
2. In one or more horizons within 150 cm of the mineral soil surface, a color value, moist, of 4 or more and either chroma of 0 or hue of 5GY, 5G, 5BG, or 5B and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Ustifluvents

LDCF. Other Ustifluvents that are saturated with water in one or more layers within 150 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Ustifluvents

LDCG. Other Ustifluvents that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime and a moisture control section that, in normal years, is dry in all parts for four-

tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

2. A mesic or thermic soil temperature regime and a moisture control section that, in normal years, is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Aridic Ustifluvents

LDCH. Other Ustifluvents that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime and a moisture control section that, in normal years, is dry in some or all parts for less than 105 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

2. A mesic or thermic soil temperature regime and a moisture control section that, in normal years, is dry in some part for less than four-tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Ustifluvents

LDCI. Other Ustifluvents that have either an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing.

Mollic Ustifluvents

LDCJ. Other Ustifluvents.

Typic Ustifluvents

Xerofluvents

Key to Subgroups

LDBA. Xerofluvents that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick

that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Xerofluvents

LDBB. Other Xerofluvents that have:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *or*

2. In one or more horizons within 150 cm of the mineral soil surface, a color value, moist, of 4 or more and either chroma of 0 or hue bluer than 10Y and also aquic conditions for some time in normal years (or artificial drainage); *and*

3. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Xerofluvents

LDBC. Other Xerofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Xerofluvents

LDBD. Other Xerofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser

than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Xerofluvents

LDBE. Other Xerofluvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *or*
2. In one or more horizons within 150 cm of the mineral soil surface, a color value, moist, of 4 or more and either chroma of 0 or hue of 5GY, 5G, 5BG, or 5B or aquic conditions for some time in normal years.

Aquic Xerofluvents

LDBF. Other Xerofluvents that are saturated with water in one or more layers within 150 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Xerofluvents

LDBG. Other Xerofluvents that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Durinodic Xerofluvents

LDBH. Other Xerofluvents that have either an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) or materials in the upper 15 cm that have these colors after mixing.

Mollic Xerofluvents

LDBI. Other Xerofluvents.

Typic Xerofluvents

Orthents

Key to Great Groups

LEA. Orthents that have a cryic soil temperature regime.
[Cryorthents](#), p. 139

LEB. Other Orthents that have an aridic (or torric) moisture regime.
[Torriorthents](#), p. 140

LEC. Other Orthents that have a xeric moisture regime.
[Xerorthents](#), p. 143

LED. Other Orthents that have an ustic moisture regime.
[Ustorthents](#), p. 141

LEE. Other Orthents.
[Udorthents](#), p. 141

Cryorthents

Key to Subgroups

LEAA. Cryorthents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryorthents

LEAB. Other Cryorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Cryorthents

LEAC. Other Cryorthents that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Cryorthents

LEAD. Other Cryorthents that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Cryorthents

LEAE. Other Cryorthents that have lamellae within 200 cm of the mineral soil surface.

Lamellic Cryorthents

LEAF. Other Cryorthents.

Typic Cryorthents

Torriorthents

Key to Subgroups

LEBA. Torriorthents that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
3. A hyperthermic, thermic, mesic, frigid, or *iso* soil temperature regime and an aridic (or torric) moisture regime that borders on ustic.

Lithic Ustic Torriorthents

LEBB. Other Torriorthents that have:

1. A lithic contact within 50 cm of the soil surface; *and*
2. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
3. A thermic, mesic, or frigid soil temperature regime and an aridic (or torric) moisture regime that borders on xeric.

Lithic Xeric Torriorthents

LEBC. Other Torriorthents that have a lithic contact within 50 cm of the soil surface.

Lithic Torriorthents

LEBD. Other Torriorthents that have:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative

days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*

3. A thermic, mesic, or frigid soil temperature regime and an aridic (or torric) moisture regime that borders on xeric.

Xerertic Torriorthents

LEBE. Other Torriorthents that have:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
3. An aridic (or torric) moisture regime that borders on ustic.

Ustertic Torriorthents

LEBF. Other Torriorthents that have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Torriorthents

LEBG. Other Torriorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium

oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Torriorthents

LEBH. Other Torriorthents that have, in one or more horizons within 100 cm of the soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Torriorthents

LEBI. Other Torriorthents that are saturated with water in one or more layers within 150 cm of the soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Torriorthents

LEBJ. Other Torriorthents that have a horizon within 100 cm of the soil surface that is 15 cm or more thick and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Torriorthents

LEBK. Other Torriorthents that have *both*:

1. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
2. A hyperthermic, thermic, mesic, frigid, or *iso* soil temperature regime and an aridic (or torric) moisture regime that borders on ustic.

Ustic Torriorthents

LEBL. Other Torriorthents that have *both*:

1. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*
2. A thermic, mesic, or frigid soil temperature regime and an aridic (or torric) moisture regime that borders on xeric.

Xeric Torriorthents

LEBM. Other Torriorthents.

Typic Torriorthents

Udorthents

Key to Subgroups

LEEA. Udorthents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Udorthents

LEEB. Other Udorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Udorthents

LEEC. Other Udorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Udorthents

LEED. Other Udorthents that are saturated with water in one or more layers within 150 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Udorthents

LEEE. Other Udorthents that have 50 percent or more (by volume) wormholes, wormcasts, and filled animal burrows between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 100 cm or a densic, lithic, paralithic, or petroferric contact, whichever is shallower.

Vermic Udorthents

LEEF. Other Udorthents.

Typic Udorthents

Ustorthents

Key to Subgroups

LEDA. Ustorthents that have:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that, in normal years, is dry in all parts

for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A mesic or thermic soil temperature regime and a moisture control section that, in normal years, is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Aridic Lithic Ustorthents

LEDB. Other Ustorthents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Ustorthents

LEDC. Other Ustorthents that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that, in normal years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that, in normal years, is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, remains moist in some or all parts for less than 90 consecutive days per year when the

temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Torrertic Ustorthents

LEDD. Other Ustorthents that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Ustorthents

LEDE. Other Ustorthents that have anthraquic conditions.

Anthraquic Ustorthents

LEDF. Other Ustorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Ustorthents

LEDG. Other Ustorthents that are saturated with water in one or more layers within 150 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Ustorthents

LEDH. Other Ustorthents that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Durinodic Ustorthents

LEDI. Other Ustorthents that have *both*:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that, in normal years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a

moisture control section that, in normal years, is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrorrandic Ustorthents

LEDJ. Other Ustorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Ustorthents

LEDK. Other Ustorthents that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime and a moisture control section that, in normal years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

2. A mesic or thermic soil temperature regime and a

moisture control section that, in normal years, is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Aridic Ustorthents

LEDL. Other Ustorthents that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime and a moisture control section that, in normal years, is dry in some or all parts for less than 105 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

2. A mesic or thermic soil temperature regime and a moisture control section that, in normal years, is dry in some part for less than four-tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Ustorthents

LEDM. Other Ustorthents that have 50 percent or more (by volume) wormholes, wormcasts, and filled animal burrows between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 100 cm or a densic, lithic, paralithic, or petroferric contact, whichever is shallower.

Vermic Ustorthents

LEDN. Other Ustorthents.

Typic Ustorthents

Xerorthents

Key to Subgroups

LECA. Xerorthents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Xerorthents

LECB. Other Xerorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Xerorthents

LECC. Other Xerorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Xerorthents

LECD. Other Xerorthents that are saturated with water in one or more layers within 150 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Xerorthents

LECE. Other Xerorthents that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Durinodic Xerorthents

LECF. Other Xerorthents that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons at a depth between 25 and 75 cm below the mineral soil surface.

Dystric Xerorthents

LECG. Other Xerorthents.

Typic Xerorthents

Psamments

Key to Great Groups

LCA. Psamments that have a cryic soil temperature regime.

[Cryopsamments](#), p. 144

LCB. Other Psamments that have an aridic (or torric) moisture regime.

[Torripsamments](#), p. 146

LCC. Other Psamments that have, in the 0.02 to 2.0 mm fraction within the particle-size control section, a total of more than 90 percent (by weighted average) resistant minerals.

[Quartzipsamments](#), p. 145

LCD. Other Psamments that have an ustic moisture regime.

[Ustipsamments](#), p. 147

LCE. Other Psamments that have a xeric moisture regime.

[Xeropsamments](#), p. 147

LCF. Other Psamments.

[Udipsamments](#), p. 146

Cryopsamments

Key to Subgroups

LCAA. Cryopsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryopsamments

LCAB. Other Cryopsamments that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Cryopsamments

LCAC. Other Cryopsamments that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Cryopsamments

LCAD. Other Cryopsamments that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction containing 5 percent or more volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Cryopsamments

LCAE. Other Cryopsamments that have a horizon 5 cm or more thick that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*
2. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Cryopsamments

LCAF. Other Cryopsamments that have lamellae within 200 cm of the mineral soil surface.

Lamellic Cryopsamments

LCAG. Other Cryopsamments.

Typic Cryopsamments

Quartzipsamments

Key to Subgroups

LCCA. Quartzipsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Quartzipsamments

LCCB. Other Quartzipsamments that have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A horizon, 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:
 - a. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*
 - b. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*
 - c. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Aquodic Quartzipsamments

LCCC. Other Quartzipsamments that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Quartzipsamments

LCCD. Other Quartzipsamments that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Quartzipsamments

LCCE. Other Quartzipsamments that meet *all* of the following:

1. Have an ustic moisture regime; *and*
2. Have a clay fraction with a CEC of 16 cmol(+) or less per kg clay (by NH_4OAc pH 7); *and*
3. The sum of the weighted average silt plus 2 times the weighted average clay (both by weight) is more than 5.

Ustoxic Quartzipsamments

LCCF. Other Quartzipsamments that meet *all* of the following:

1. Have a udic moisture regime; *and*
2. Have a clay fraction with a CEC of 16 cmol(+) or less per kg clay (by NH_4OAc pH 7); *and*
3. The sum of the weighted average silt plus 2 times the weighted average clay (both by weight) is more than 5.

Udoxic Quartzipsamments

LCCG. Other Quartzipsamments that have 5 percent or more (by volume) plinthite in one or more horizons within 100 cm of the mineral soil surface.

Plinthic Quartzipsamments

LCCH. Other Quartzipsamments that have *both*:

1. Lamellae within 200 cm of the mineral soil surface; *and*
2. An ustic moisture regime.

Lamellic Ustic Quartzipsamments

LCCI. Other Quartzipsamments that have lamellae within 200 cm of the mineral soil surface.

Lamellic Quartzipsamments

LCCJ. Other Quartzipsamments that have an ustic moisture regime.

Ustic Quartzipsamments

LCCK. Other Quartzipsamments that have a xeric moisture regime.

Xeric Quartzipsamments

LCCL. Other Quartzipsamments that have a horizon, 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*
2. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate)

totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Quartzipsamments

LCCM. Other Quartzipsamments.

Typic Quartzipsamments

Torripsamments

Key to Subgroups

LCBA. Torripsamments that have a lithic contact within 50 cm of the soil surface.

Lithic Torripsamments

LCBB. Other Torripsamments that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction containing 5 percent or more volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Torripsamments

LCBC. Other Torripsamments that have a horizon within 100 cm of the soil surface that is 15 cm or more thick and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Haploduridic Torripsamments

LCBD. Other Torripsamments that have *both*:

1. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*

2. An aridic (or torric) moisture regime that borders on ustic.

Ustic Torripsamments

LCBE. Other Torripsamments that have *both*:

1. A moisture control section that, in normal years, is dry in all its parts for less than three-fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5 °C or higher; *and*

2. A thermic, mesic, or frigid soil temperature regime and an aridic (or torric) moisture regime that borders on xeric.

Xeric Torripsamments

LCBF. Other Torripsamments that have, in all horizons from a depth of 25 to 100 cm, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*

2. A color value, moist, of 3 or less; *and*

3. A dry value no more than 1 unit higher than the moist value.

Rhodic Torripsamments

LCBG. Other Torripsamments.

Typic Torripsamments

Udipsamments

Key to Subgroups

LCFA. Udipsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Udipsamments

LCFB. Other Udipsamments that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Udipsamments

LCFC. Other Udipsamments that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*

2. 30 or more cumulative days.

Oxyaquic Udipsamments

LCFD. Other Udipsamments that have a horizon, 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Udipsamments

LCFE. Other Udipsamments that have lamellae within 200 cm of the mineral soil surface.

Lamellic Udipsamments

LCFF. Other Udipsamments that have a surface horizon between 25 and 50 cm thick that meets all of the requirements for a plaggen epipedon except thickness.

Plagganthreptic Udipsamments

LCFG. Other Udipsamments.

Typic Udipsamments

Ustipsamments

Key to Subgroups

LCDA. Ustipsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Ustipsamments

LCDB. Other Ustipsamments that have, in one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Ustipsamments

LCDC. Other Ustipsamments that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Ustipsamments

LCDD. Other Ustipsamments that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime and a moisture control section that, in normal years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime and a moisture control section that, in normal years, is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that, in normal years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Aridic Ustipsamments

LCDE. Other Ustipsamments that have lamellae within 200 cm of the mineral soil surface.

Lamellic Ustipsamments

LCDF. Other Ustipsamments that have, in all horizons from a depth of 25 to 100 cm, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. A color value, moist, of 3 or less; *and*
3. A dry value no more than 1 unit higher than the moist value.

Rhodic Ustipsamments

LCDG. Other Ustipsamments.

Typic Ustipsamments

Xeropsamments

Key to Subgroups

LCEA. Xeropsamments have a lithic contact within 50 cm of the mineral soil surface.

Lithic Xeropsamments

LCEB. Other Xeropsamments that have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Aquic Durinodic Xeropsamments

LCEC. Other Xeropsamments that have, in one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Xeropsamments

LCED. Other Xeropsamments that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Xeropsamments

LCEE. Other Xeropsamments that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction containing 5 percent or more volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandidic Xeropsamments

LCEF. Other Xeropsamments that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick

and that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Durinodic Xeropsamments

LCEG. Other Xeropsamments that have lamellae within 200 cm of the mineral soil surface.

Lamellic Xeropsamments

LCEH. Other Xeropsamments that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons at a depth between 25 and 75 cm below the mineral soil surface.

Dystric Xeropsamments

LCEI. Other Xeropsamments.

Typic Xeropsamments

CHAPTER 9

*Gelisols*¹

Key to Suborders

AA. Gelisols that have organic soil materials that meet *one or more* of the following:

1. Overlie cindery, fragmental, or pumiceous materials and/or fill their interstices *and* directly below these materials have either a densic, lithic, or paralithic contact; *or*
2. When added with the underlying cindery, fragmental, or pumiceous materials, total 40 cm or more between the soil surface and a depth of 50 cm; *or*
3. Are saturated with water for 30 or more cumulative days during normal years (or are artificially drained) and have 80 percent or more, by volume, organic soil materials from the soil surface to a depth of 50 cm or to a glacic layer or a densic, lithic, or paralithic contact, whichever is shallowest.

[Histels](#), p. 149

AB. Other Gelisols that have one or more horizons showing cryoturbation in the form of irregular, broken, or distorted horizon boundaries, involutions, the accumulation of organic matter on top of the permafrost, ice or sand wedges, and oriented rock fragments.

[Turbels](#), p. 154

AC. Other Gelisols.

[Orthels](#), p. 150

Histels

Key to Great Groups

AAA. Histels that are saturated with water for less than 30 cumulative days during normal years (and are not artificially drained).

[Folistels](#), p. 150



AAB. Other Histels that are saturated with water for 30 or more cumulative days during normal years and that have *both*:

1. A glacic layer with its upper boundary within 100 cm of the soil surface; *and*
2. Less than three-fourths (by volume) *Sphagnum* fibers in the organic soil materials to a depth of 50 cm or to a densic, lithic, or paralithic contact, whichever is shallower.

[Glacistels](#), p. 150

AAC. Other Histels that have more thickness of fibric soil materials than any other kind of organic soil material to a depth of 50 cm or to a densic, lithic, or paralithic contact, whichever is shallowest.

[Fibristels](#), p. 149

AAD. Other Histels that have more thickness of hemic soil materials than any other kind of organic soil material to a depth of 50 cm or to a densic, lithic, or paralithic contact, whichever is shallowest.

[Hemistels](#), p. 150

AAE. Other Histels.

[Sapristels](#), p. 150

Fibristels

Key to Subgroups

AACA. Fibristels that have a lithic contact within 100 cm of the soil surface.

Lithic Fibristels

¹ This chapter is based on recommendations by the International Committee on Permafrost-Affected Soils (ICOMPAS), chaired by Dr. James G. Bockheim, University of Wisconsin.

AACB. Other Fibristsels that have a mineral layer 30 cm or more thick within 100 cm of the soil surface.

Terric Fibristsels

AACC. Other Fibristsels that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more layers of any thickness within 100 cm of the soil surface.

Fluvaquentic Fibristsels

AACD. Other Fibristsels in which three-fourths or more of the fibric material is derived from *Sphagnum* to a depth of 50 cm or to a densic, lithic, or paralithic contact, whichever is shallowest.

Sphagnic Fibristsels

AACE. Other Fibristsels.

Typic Fibristsels

Folistels

Key to Subgroups

AAAA. Folistels that have a lithic contact within 50 cm of the soil surface.

Lithic Folistels

AAAB. Other Folistels that have a glacic layer with its upper boundary within 100 cm of the soil surface.

Glacic Folistels

AAAC. Other Folistels.

Typic Folistels

Glacistels

Key to Subgroups

AABA. Glacistels that have more thickness of hemic materials than any other kind of organic soil material in the upper 50 cm.

Hemic Glacistels

AABB. Other Glacistels that have more thickness of sapric materials than any other kind of organic soil material in the upper 50 cm.

Sapric Glacistels

AABC. Other Glacistels

Typic Glacistels

Hemistels

Key to Subgroups

AADA. Hemistels that have a lithic contact within 100 cm of the soil surface.

Lithic Hemistels

AADB. Other Hemistels that have a mineral layer 30 cm or more thick within 100 cm of the soil surface.

Terric Hemistels

AADC. Other Hemistels that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more layers of any thickness within 100 cm of the soil surface.

Fluvaquentic Hemistels

AADD. Other Hemistels.

Typic Hemistels

Sapristsels

Key to Subgroups

AAEA. Sapristsels that have a lithic contact within 100 cm of the soil surface.

Lithic Sapristsels

AAEB. Other Sapristsels that have a mineral layer 30 cm or more thick within 100 cm of the soil surface.

Terric Sapristsels

AAEC. Other Sapristsels that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more layers of any thickness within 100 cm of the soil surface.

Fluvaquentic Sapristsels

AAED. Other Sapristsels.

Typic Sapristsels

Orthels

Key to Great Groups

ACA. Orthels that have in 30 percent or more of the pedon more than 40 percent, by volume, organic materials from the soil surface to a depth of 50 cm.

[Historthels](#), p. 152

ACB. Other Orthels that have, within 50 cm of the mineral

soil surface, redox depletions with chroma of 2 or less and also aquic conditions during normal years (or artificial drainage).

[Aquorthels](#), p. 151

ACC. Other Orthels that have anhydrous conditions.

[Anhyorthels](#), p. 151

ACD. Other Orthels that have a mollic epipedon.

[Mollorthels](#), p. 152

ACE. Other Orthels that have an umbric epipedon.

[Umbroorthels](#), p. 153

ACF. Other Orthels that have an argillic horizon that has its upper boundary within 100 cm of the mineral soil surface.

[Argiorthels](#), p. 152

ACG. Other Orthels that have, below the Ap horizon or below a depth of 25 cm, whichever is deeper, less than 35 percent (by volume) rock fragments and have a texture of loamy fine sand or coarser in the particle-size control section.

[Psammorthels](#), p. 153

ACH. Other Orthels.

[Haploorthels](#), p. 152

Anhyorthels

Key to Subgroups

ACCA. Anhyorthels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Anhyorthels

ACCB. Other Anhyorthels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Anhyorthels

ACCC. Other Anhyorthels that have a petrogypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrogypsic Anhyorthels

ACCD. Other Anhyorthels that have a gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Gypsic Anhyorthels

ACCE. Other Anhyorthels that have a horizon 15 cm or more thick that contains 12 cmol(-)/L in 1:5 soil:water nitrate and in which the product of its thickness (in cm) and its nitrate concentration is 3,500 or more.

Nitric Anhyorthels

ACCF. Other Anhyorthels that have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Salic Anhyorthels

ACCG. Other Anhyorthels that have a calcic horizon with its upper boundary within 100 cm of the mineral soil surface.

Calcic Anhyorthels

ACCH. Other Anhyorthels.

Typic Anhyorthels

Aquorthels

Key to Subgroups

ACBA. Aquorthels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Aquorthels

ACBB. Other Aquorthels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Aquorthels

ACBC. Other Aquorthels that have a sulfuric horizon or sulfidic materials with an upper boundary within 100 cm of the mineral soil surface.

Sulfuric Aquorthels

ACBD. Other Aquorthels that have *either*:

1. Organic soil materials that are discontinuous at the surface; *or*
2. Organic soil materials at the surface that change in thickness fourfold or more within a pedon.

Ruptic-Histic Aquorthels

ACBE. Other Aquorthels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Aquorthels

ACBF. Other Aquorthels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Aquorthels

ACBG. Other Aquorthels that have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Salic Aquorthels

ACBH. Other Aquorthels that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers within the particle-size control section.

Psammentic Aquorthels

ACBI. Other Aquorthels.

Typic Aquorthels

Argiorthels

Key to Subgroups

ACFA. Argiorthels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argiorthels

ACFB. Other Argiorthels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Argiorthels

ACFC. Other Argiorthels that have a natric horizon.

Natric Argiorthels

ACFD. Other Argiorthels.

Typic Argiorthels

Haplorthels

Key to Subgroups

ACHA. Haplorthels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplorthels

ACHB. Other Haplorthels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Haplorthels

ACHC. Other Haplorthels that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time during normal years (or artificial drainage).

Aquic Haplorthels

ACHD. Other Haplorthels.

Typic Haplorthels

Historthels

Key to Subgroups

ACAA. Historthels that have a lithic contact within 50 cm of the soil surface.

Lithic Historthels

ACAB. Other Historthels that have a glacial layer that has its upper boundary within 100 cm of the soil surface.

Glacial Historthels

ACAC. Other Historthels that have more than 40 percent, by volume, organic soil materials from the soil surface to a depth of 50 cm in 75 percent or less of the pedon.

Ruptic Historthels

ACAD. Other Historthels.

Typic Historthels

Mollorthels

Key to Subgroups

ACDA. Mollorthels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Mollorthels

ACDB. Other Mollorthels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Mollorthels

ACDC. Other Mollorthels that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time during normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallowest.

Vertic Mollorthels

ACDD. Other Mollorthels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water

retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Mollorthels

ACDE. Other Mollorthels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Mollorthels

ACDF. Other Mollorthels that have:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*
2. A slope of less than 25 percent.

Cumulic Mollorthels

ACDG. Other Mollorthels that have, in one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time during normal years (or artificial drainage).

Aquic Mollorthels

ACDH. Other Mollorthels.

Typic Mollorthels

Psammorthels

Key to Subgroups

ACGA. Psammorthels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Psammorthels

ACGB. Other Psammorthels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Psammorthels

ACGC. Other Psammorthels that have a horizon 5 cm or more thick that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Psammorthels

ACGD. Other Psammorthels.

Typic Psammorthels

Umbrothels

Key to Subgroups

ACEA. Umbrothels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Umbrothels

ACEB. Other Umbrothels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Umbrothels

ACEC. Other Umbrothels that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time during normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallowest.

Vertic Umbrothels

ACED. Other Umbrothels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Umbrothels

ACEE. Other Umbrothels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

- a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
- b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Umbrorthels

ACEF. Other Umbrorthels that have:

1. An umbric epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*
2. A slope of less than 25 percent.

Cumulic Umbrorthels

ACEG. Other Umbrorthels that have, in one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time during normal years (or artificial drainage).

Aquic Umbrorthels

ACEH. Other Umbrorthels.

Typic Umbrorthels

Turbels

Key to Great Groups

ABA. Turbels that have in 30 percent or more of the pedon more than 40 percent, by volume, organic materials from the soil surface to a depth of 50 cm.

[Histoturbels](#), p. 155

ABB. Other Turbels that have, within 50 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions during normal years (or artificial drainage).

[Aquiturbels](#), p. 154

ABC. Other Turbels that have anhydrous conditions.

[Anhyturbels](#), p. 154

ABD. Other Turbels that have a mollic epipedon.

[Molliturbels](#), p. 155

ABE. Other Turbels that have an umbric epipedon.

[Umbrturbels](#), p. 156

ABF. Other Turbels that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers within the particle-size control section.

[Psammoturbels](#), p. 156

ABG. Other Turbels.

[Haploturbels](#), p. 155

Anhyturbels

Key to Subgroups

ABCA. Anhyturbels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Anhyturbels

ABCB. Other Anhyturbels that have a glacial layer with its upper boundary within 100 cm of the mineral soil surface.

Glacial Anhyturbels

ABCC. Other Anhyturbels that have a petrogypsic horizon with its upper boundary within 100 cm of the mineral soil surface.

Petrogypsic Anhyturbels

ABCD. Other Anhyturbels that have a gypsic horizon with its upper boundary within 100 cm of the mineral soil surface.

Gypsic Anhyturbels

ABCE. Other Anhyturbels that have a horizon 15 cm or more thick that contains 12 cmol(-)/L nitrate in 1:5 soil:water extract and in which the product of its thickness (in cm) and its nitrate concentration is 3,500 or more.

Nitric Anhyturbels

ABCF. Other Anhyturbels that have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Salic Anhyturbels

ABCG. Other Anhyturbels that have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calcic Anhyturbels

ABCH. Other Anhyturbels.

Typic Anhyturbels

Aquiturbels

Key to Subgroups

ABBA. Aquiturbels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Aquiturbels

ABBB. Other Aquiturbels that have a glacial layer with its upper boundary within 100 cm of the mineral soil surface.

Glacial Aquiturbels

ABBC. Other Aquiturbels that have a sulfuric horizon or

sulfidic materials with an upper boundary within 100 cm of the mineral soil surface.

Sulfuric Aquiturbels

ABBD. Other Aquiturbels that have *either*:

1. Organic soil materials that are discontinuous at the surface; *or*
2. Organic soil materials at the surface that change in thickness fourfold or more within a pedon.

Ruptic-Histic Aquiturbels

ABBE. Other Aquiturbels that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers within the particle-size control section.

Psammentic Aquiturbels

ABBF. Other Aquiturbels.

Typic Aquiturbels

Haploturbels

Key to Subgroups

ABGA. Haploturbels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploturbels

ABGB. Other Haploturbels that have a glacial layer that has an upper boundary within 100 cm of the mineral soil surface.

Glacial Haploturbels

ABGC. Other Haploturbels that have, in one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time during normal years (or artificial drainage).

Aquic Haploturbels

ABGD. Other Haploturbels.

Typic Haploturbels

Histoturbels

Key to Subgroups

ABAA. Histoturbels that have a lithic contact within 50 cm of the soil surface.

Lithic Histoturbels

ABAB. Other Histoturbels that have a glacial layer with its upper boundary within 100 cm of the soil surface.

Glacial Histoturbels

ABAC. Other Histoturbels that have more than 40 percent, by volume, organic soil materials from the soil surface to a depth of 50 cm in 75 percent or less of the pedon.

Ruptic Histoturbels

ABAD. Other Histoturbels.

Typic Histoturbels

Molliturbels

Key to Subgroups

ABDA. Molliturbels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Molliturbels

ABDB. Other Molliturbels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Molliturbels

ABDC. Other Molliturbels that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time during normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallowest.

Vertic Molliturbels

ABDD. Other Molliturbels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Molliturbels

ABDE. Other Molliturbels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

- b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Molliturbels

ABDF. Other Molliturbels that have:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*
2. A slope of less than 25 percent.

Cumulic Molliturbels

ABDG. Other Molliturbels that have, in one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time during normal years (or artificial drainage).

Aquic Molliturbels

ABDH. Other Molliturbels.

Typic Molliturbels

Psammenturbels

Key to Subgroups

ABFA. Psammenturbels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Psammenturbels

ABFB. Other Psammenturbels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Psammenturbels

ABFC. Other Psammenturbels that have a horizon 5 cm or more thick that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*
2. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*
3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Psammenturbels

ABFD. Other Psammenturbels.

Typic Psammenturbels

Umbrilturbels

Key to Subgroups

ABEA. Umbrilturbels that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Umbrilturbels

ABEB. Other Umbrilturbels that have a glacial layer that has its upper boundary within 100 cm of the mineral soil surface.

Glacial Umbrilturbels

ABEC. Other Umbrilturbels that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time during normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallowest.

Vertic Umbrilturbels

ABED. Other Umbrilturbels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Umbrilturbels

ABEE. Other Umbrilturbels that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium

oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Umbriterrubels

ABEF. Other Umbriterrubels that have:

1. An umbric epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*
2. A slope of less than 25 percent.

Cumulic Umbriterrubels

ABEG. Other Umbriterrubels that have, in one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time during normal years (or artificial drainage).

Aquic Umbriterrubels

ABEH. Other Umbriterrubels.

Typic Umbriterrubels

CHAPTER 10

Histosols

Key to Suborders

BA. Histosols that are saturated with water for less than 30 cumulative days during normal years (and are not artificially drained).

[Folists](#), p. 160

BB. Other Histosols that:

1. Have more thickness of fibric soil materials than any other kind of organic soil material *either*:

a. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier;
or

b. In the *combined* thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier;
and

2. Do not have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface; *and*

3. Do not have sulfidic materials within 100 cm of the soil surface.

[Fibrists](#), p. 159

BC. Other Histosols that have more thickness of sapric soil materials than any other kind of organic soil materials *either*:

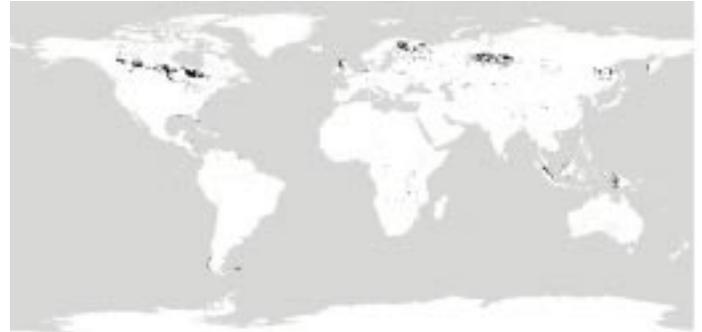
1. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; *or*

2. In the *combined* thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.

[Saprists](#), p. 162

BD. Other Histosols.

[Hemists](#), p. 161



Fibrists

Key to Great Groups

BBA. Fibrists that have a cryic soil temperature regime.

[Cryofibrists](#), p. 159

BBB. Other Fibrists in which fibric *Sphagnum* constitutes three-fourths or more of the volume to *either* a depth of 90 cm from the soil surface *or* to a densic, lithic, or paralithic contact, fragmental materials, or other mineral soil materials if at a depth of less than 90 cm.

[Sphagnofibrists](#), p. 160

BBC. Other Fibrists.

[Haplofibrists](#), p. 160

Cryofibrists

Key to Subgroups

BBAA. Cryofibrists that have a layer of water within the control section, below the surface tier.

Hydric Cryofibrists

BBAB. Other Cryofibrists that have a lithic contact within the control section.

Lithic Cryofibrists

BBAC. Other Cryofibrists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Terric Cryofibrists

BBAD. Other Cryofibrists that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more mineral layers of any thickness in the control section, below the surface tier.

Fluvaquentic Cryofibrists

BBAE. Other Cryofibrists in which three-fourths or more of the fiber volume in the surface tier is derived from *Sphagnum*.

Sphagnic Cryofibrists

BBAF. Other Cryofibrists.

Typic Cryofibrists

Haplofibrists

Key to Subgroups

BBCA. Haplofibrists that have a layer of water within the control section, below the surface tier.

Hydric Haplofibrists

BBCB. Other Haplofibrists that have a lithic contact within the control section.

Lithic Haplofibrists

BBC. Other Haplofibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Haplofibrists

BBCD. Other Haplofibrists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Terric Haplofibrists

BBCE. Other Haplofibrists that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more mineral layers of any thickness in the control section, below the surface tier.

Fluvaquentic Haplofibrists

BBCF. Other Haplofibrists that have one or more layers of hemic and sapric materials with a total thickness of 25 cm or more below the surface tier.

Hemic Haplofibrists

BBCG. Other Haplofibrists.

Typic Haplofibrists

Sphagnofibrists

Key to Subgroups

BBBA. Sphagnofibrists that have a layer of water within the control section, below the surface tier.

Hydric Sphagnofibrists

BBBB. Other Sphagnofibrists that have a lithic contact within the control section.

Lithic Sphagnofibrists

BBBC. Other Sphagnofibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Sphagnofibrists

BBBD. Other Sphagnofibrists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Terric Sphagnofibrists

BBBE. Other Sphagnofibrists that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more mineral layers of any thickness in the control section, below the surface tier.

Fluvaquentic Sphagnofibrists

BBBF. Other Sphagnofibrists that have one or more layers of hemic and sapric materials with a total thickness of 25 cm or more below the surface tier.

Hemic Sphagnofibrists

BBBG. Other Sphagnofibrists.

Typic Sphagnofibrists

Folists

Key to Great Groups

BAA. Folists that have a cryic soil temperature regime.

[Cryofolists](#), p. 161

BAB. Other Folists that have an aridic (or torric) soil moisture regime.

[Torrifolists](#), p. 161

BAC. Other Folists that have an ustic or xeric soil moisture regime.

[Ustifolists](#), p. 161

BAD. Other Folists.

[Udifolists](#), p. 161

Cryofolists

Key to Subgroups

BAAA. Cryofolists that have a lithic contact within 50 cm of the soil surface.

Lithic Cryofolists

BAAB. Other Cryofolists.

Typic Cryofolists

Torrifolists

Key to Subgroups

BABA. Torrifolists that have a lithic contact within 50 cm of the soil surface.

Lithic Torrifolists

BABB. Other Torrifolists.

Typic Torrifolists

Udifolists

Key to Subgroups

BADA. Udifolists that have a lithic contact within 50 cm of the soil surface.

Lithic Udifolists

BADB. Other Udifolists.

Typic Udifolists

Ustifolists

Key to Subgroups

BACA. Ustifolists that have a lithic contact within 50 cm of the soil surface.

Lithic Ustifolists

BACB. Other Ustifolists.

Typic Ustifolists

Hemists

Key to Great Groups

BDA. Hemists that have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.
[Sulfohemists](#), p. 162

BDB. Other Hemists that have sulfidic materials within 100 cm of the soil surface.
[Sulfihemists](#), p. 162

BDC. Other Hemists that have a horizon 2 cm or more thick in which humilluvic materials constitute one-half or more of the volume.
[Luvihemists](#), p. 162

BDD. Other Hemists that have a cryic temperature regime.
[Cryohemists](#), p. 161

BDE. Other Hemists.
[Haplohemists](#), p. 161

Cryohemists

Key to Subgroups

BDDA. Cryohemists that have a layer of water within the control section, below the surface tier.
Hydric Cryohemists

BDDB. Other Cryohemists that have a lithic contact within the control section.
Lithic Cryohemists

BDDC. Other Cryohemists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.
Terric Cryohemists

BDDD. Other Cryohemists that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more mineral layers of any thickness in the control section, below the surface tier.
Fluvaquentic Cryohemists

BDDE. Other Cryohemists.
Typic Cryohemists

Haplohemists

Key to Subgroups

BDEA. Haplohemists that have a layer of water within the control section, below the surface tier.
Hydric Haplohemists

BDEB. Other Haplohemists that have a lithic contact within the control section.
Lithic Haplohemists

BDEC. Other Haplohemists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.
Limnic Haplohemists

BDED. Other Haplohemists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Terric Haplohemists

BDEE. Other Haplohemists that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more mineral layers of any thickness in the control section, below the surface tier.

Fluvaquentic Haplohemists

BDEF. Other Haplohemists that have one or more layers of fibric materials with a total thickness of 25 cm or more below the surface tier.

Fibric Haplohemists

BDEG. Other Haplohemists that have one or more layers of sapric materials with a total thickness of 25 cm or more below the surface tier.

Sapric Haplohemists

BDEH. Other Haplohemists.

Typic Haplohemists

Luvihemists

Key to Subgroups

BDCA. All Luvihemists (provisionally).

Typic Luvihemists

Sulfihemists

Key to Subgroups

BDBA. Sulfihemists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Terric Sulfihemists

BDBB. Other Sulfihemists.

Typic Sulfihemists

Sulfohemists

Key to Subgroups

BDAA. All Sulfohemists (provisionally).

Typic Sulfohemists

Saprists

Key to Great Groups

BCA. Saprists that have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.

[Sulfosaprists](#), p. 163

BCB. Other Saprists that have sulfidic materials within 100 cm of the soil surface.

[Sulfisaprists](#), p. 163

BCC. Other Saprists that have a cryic temperature regime.

[Cryosaprists](#), p. 162

BCD. Other Saprists.

[Haplosaprists](#), p. 162

Cryosaprists

Key to Subgroups

BCCA. Cryosaprists that have a lithic contact within the control section.

Lithic Cryosaprists

BCCB. Other Cryosaprists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Terric Cryosaprists

BCCC. Other Cryosaprists that have, within the organic materials, either one mineral layer 5 cm or more thick or two or more mineral layers of any thickness in the control section, below the surface tier.

Fluvaquentic Cryosaprists

BCCD. Other Cryosaprists.

Typic Cryosaprists

Haplosaprists

Key to Subgroups

BCDA. Haplosaprists that have a lithic contact within the control section.

Lithic Haplosaprists

BCDB. Other Haplosaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Haplosaprists

BCDC. Other Haplosaprists that have *both*:

1. Throughout a layer 30 cm or thick that has its upper boundary within the control section, an electrical conductivity of 30 dS/m or more (1:1 soil:water) for 6 months or more during normal years; *and*
2. A mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Halic Terric Haplosaprists

BCDD. Other Haplosaprists that have throughout a layer 30 cm or more thick within the control section, an electrical conductivity of 30 dS/m or more (1:1 soil:water) for 6 months or more during normal years.

Halic Haplosaprists

BCDE. Other Haplosaprists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Terric Haplosaprists

BCDF. Other Haplosaprists that have, within the organic materials, either one mineral layer 5 cm or more thick or two

or more mineral layers of any thickness in the control section, below the surface tier.

Fluvaquentic Haplosaprists

BCDG. Other Haplosaprists that have one or more layers of fibric or hemic materials with a total thickness of 25 cm or more below the surface tier.

Hemic Haplosaprists

BCDH. Other Haplosaprists.

Typic Haplosaprists

Sulfisaprists

Key to Subgroups

BCBA. Sulfisaprists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.

Terric Sulfisaprists

BCBB. Other Sulfisaprists.

Typic Sulfisaprists

Sulfosaprists

Key to Subgroups

BCAA. All Sulfosaprists (provisionally).

Typic Sulfosaprists

CHAPTER 11

Inceptisols

Key to Suborders

KA. Inceptisols that have *one or more* of the following:

1. In a layer above a densic, lithic, or paralithic contact or in a layer at a depth between 40 and 50 cm from the mineral soil surface, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

- a. A histic epipedon; *or*
- b. A sulfuric horizon that has its upper boundary within 50 cm of the mineral soil surface; *or*
- c. A layer directly under the epipedon, or within 50 cm of the mineral soil surface, that has, on faces of peds or in the matrix if peds are absent, 50 percent or more chroma of *either*:

- (1) 2 or less if there are redox concentrations; *or*
- (2) 1 or less; *or*

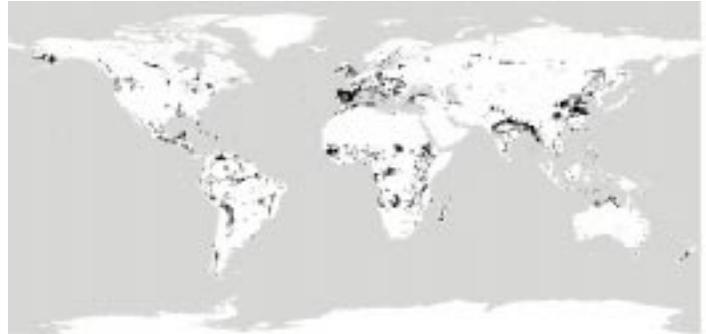
d. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated; *or*

2. An exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio [SAR] of 13 or more) in half or more of the soil volume within 50 cm of the mineral soil surface, a decrease in ESP (or SAR) values with increasing depth below 50 cm, and ground water within 100 cm of the mineral soil surface for some time during the year.
[Aquepts](#), p. 166

KB. Other Inceptisols that have a plaggan or anthropic epipedon.
[Anthrepts](#), p. 165

KC. Other Inceptisols that have a cryic soil temperature regime.
[Cryepts](#), p. 171

KD. Other Inceptisols that have an ustic soil moisture regime.
[Ustepts](#), p. 178



KE. Other Inceptisols that have a xeric soil moisture regime.
[Xerepts](#), p. 184

KF. Other Inceptisols that have a udic soil moisture regime.
[Udepts](#), p. 172

Anthrepts

Key to Great Groups

KBA. Anthrepts that have a plaggan epipedon.
[Plagganthrepts](#), p. 165

KBB. Other Anthrepts.
[Haplanthrepts](#), p. 165

Haplanthrepts

Key to Subgroups

KBBA. All Haplanthrepts (provisionally).
Typic Haplanthrepts

Plagganthrepts

Key to Subgroups

KBAA. All Plagganthrepts (provisionally).
Typic Plagganthrepts

Aquepts

Key to Great Groups

KAA. Aquepts that have a sulfuric horizon that has its upper boundary within 50 cm of the mineral soil surface.

[Sulfaquepts](#), p. 170

KAB. Other Aquepts that have, within 100 cm of the mineral soil surface, one or more horizons in which plinthite or a cemented or indurated diagnostic horizon either forms a continuous phase or constitutes one-half or more of the volume.

[Petraquepts](#), p. 170

KAC. Other Aquepts that have *either*:

1. A salic horizon; *or*
2. In one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, an exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio [SAR] of 13 or more) and a decrease in ESP (or SAR) values with increasing depth below 50 cm.

[Halaquepts](#), p. 169

KAD. Other Aquepts that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

[Fragiaquepts](#), p. 169

KAE. Other Aquepts that have a cryic soil temperature regime.

[Cryaquepts](#), p. 166

KAF. Other Aquepts that have, in one or more layers at least 25 cm thick (cumulative) within 100 cm of the mineral soil surface, 25 percent or more (by volume) recognizable bioturbation, such as filled animal burrows, wormholes, or casts.

[Vermaquepts](#), p. 171

KAG. Other Aquepts that have a histic, melanic, mollic, or umbric epipedon.

[Humaquepts](#), p. 170

KAH. Other Aquepts that have episaturation.

[Epiaquepts](#), p. 168

KAI. Other Aquepts.

[Endoquepts](#), p. 167

Cryaquepts

Key to Subgroups

KAEA. Cryaquepts that have, within 150 cm of the mineral soil surface, *one or more* of the following:

1. A sulfuric horizon; *or*
2. A horizon 15 cm or more thick that has all of the characteristics of a sulfuric horizon, except that it has a pH between 3.5 and 4.0; *or*
3. Sulfidic materials.

Sulfic Cryaquepts

KAEB. Other Cryaquepts that have both a histic epipedon and a lithic contact within 50 cm of the mineral soil surface.

Histic Lithic Cryaquepts

KAEC. Other Cryaquepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryaquepts

KAED. Other Cryaquepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Cryaquepts

KAEE. Other Cryaquepts that have a histic epipedon.

Histic Cryaquepts

KAEF. Other Cryaquepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Cryaquepts

KAEG. Other Cryaquepts that have a slope of less than 25 percent; *and*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaqueptic Cryaquepts

KAEH. Other Cryaquepts that have *both*:

1. Chroma of 3 or more in 40 percent or more of the matrix of one or more horizons at a depth between 15 and 50 cm from the mineral soil surface; *and*
2. A mollic or umbric epipedon.

Aeric Humic Cryaquepts

KAEL. Other Cryaquepts that have chroma of 3 or more in 40 percent or more of the matrix of one or more horizons at a depth between 15 and 50 cm from the mineral soil surface.

Aeric Cryaquepts

KAEL. Other Cryaquepts that have a mollic or umbric epipedon.

Humic Cryaquepts

KAEL. Other Cryaquepts.

Typic Cryaquepts

Endoaquepts

Key to Subgroups

KAIA. Endoaquepts that have, within 150 cm of the mineral soil surface, *one or more* of the following:

1. A sulfuric horizon; *or*
2. A horizon 15 cm or more thick that has all of the characteristics of a sulfuric horizon, except that it has a pH between 3.5 and 4.0; *or*
3. Sulfidic materials.

Sulfic Endoaquepts

KAIB. Other Endoaquepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Endoaquepts

KAIC. Other Endoaquepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Endoaquepts

KAID. Other Endoaquepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Endoaquepts

KAIE. Other Endoaquepts that have a slope of less than 25 percent; *and*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaqueptic Endoaquepts

KAIF. Other Endoaquepts that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Endoaquepts

KAIG. Other Endoaquepts that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, *one* of the following colors:

1. Hue of 7.5YR or redder in 50 percent or more of the matrix; *and*
 - a. If peds are present, either chroma of 2 or more on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less in ped interiors; *or*
 - b. If peds are absent, chroma of 2 or more in 50 percent or more of the matrix; *or*
2. In 50 percent or more of the matrix, hue of 10YR or yellower and *either*:
 - a. Both a color value, moist, and chroma of 3 or more; *or*
 - b. Chroma of 2 or more if there are no redox concentrations.

Aeric Endoaquepts

KAIH. Other Endoaquepts that have:

1. A color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) in the Ap horizon or in the upper 15 cm after mixing; *and*
2. A base saturation (by NH₄OAc) of less than 50 percent in some part within 100 cm of the mineral soil surface.

Humic Endoaquepts

KAIL. Other Endoaquepts that have a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) either in the Ap horizon or in the upper 15 cm after mixing.

Mollic Endoaquepts

KAIJ. Other Endoaquepts.

Typic Endoaquepts

Epiaquepts

Key to Subgroups

KAHA. Epiaquepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Epiaquepts

KAHB. Other Epiaquepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Epiaquepts

KAHC. Other Epiaquepts that have a slope of less than 25 percent; *and*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaquentic Epiaquepts

KAHD. Other Epiaquepts that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Epiaquepts

KAHE. Other Epiaquepts that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, *one* of the following colors:

1. Hue of 7.5YR or redder in 50 percent or more of the matrix; *and*
 - a. If peds are present, either chroma of 2 or more on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less in ped interiors; *or*

- b. If peds are absent, chroma of 2 or more in 50 percent or more of the matrix; *or*
2. In 50 percent or more of the matrix, hue of 10YR or yellower and *either*:
- Both a color value, moist, and chroma of 3 or more; *or*
 - Chroma of 2 or more if there are no redox concentrations.

Aeric Epiaquepts

KAHF. Other Epiaquepts that have *both*:

- A color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) in the Ap horizon or in the upper 15 cm after mixing; *and*
- A base saturation (by NH_4OAc) of less than 50 percent in some part within 100 cm of the mineral soil surface.

Humic Epiaquepts

KAHG. Other Epiaquepts that have a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed) either in the Ap horizon or in the upper 15 cm after mixing.

Mollic Epiaquepts

KAHH. Other Epiaquepts.

Typic Epiaquepts

Fragiaquepts

Key to Subgroups

KADA. Fragiaquepts that have, in 50 percent or more of the matrix of one or more horizons either between the plow layer and a depth of 75 cm below the mineral soil surface or, if there is no plow layer, between depths of 15 and 75 cm, chroma of *either*:

- 3 or more; *or*
- 2 or more if there are no redox concentrations.

Aeric Fragiaquepts

KADB. Other Fragiaquepts that have a histic, mollic, or umbric epipedon.

Humic Fragiaquepts

KADC. Other Fragiaquepts.

Typic Fragiaquepts

Halaquepts

Key to Subgroups

KACA. Halaquepts that have *one or both* of the following:

- Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
- A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Halaquepts

KACB. Other Halaquepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

- A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
- More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
- A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - $[(\text{Al plus } \frac{1}{2} \text{ Fe, percent extracted by ammonium oxalate) times 60}]$ plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Halaquepts

KACC. Other Halaquepts that have a horizon 15 cm or more thick that has 20 percent or more (by volume) cemented or indurated soil material and has its upper boundary within 100 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Halaquepts

KACD. Other Halaquepts that have chroma of 3 or more in 40 percent or more of the matrix of one or more horizons at a depth between 15 and 75 cm from the mineral soil surface.

Aeric Halaquepts

KACE. Other Halaquepts.

Typic Halaquepts

Humaquepts

Key to Subgroups

KAGA. Humaquepts that have an *n* value of *either*:

1. More than 0.7 (and less than 8 percent clay) in one or more layers at a depth between 20 and 50 cm from the mineral soil surface; *or*
2. More than 0.9 in one or more layers at a depth between 50 and 100 cm.

Hydraqueptic Humaquepts

KAGB. Other Humaquepts that have a histic epipedon.

Histic Humaquepts

KAGC. Other Humaquepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Humaquepts

KAGD. Other Humaquepts that have a slope of less than 25 percent; *and*

1. An umbric or mollic epipedon 60 cm or more thick; *and either*
2. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
3. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Cumulic Humaquepts

KAGE. Other Humaquepts that have a slope of less than 25 percent; *and*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaqueptic Humaquepts

KAGF. Other Humaquepts that have hue of 5Y or redder and chroma of 3 or more in more than 40 percent of the matrix of one or more subhorizons at a depth between 15 and 75 cm from the mineral soil surface.

Aeric Humaquepts

KAGG. Other Humaquepts.

Typic Humaquepts

Petraquepts

Key to Subgroups

KABA. Petraquepts that have *both*:

1. A histic epipedon; *and*
2. A placic horizon.

Histic Placic Petraquepts

KABB. Other Petraquepts that have a placic horizon.

Placic Petraquepts

KABC. Other Petraquepts that have one or more horizons within 125 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one-half or more of the volume.

Plinthic Petraquepts

KABD. Other Petraquepts.

Typic Petraquepts

Sulfaquepts

Key to Subgroups

KAAA. Sulfaquepts that have a salic horizon within 75 cm of the mineral soil surface.

Salidic Sulfaquepts

KAAB. Other Sulfaquepts that have an *n* value of *either*:

1. More than 0.7 (and less than 8 percent clay) in one or

more layers at a depth between 20 and 50 cm from the mineral soil surface; *or*

2. More than 0.9 in one or more layers at a depth between 50 and 100 cm from the mineral soil surface.

Hydraquentic Sulfaquepts

KAAC. Other Sulfaquepts.

Typic Sulfaquepts

Vermaquepts

Key to Subgroups

KAFA. Vermaquepts that have an exchangeable sodium percentage of 7 or more (or a sodium adsorption ratio [SAR] of 6 or more) in one or more subhorizons within 100 cm of the mineral soil surface.

Sodic Vermaquepts

KAFB. Other Vermaquepts.

Typic Vermaquepts

Cryepts

Key to Great Groups

KCA. Cryepts that have *one or both* of the following:

1. Free carbonates within the soils; *or*
2. A base saturation (by NH_4OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface.

[Eutrocryepts](#), p. 172

KCB. Other Cryepts.

[Dystrocryepts](#), p. 171

Dystrocryepts

Key to Subgroups

KCBA. Dystrocryepts that have *both*:

1. An umbric or mollic epipedon; *and*
2. A lithic contact within 50 cm of the mineral soil surface.

Humic Lithic Dystrocryepts

KCBB. Other Dystrocryepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystrocryepts

KCBC. Other Dystrocryepts that have, throughout one or more horizons with a total thickness of 18 cm or more within

75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and Al plus $1/2$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Dystrocryepts

KCBD. Other Dystrocryepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $1/2$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Dystrocryepts

KCBE. Other Dystrocryepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Dystrocryepts

KCBF. Other Dystrocryepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Dystrocryepts

KCBG. Other Dystrocryepts that have lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Dystrocryepts

KCBH. Other Dystrocryepts that have a horizon 5 cm or more thick that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*
2. Al plus $1/2$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*
3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Dystrocryepts

KCBI. Other Dystrocrepts that have a xeric moisture regime.

Xeric Dystrocrepts

KCBJ. Other Dystrocrepts that are dry in some part of the moisture control section for 45 or more days (cumulative) in normal years.

Ustic Dystrocrepts

KCBK. Other Dystrocrepts that have an umbric or mollic epipedon.

Humic Dystrocrepts

KCBL. Other Dystrocrepts.

Typic Dystrocrepts

Eutrocrepts

Key to Subgroups

KCAA. Eutrocrepts that have *both*:

1. An umbric or mollic epipedon; *and*
2. A lithic contact within 50 cm of the mineral soil surface.

Humic Lithic Eutrocrepts

KCAB. Other Eutrocrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Eutrocrepts

KCAC. Other Eutrocrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Eutrocrepts

KCAD. Other Eutrocrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Eutrocrepts

KCAE. Other Eutrocrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Eutrocrepts

KCAF. Other Eutrocrepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Eutrocrepts

KCAG. Other Eutrocrepts that have lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Eutrocrepts

KCAH. Other Eutrocrepts that have a xeric moisture regime.

Xeric Eutrocrepts

KCAI. Other Eutrocrepts that are dry in some part of the moisture control section for 45 or more days (cumulative) in normal years.

Ustic Eutrocrepts

KCAJ. Other Eutrocrepts that have an umbric or mollic epipedon.

Humic Eutrocrepts

KCAK. Other Eutrocrepts.

Typic Eutrocrepts

Udepts

Key to Great Groups

KFA. Udepts that have a sulfuric horizon within 50 cm of the mineral soil surface.

[Sulfudepts](#), p. 178

KFB. Other Udepts that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

[Durudepts](#), p. 173

KFC. Other Udepts that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

[Fragiudepts](#), p. 177

KFD. Other Udepts that have *one or both* of the following:

1. Free carbonates within the soils; *or*
2. A base saturation (by NH₄OAc) of 60 percent or more

in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface.

[Eutrudepts](#), p. 176

KFE. Other Udepts.

[Dystrudepts](#), p. 173

Durudepts

Key to Subgroups

KFBA. Durudepts that have *both*:

1. In one or more horizons above the duripan and within 60 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more, above the duripan and within 75 cm of the mineral soil surface, *one or more* of the following:
 - a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
 - b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - (1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - (2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Durudepts

KFBB. Other Durudepts that have, throughout one or more horizons with a total thickness of 18 cm or more, above the duripan and within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Durudepts

KFBC. Other Durudepts that have, throughout one or more horizons with a total thickness of 18 cm or more, above the duripan and within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

- a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
- b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Durudepts

KFBD. Other Durudepts that have, in one or more horizons above the duripan and within 30 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Durudepts

KFBE. Other Durudepts.

Typic Durudepts

Dystrudepts

Key to Subgroups

KFEA. Dystrudepts that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. An umbric or mollic epipedon.

Humic Lithic Dystrudepts

KFEB. Other Dystrudepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystrudepts

KFEC. Other Dystrudepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Dystrudepts

KFED. Other Dystrudepts that have *both*:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and

also aquic conditions for some time in normal years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Dystrudepts

KFEE. Other Dystrudepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Dystrudepts

KFEF. Other Dystrudepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Dystrudepts

KFEG. Other Dystrudepts that have *both*:

1. Fragic soil properties:

a. In 30 percent or more of the volume of a layer 15 cm

or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions in normal years (or artificial drainage).

Fragiaquic Dystrudepts

KFEH. Other Dystrudepts that have a slope of less than 25 percent; *and*

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. *Either*:

a. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*

b. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaquentic Dystrudepts

KFEI. Other Dystrudepts that have *both*:

1. An umbric or mollic epipedon; *and*

2. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Humic Dystrudepts

KFEJ. Other Dystrudepts that have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Dystrudepts

KFEK. Other Dystrudepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*

2. 30 or more cumulative days.

Oxyaquic Dystrudepts

KFEL. Other Dystrudepts that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Dystrudepts

KFEM. Other Dystrudepts that have lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Dystrudepts

KFEN. Other Dystrudepts that have *both*:

1. An umbric or mollic epipedon; *and*
2. A sandy particle-size class throughout the particle-size control section.

Humic Psammentic Dystrudepts

KFEO. Other Dystrudepts that have a slope of less than 25 percent; *and*

1. An umbric or mollic epipedon; *and*
2. *Either*:
 - a. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
 - b. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Humic Dystrudepts

KFEP. Other Dystrudepts that have a slope of less than 25 percent; *and either*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Dystrudepts

KEEQ. Other Dystrudepts that have a horizon 5 cm or more thick that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*
2. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*
3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Dystrudepts

KFER. Other Dystrudepts that have in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower:

1. A CEC (by 1N NH₄OAc pH 7) of less than 24 cmol(+) per kg clay; *or*
2. Both a ratio of measured clay in the fine-earth fraction to percent water retained at 1500 kPa tension of 0.6 or more and the following: the CEC (by 1N NH₄OAc pH 7) divided by the product of three times [percent water retained at 1500 kPa tension minus percent organic carbon (but no more than 1.00)] is less than 24.

Oxic Dystrudepts

KFES. Other Dystrudepts that have an umbric or mollic epipedon that is 50 cm or more thick.

Humic Pachic Dystrudepts

KFET. Other Dystrudepts that have an umbric or mollic epipedon.

Humic Dystrudepts

KFEU. Other Dystrudepts that have *both*:

1. In each pedon a cambic horizon that includes 10 to 50 percent (by volume) illuvial parts that otherwise meet the requirements for an argillic, kandic, or natric horizon; *and*
2. A base saturation (by sum of cations) of 35 percent or more either at a depth of 125 cm from the top of the cambic horizon or directly above a densic, lithic, or paralithic contact if shallower.

Ruptic-Alfic Dystrudepts

KFEV. Other Dystrudepts that have in each pedon a cambic horizon that includes 10 to 50 percent (by volume) illuvial parts that otherwise meet the requirements for an argillic, kandic, or natric horizon.

Ruptic-Ultic Dystrudepts

KFEW. Other Dystrudepts.

Typic Dystrudepts

Eutrudepts

Key to Subgroups

KFDA. Eutrudepts that have *both*:

1. An umbric or mollic epipedon; *and*
2. A lithic contact within 50 cm of the mineral soil surface.

Humic Lithic Eutrudepts

KFDB. Other Eutrudepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Eutrudepts

KFDC. Other Eutrudepts that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquertic Eutrudepts

KFDD. Other Eutrudepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Eutrudepts

KFDE. Other Eutrudepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water

retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Eutrudepts

KDFD. Other Eutrudepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Eutrudepts

KFDG. Other Eutrudepts that have anthraquic conditions.

Anthraquic Eutrudepts

KFDH. Other Eutrudepts that have *both*:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions in normal years (or artificial drainage).

Fragiaquic Eutrudepts

KFDI. Other Eutrudepts that have a slope of less than 25 percent; *and*

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. *Either*:
 - a. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*

b. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaquentic Eutrudepts

KFDJ. Other Eutrudepts that:

1. Have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface.

Aquic Dystric Eutrudepts

KFDK. Other Eutrudepts that have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Eutrudepts

KFDL. Other Eutrudepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Eutrudepts

KFDM. Other Eutrudepts that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Eutrudepts

KFDN. Other Eutrudepts that have lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Eutrudepts

KFDO. Other Eutrudepts that have a slope of less than 25 percent; *and*

1. Do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface; *and either*
2. Have, at a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*

3. Have an irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Dystric Fluventic Eutrudepts

KFDP. Other Eutrudepts that have a slope of less than 25 percent; *and either*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
2. An irregular decrease in organic-carbon content (Holocene Age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Eutrudepts

KFDQ. Other Eutrudepts that have a sandy or sandy-skeletal particle-size class in all horizons within 50 cm of the mineral soil surface.

Arenic Eutrudepts

KFDR. Other Eutrudepts that do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface.

Dystric Eutrudepts

KFDS. Other Eutrudepts that have 40 percent or more free carbonates, including coarse fragments as much as 75 mm in diameter, in all horizons between the top of the cambic horizon and either a depth of 100 cm from the mineral soil surface or a densic, lithic, or paralithic contact if shallower.

Rendollic Eutrudepts

KFDT. Other Eutrudepts that have an umbric or mollic epipedon.

Humic Eutrudepts

KFDU. Other Eutrudepts that have a cambic horizon that includes 10 to 50 percent (by volume) illuvial parts that otherwise meet the requirements for an argillic, kandic, or natric horizon.

Ruptic-Alfic Eutrudepts

KFDV. Other Eutrudepts.

Typic Eutrudepts

Fragiudepts

Key to Subgroups

KFCA. Fragiudepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm

of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragiudepts

KFCB. Other Fragiudepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Fragiudepts

KFCC. Other Fragiudepts that have, in one or more horizons within 30 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Fragiudepts

KFCD. Other Fragiudepts that have an umbric or mollic epipedon.

Humic Fragiudepts

KFCE. Other Fragiudepts.

Typic Fragiudepts

Sulfudepts

Key to Subgroups

KFAA. All Sulfudepts (provisionally).

Typic Sulfudepts

Ustepts

Key to Great Groups

KDA. Ustepts that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

[Durustepts](#), p. 179

KDB. Other Ustepts that *both*:

1. Have a calcic horizon with its upper boundary within 100 cm of the mineral soil surface or a petrocalcic

horizon that has its upper boundary within 150 cm of the mineral soil surface; *and*

2. Are either calcareous or have a texture of loamy fine sand or coarser in all parts above the calcic or petrocalcic horizon, after the soil between the mineral soil surface and a depth of 18 cm has been mixed.

[Calciustepts](#), p. 178

KDC. Other Ustepts that have *both* of the following:

1. No free carbonates within 200 cm of the mineral soil surface; *and*
2. A base saturation (by NH₄OAc) of less than 60 percent in all horizons at a depth between 25 and 75 cm from the mineral soil surface.

[Dystrustepts](#), p. 179

KDD. Other Ustepts.

[Haplustepts](#), p. 180

Calciustepts

Key to Subgroups

KDBA. Calciustepts that have a petrocalcic horizon and a lithic contact within 50 cm of the mineral soil surface.

Lithic Petrocalcic Calciustepts

KDBB. Other Calciustepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciustepts

KDBC. Other Calciustepts that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

(1) Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

(2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Torrertic Calcustepts

KDBD. Other Calcustepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Calcustepts

KDBE. Other Calcustepts that have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calcustepts

KDBF. Other Calcustepts that have a gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Gypsic Calcustepts

KDBG. Other Calcustepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Calcustepts

KDBH. Other Calcustepts that have, when neither irrigated nor fallowed to store moisture, *one* of the following:

1. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the

temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

2. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

a. Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

b. Is dry in some or all parts for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Calcustepts

KDBI. Other Calcustepts that have, when neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for four-tenths or less of the consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Calcustepts

KDBJ. Other Calcustepts.

Typic Calcustepts

Durustepts

Key to Subgroups

KDAA. All Durustepts (provisionally).

Typic Durustepts

Dystrustepts

Key to Subgroups

KDCA. Dystrustepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystrustepts

KDCB. Other Dystrustepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Dystrustepts

KDCC. Other Dystrustepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Dystrustepts

KDCD. Other Dystrustepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Dystrustepts

KDCE. Other Dystrustepts that have a slope of less than 25 percent; *and either*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Dystrustepts

KDCF. Other Dystrustepts that have in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower:

1. A CEC (by 1N NH₄OAc pH 7) of less than 24 cmol(+) per kg clay; *or*
2. Both a ratio of measured clay in the fine-earth fraction to percent water retained at 1500 kPa tension of 0.6 or more

and the following: the CEC (by 1N NH₄OAc pH 7) divided by the product of three times [percent water retained at 1500 kPa tension minus percent organic carbon (but no more than 1.00)] is less than 24.

Oxic Dystrustepts

KDCG. Other Dystrustepts that have an umbric or mollic epipedon.

Humic Dystrustepts

KDCH. Other Dystrustepts.

Typic Dystrustepts

Haplustepts

Key to Subgroups

KDDA. Haplustepts that have:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Lithic Haplustepts

KDDB. Other Haplustepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplustepts

KDDC. Other Haplustepts that have *both*:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 105 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for less than four-tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Udertic Haplustepts

KDDD. Other Haplustepts that have *both*:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid soil temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a

depth of 50 cm below the soil surface is higher than 8 °C; *and*

(2) Is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*

2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Haplustepts

KDDE. Other Haplustepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplustepts

KDDF. Other Haplustepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplustepts

KDDG. Other Haplustepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

- b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Haplustepts

KDDH. Other Haplustepts that have anthraquic conditions.

Anthraquic Haplustepts

KDDI. Other Haplustepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplustepts

KDDJ. Other Haplustepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haplustepts

KDDK. Other Haplustepts that have in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower:

1. A CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay; *or*
2. Both a ratio of measured clay in the fine-earth fraction to percent water retained at 1500 kPa tension of 0.6 or more and the following: the CEC (by 1N NH_4OAc pH 7) divided by the product of three times [percent water retained at 1500 kPa tension minus percent organic carbon (but no more than 1.00)] is less than 24.

Oxic Haplustepts

KDDL. Other Haplustepts that have lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Haplustepts

KDDM. Other Haplustepts that have a slope of less than 25 percent; *and*

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid soil temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in

some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

- (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
- (2) Is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*

2. *Either*:

- a. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
- b. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Torrifluventic Haplustepts

KDDN. Other Haplustepts that have a slope of less than 25 percent; *and*

1. When neither irrigated nor fallowed to store moisture, *one* of the following:

- a. A frigid soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 105 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
- b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for less than four-tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

2. *Either*:

- a. At a depth of 125 cm below the mineral soil surface,

an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*

b. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Udifluventic Haplustepts

KDDO. Other Haplustepts that have a slope of less than 25 percent; *and either*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*

2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Haplustepts

KDDP. Other Haplustepts that have a gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Gypsic Haplustepts

KDDQ. Other Haplustepts that have *both*:

1. A calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. When neither irrigated nor fallowed to store moisture, *one* of the following:

a. A frigid soil temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

(1) Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

(2) Is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Haplocalcic Haplustepts

KDDR. Other Haplustepts that have *both*:

1. A calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. When neither irrigated nor fallowed to store moisture, *one* of the following:

a. A frigid soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 105 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for less than four-tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Calcic Udic Haplustepts

KDDS. Other Haplustepts that have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calcic Haplustepts

KDDT. Other Haplustepts that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

2. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

a. Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a

depth of 50 cm below the soil surface is higher than 8 °C;
and

- b. Is dry in some part for six-tenths or more of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Haplustepts

KDDU. Other Haplustepts that have a base saturation (by sum of cations) of less than 60 percent in some horizon between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Dystric Haplustepts

KDDV. Other Haplustepts that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 105 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for less than four-tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Haplustepts

KDDW. Other Haplustepts.

Typic Haplustepts

Xerepts

Key to Great Groups

KEA. Xerepts that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

[Durixerepts](#), p. 185

KEB. Other Xerepts that *both*:

1. Have a calcic horizon with its upper boundary within 100 cm of the mineral soil surface or a petrocalcic horizon with its upper boundary within 150 cm of the mineral soil surface; *and*

2. Are calcareous in all parts above the calcic or petrocalcic horizon, after the soil between the mineral soil surface and a depth of 18 cm has been mixed.

[Calcixerepts](#), p. 184

KEC. Other Xerepts that have a fragipan that has its upper boundary within 100 cm of the mineral soil surface.

[Fragixerepts](#), p. 187

KED. Other Xerepts that have *both* of the following:

1. No free carbonates within 200 cm of the mineral soil surface; *and*
2. A base saturation (by NH₄OAc) of less than 60 percent in all horizons at a depth between 25 and 75 cm from the mineral soil surface.

[Dystroxerepts](#), p. 185

KEE. Other Xerepts.

[Haploxerepts](#), p. 187

Calcixerepts

Key to Subgroups

KEBA. Calcixerepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calcixerepts

KEBB. Other Calcixerepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Calcixerepts

KEBC. Other Calcixerepts that have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calcixerepts

KEBD. Other Calcixerepts that have an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio [SAR] of 13 or more) in one or more subhorizons within 100 cm of the mineral soil surface.

Sodic Calcixerepts

KEBE. Other Calcixerepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Calcixerepts

KEBF. Other Calcixerepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Calcixerepts

KEBG. Other Calcixerepts.

Typic Calcixerepts

Durixerepts

Key to Subgroups

KEAA. Durixerepts that have *both*:

1. In one or more horizons above the duripan and within 30 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more, above the duripan and within 75 cm of the mineral soil surface, *one or more* of the following:
 - a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
 - b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - (1) In the 0.02 to 2.0 mm fraction, 5 percent (or more) volcanic glass; *and*
 - (2) [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium

oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Durixerepts

KEAB. Other Durixerepts that have, throughout one or more horizons with a total thickness of 18 cm or more, above the duripan and within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Durixerepts

KEAC. Other Durixerepts that have, throughout one or more horizons with a total thickness of 18 cm or more, above the duripan and within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Durixerepts

KEAD. Other Durixerepts that have, in one or more horizons above the duripan and within 30 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Durixerepts

KEAE. Other Durixerepts that have a duripan that is strongly cemented or less cemented in all subhorizons.

Entic Durixerepts

KEAF. Other Durixerepts.

Typic Durixerepts

Dystroxerepts

Key to Subgroups

KEDA. Dystroxerepts that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. An umbric or mollic epipedon.

Humic Lithic Dystroxerepts

KEDB. Other Dystrocherepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystrocherepts

KEDC. Other Dystrocherepts that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:
 - a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
 - b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - (1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - (2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Dystrocherepts

KEDD. Other Dystrocherepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Dystrocherepts

KEDE. Other Dystrocherepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium

oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Dystrocherepts

KEDF. Other Dystrocherepts that have *both*:

1. Fragile soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions in normal years (or artificial drainage).

Fragiaquic Dystrocherepts

KEDG. Other Dystrocherepts that have a slope of less than 25 percent; *and*

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. *Either*:
 - a. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
 - b. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaquentic Dystrocherepts

KEDH. Other Dystrocherepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Dystrocherepts

KEDI. Other Dystrocherepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Dystrocherepts

KEDJ. Other Dystroxepts that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Dystroxepts

KEDK. Other Dystroxepts that have a slope of less than 25 percent; *and*

1. An umbric or mollic epipedon; *and*
2. *Either*:
 - a. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
 - b. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Humic Dystroxepts

KEDL. Other Dystroxepts that have a slope of less than 25 percent; *and either*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*
2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Dystroxepts

KEDM. Other Dystroxepts that have an umbric or mollic epipedon.

Humic Dystroxepts

KEDN. Other Dystroxepts.

Typic Dystroxepts

Fragixerepts

Key to Subgroups

KECA. Fragixerepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water

retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragixerepts

KECB. Other Fragixerepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Fragixerepts

KECC. Other Fragixerepts that have, in one or more horizons within 30 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Fragixerepts

KECD. Other Fragixerepts that have an umbric or mollic epipedon.

Humic Fragixerepts

KECE. Other Fragixerepts.

Typic Fragixerepts

Haploxerepts

Key to Subgroups

KEEA. Haploxerepts that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. An umbric or mollic epipedon.

Humic Lithic Haploxerepts

KEEB. Other Haploxerepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxerepts

KEEC. Other Haploxerepts that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or

wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haploxerepts

KEED. Other Haploxerepts that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Haploxerepts

KEEE. Other Haploxerepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploxerepts

KEEF. Other Haploxerepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haploxerepts

KEEG. Other Haploxerepts that have a gypsic horizon within 100 cm of the mineral soil surface.

Gypsic Haploxerepts

KEEH. Other Haploxerepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haploxerepts

KEEI. Other Haploxerepts that have lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Haploxerepts

KEEJ. Other Haploxerepts that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Haploxerepts

KEEK. Other Haploxerepts that have a slope of less than 25 percent; *and either*

1. At a depth of 125 cm below the mineral soil surface, an organic-carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; *or*

2. An irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Haploxerepts

KEEL. Other Haploxerepts that have a calcic horizon or identifiable secondary carbonates within *one* of the following particle-size class and depth combinations:

1. A sandy or sandy-skeletal particle-size class and within 150 cm of the mineral soil surface; *or*

2. A clayey, clayey-skeletal, fine, or very-fine particle-size class and within 90 cm of the mineral soil surface; *or*

3. Any other particle-size class and within 110 cm of the mineral soil surface.

Calcic Haploxerepts

KEEM. Other Haploxerepts that have an umbric or mollic epipedon.

Humic Haploxerepts

KEEN. Other Haploxerepts.

Typic Haploxerepts

CHAPTER 12

Mollisols

Key to Suborders

IA. Mollisols that have:

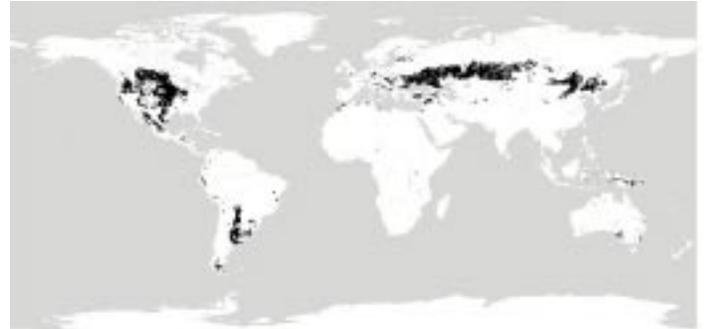
1. An argillic or natric horizon; *and*
2. An albic horizon that has chroma of 2 or less and is 2.5 cm or more thick, has its lower boundary 18 cm or more below the mineral soil surface, and either lies directly below the mollic epipedon or separates horizons that together meet all of the requirements for a mollic epipedon; *and*
3. In one or more subhorizons of the albic horizon and/or of the argillic or natric horizon and within 100 cm of the mineral soil surface, redox concentrations in the form of masses or concretions, or both, and also aquic conditions for some time in normal years (or artificial drainage).

[Albolls](#), p. 192

IB. Other Mollisols that have, in a layer above a densic, lithic, or paralithic contact or in a layer at a depth between 40 and 50 cm from the mineral soil surface, whichever is shallower, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:

1. A histic epipedon overlying the mollic epipedon; *or*
2. An exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio [SAR] of 13 or more) in the upper part of the mollic epipedon and a decrease in ESP (or SAR) values with increasing depth below 50 cm from the mineral soil surface; *or*
3. A calcic or petrocalcic horizon that has its upper boundary within 40 cm of the mineral soil surface; *or*
4. A mollic epipedon, with chroma of 1 or less, that extends to a lithic contact within 30 cm of the mineral soil surface; *or*
5. *One* of the following colors:
 - a. Chroma of 1 or less in the lower part of the mollic epipedon;¹ *and either*
 - (1) Distinct or prominent redox concentrations in the lower part of the mollic epipedon; *or*

¹ If the mollic epipedon extends to a lithic contact within 30 cm of the mineral soil surface, the requirement for redoximorphic features is waived.



(2) Either directly below the mollic epipedon or within 75 cm of the mineral soil surface if a calcic horizon intervenes, a color value, moist, of 4 or more and *one* of the following:

- (a) 50 percent or more chroma of 1 on faces of peds or in the matrix, hue of 10YR or redder, and redox concentrations; *or*
 - (b) 50 percent or more chroma of 2 or less on faces of peds or in the matrix, hue of 2.5Y, and redox concentrations; *or*
 - (c) 50 percent or more chroma of 1 on faces of peds or in the matrix and hue of 2.5Y or yellowier; *or*
 - (d) 50 percent or more chroma of 3 or less on faces of peds or in the matrix, hue of 5Y, and redox concentrations; *or*
 - (e) 50 percent or more chroma of 0 on faces of peds or in the matrix; *or*
 - (f) Hue of 5GY, 5G, 5BG, or 5B; *or*
 - (g) Any color if it results from uncoated sand grains; *or*
- b. Chroma of 2 in the lower part of the mollic epipedon; *and either*
- (1) Distinct or prominent redox concentrations in the lower part of the mollic epipedon; *or*
 - (2) Directly below the mollic epipedon, *one* of the following matrix colors:

- (a) A color value, moist, of 4, chroma of 2, and some redox depletions with a color value, moist, of 4 or more and chroma of 1 or less; *or*
- (b) A color value, moist, of 5 or more, chroma of 2 or less, and redox concentrations; *or*
- (c) A color value, moist, of 4 and chroma of 1 or less; *or*

6. At a depth between 40 and 50 cm from the mineral soil surface, enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

[Aquolls](#), p. 193

IC. Other Mollisols that:

- 1. Have a mollic epipedon less than 50 cm thick; *and*
- 2. Do not have an argillic or calcic horizon; *and*
- 3. Have, either within or directly below the mollic epipedon, mineral soil materials less than 7.5 cm in diameter that have a CaCO₃ equivalent of 40 percent or more; *and*
- 4. Have either or both a udic moisture regime or a cryic soil temperature regime.

[Rendolls](#), p. 200

ID. Other Mollisols that have a cryic soil temperature regime.

[Cryolls](#), p. 197

IE. Other Mollisols that have either a xeric moisture regime or an aridic moisture regime that borders on xeric.

[Xerolls](#), p. 222

IF. Other Mollisols that have either an ustic moisture regime or an aridic moisture regime that borders on ustic.

[Ustolls](#), p. 207

IG. Other Mollisols.

[Udolls](#), p. 201

Albolls

Key to Great Groups

IAA. Albolls that have a natric horizon.

[Natralbolls](#), p. 193

IAB. Other Albolls.

[Argialbolls](#), p. 192

Argialbolls

Key to Subgroups

IABA. Argialbolls that have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. If not irrigated, a moisture control section that in normal years is dry in all parts for 45 or more consecutive days during the 120 days following the summer solstice.

Xerertic Argialbolls

IABB. Other Argialbolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argialbolls

IABC. Other Argialbolls that:

1. Do not have an abrupt textural change from the albic to the argillic horizon; *and*

2. If not irrigated, have a moisture control section that in normal years is dry in all parts for 45 or more consecutive days during the 120 days following the summer solstice.

Argiaquic Xeric Argialbolls

IABD. Other Argialbolls that do not have an abrupt textural change from the albic to the argillic horizon.

Argiaquic Argialbolls

IABE. Other Argialbolls that, if not irrigated, have a moisture control section that in normal years is dry in all parts

for 45 or more consecutive days during the 120 days following the summer solstice.

Xeric Argialbolls

IABF. Other Argialbolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Argialbolls

IABG. Other Argialbolls.

Typic Argialbolls

Natralbolls

Key to Subgroups

IAAA. Natralbolls that have visible crystals of gypsum and/or more soluble salts within 40 cm of the mineral soil surface.

Leptic Natralbolls

IAAB. Other Natralbolls.

Typic Natralbolls

Aquolls

Key to Great Groups

IBA. Aquolls that have a cryic soil temperature regime.
[Cryaquolls](#), p. 194

IBB. Other Aquolls that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.
[Duraquolls](#), p. 194

IBC. Other Aquolls that have a natric horizon.
[Natraquolls](#), p. 197

IBD. Other Aquolls that have a calcic or gypsic horizon that has its upper boundary within 40 cm of the mineral soil surface but do not have an argillic horizon unless it is a buried horizon.
[Calciaquolls](#), p. 194

IBE. Other Aquolls that have an argillic horizon.
[Argiaquolls](#), p. 193

IBF. Other Aquolls that have episaturation.
[Epiaquolls](#), p. 196

IBG. Other Aquolls.
[Endoaquolls](#), p. 195

Argiaquolls

Key to Subgroups

IBEA. Argiaquolls that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Argiaquolls

IBEB. Other Argiaquolls that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Argiaquolls

IBEC. Other Argiaquolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argiaquolls

IBED. Other Argiaquolls that have an argillic horizon that, with increasing depth, has a clay increase of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Argiaquolls

IBEE. Other Argiaquolls.

Typic Argiaquolls

Calciaquolls

Key to Subgroups

IBDA. Calciaquolls that have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calciaquolls

IBDB. Other Calciaquolls that have 50 percent or more chroma of 3 or more on faces of peds or in the matrix of one or more horizons within 75 cm of the mineral soil surface or that have the following colors directly below the mollic epipedon:

1. Hue of 2.5Y or yellower and chroma of 3 or more; *or*
2. Hue of 10YR or redder and chroma of 2 or more; *or*
3. Hue of 2.5Y or yellower and chroma of 2 or more if there are no distinct or prominent redox concentrations.

Aeric Calciaquolls

IBDC. Other Calciaquolls.

Typic Calciaquolls

Cryaquolls

Key to Subgroups

IBAA. Cryaquolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Cryaquolls

IBAB. Other Cryaquolls that have a histic epipedon.

Histic Cryaquolls

IBAC. Other Cryaquolls that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Cryaquolls

IBAD. Other Cryaquolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al

plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Cryaquolls

IBAE. Other Cryaquolls that have an argillic horizon.

Argic Cryaquolls

IBAF. Other Cryaquolls that have a calcic horizon either within or directly below the mollic epipedon.

Calcic Cryaquolls

IBAG. Other Cryaquolls that have a mollic epipedon 50 cm or more thick.

Cumulic Cryaquolls

IBAH. Other Cryaquolls.

Typic Cryaquolls

Duraquolls

Key to Subgroups

IBBA. Duraquolls that have a natric horizon.

Natric Duraquolls

IBBB. Other Duraquolls that have, above the duripan, *one or both* of the following:

1. Cracks that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick; *or*
2. A linear extensibility of 6.0 cm or more.

Vertic Duraquolls

IBBC. Other Duraquolls that have an argillic horizon.

Argic Duraquolls

IBBD. Other Duraquolls.

Typic Duraquolls

Endoquolls

Key to Subgroups

IBGA. Endoquolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Endoquolls

IBGB. Other Endoquolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. A mollic epipedon 60 cm or more thick.

Cumulic Vertic Endoquolls

IBGC. Other Endoquolls that have *both* of the following:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. A slope of less than 25 percent; *and either*
 - a. An organic-carbon content of 0.3 percent or more in all horizons within 125 cm of the mineral soil surface; *or*
 - b. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluvaquentic Vertic Endoquolls

IBGD. Other Endoquolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or

wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Endoquolls

IBGE. Other Endoquolls that have a histic epipedon.

Histic Endoquolls

IBGF. Other Endoquolls that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Endoquolls

IBGG. Other Endoquolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Endoquolls

IBGH. Other Endoquolls that have a horizon, 15 cm or more thick within 100 cm of the mineral soil surface, that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Endoquolls

IBGI. Other Endoquolls that have a mollic epipedon 60 cm or more thick.

Cumulic Endoquolls

IBGJ. Other Endoquolls that have a slope of less than 25 percent; *and either*

1. An organic-carbon content of 0.3 percent or more in all horizons within 125 cm of the mineral soil surface; *or*

2. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a dense, lithic, or paralithic contact if shallower.

Fluvaquentic Endoaquolls

IBGK. Other Endoaquolls.

Typic Endoaquolls

Epiaquolls

Key to Subgroups

IBFA. Epiaquolls that have *both* of the following:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a dense, lithic, or paralithic contact, whichever is shallower; *and*
2. A mollic epipedon 60 cm or more thick.

Cumulic Vertic Epiaquolls

IBFB. Other Epiaquolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a dense, lithic, or paralithic contact, whichever is shallower; *and*
2. A slope of less than 25 percent; *and either*
 - a. An organic-carbon content of 0.3 percent or more in all horizons within 125 cm of the mineral soil surface; *or*
 - b. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a dense, lithic, or paralithic contact if shallower.

Fluvaquentic Vertic Epiaquolls

IBFC. Other Epiaquolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a dense, lithic, or paralithic contact, whichever is shallower.

Vertic Epiaquolls

IBFD. Other Epiaquolls that have a histic epipedon.

Histic Epiaquolls

IBFE. Other Epiaquolls that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Epiaquolls

IBFF. Other Epiaquolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Epiaquolls

IBFG. Other Epiaquolls that have a horizon, 15 cm or more thick within 100 cm of the mineral soil surface, that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Epiaquolls

IBFH. Other Epiaquolls that have a mollic epipedon 60 cm or more thick.

Cumulic Epiaquolls

IBFI. Other Epiaquolls that have a slope of less than 25 percent; *and either*

1. An organic-carbon content of 0.3 percent or more in all horizons within 125 cm of the mineral soil surface; *or*
2. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluvaquentic Epiaquolls

IBFJ. Other Epiaquolls.

Typic Epiaquolls

Natraquolls

Key to Subgroups

IBCA. Natraquolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natraquolls

IBCB. Other Natraquolls.

Typic Natraquolls

Cryolls

Key to Great Groups

IDA. Cryolls that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

[Duricryolls](#), p. 198

IDB. Other Cryolls that have a natric horizon.

[Natricryolls](#), p. 200

IDC. Other Cryolls that have *both*:

1. An argillic horizon that has its upper boundary 60 cm or more below the mineral soil surface; *and*
2. A texture finer than loamy fine sand in all horizons above the argillic horizon.

[Palecryolls](#), p. 200

IDD. Other Cryolls that have an argillic horizon.

[Argicryolls](#), p. 197

IDE. Other Cryolls that:

1. Have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. In all parts above the calcic or petrocalcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, either are calcareous or have a texture of loamy fine sand or coarser.

[Calcicryolls](#), p. 198

IDF. Other Cryolls.

[Haplocryolls](#), p. 198

Argicryolls

Key to Subgroups

IDDA. Argicryolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argicryolls

IDDB. Other Argicryolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argicryolls

IDDC. Other Argicryolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argicryolls

IDDD. Other Argicryolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Argicryolls

IDDE. Other Argicryolls that have an argillic horizon that, with increasing depth, has a clay increase of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Argicryolls

IDDF. Other Argicryolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Argicryolls

IDDG. Other Argicryolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Argicryolls

IDDH. Other Argicryolls that have a mollic epipedon that is 40 cm or more thick and has a texture finer than loamy fine sand.

Pachic Argicryolls

IDDI. Other Argicryolls that have *either*:

1. Above the argillic horizon, an albic horizon or a horizon that has color values too high for a mollic epipedon and chroma too high for an albic horizon; *or*
2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletons of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Alfic Argicryolls

IDDJ. Other Argicryolls that have an ustic moisture regime.

Ustic Argicryolls

IDDK. Other Argicryolls that have a xeric moisture regime.

Xeric Argicryolls

IDDL. Other Argicryolls.

Typic Argicryolls

Calcicryolls

Key to Subgroups

IDEA. Calcicryolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calcicryolls

IDEB. Other Calcicryolls that have a petrocalcic horizon that

has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calcicryolls

IDEC. Other Calcicryolls that have a mollic epipedon that is 40 cm or more thick and has a texture finer than loamy fine sand.

Pachic Calcicryolls

IDED. Other Calcicryolls that have an ustic moisture regime.

Ustic Calcicryolls

IDEE. Other Calcicryolls that have a xeric moisture regime.

Xeric Calcicryolls

IDEF. Other Calcicryolls.

Typic Calcicryolls

Duricryolls

Key to Subgroups

IDAA. Duricryolls that have an argillic horizon.

Argic Duricryolls

IDAB. Other Duricryolls.

Typic Duricryolls

Haplocryolls

Key to Subgroups

IDFA. Haplocryolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplocryolls

IDFB. Other Haplocryolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplocryolls

IDFC. Other Haplocryolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water

retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplocryolls

IDFD. Other Haplocryolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haplocryolls

IDFE. Other Haplocryolls that have:

1. A mollic epipedon that is 40 cm or more thick and has a texture finer than loamy fine sand; *and*
2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A slope of less than 25 percent; *and*
4. In one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Cumulic Haplocryolls

IDFF. Other Haplocryolls that have:

1. A mollic epipedon that is 40 cm or more thick and has a texture finer than loamy fine sand; *and*
2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A slope of less than 25 percent.

Cumulic Haplocryolls

IDFG. Other Haplocryolls that have *both*:

1. A slope of less than 25 percent; *and either*
 - a. An organic-carbon content of 0.3 percent or more at a depth of 125 cm below the mineral soil surface;
 - or*

b. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Fluvaquentic Haplocryolls

IDFH. Other Haplocryolls that have, in one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplocryolls

IDFI. Other Haplocryolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haplocryolls

IDFJ. Other Haplocryolls that have *both*:

1. A mollic epipedon that is 40 cm or more thick and has a texture finer than loamy fine sand; *and*
2. A calcic horizon either within or directly below the mollic epipedon, but no argillic horizon in the lower part of the mollic epipedon.

Calcic Pachic Haplocryolls

IDFK. Other Haplocryolls that have a mollic epipedon that is 40 cm or more thick and has a texture finer than loamy fine sand.

Pachic Haplocryolls

IDFL. Other Haplocryolls that have a slope of less than 25 percent; *and either*

1. An organic-carbon content of 0.3 percent or more at a depth of 125 cm below the mineral soil surface; *or*
2. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluventic Haplocryolls

IDFM. Other Haplocryolls that have a calcic horizon within 100 cm of the mineral soil surface.

Calcic Haplocryolls

IDFN. Other Haplocryolls that have an ustic moisture regime.

Ustic Haplocryolls

IDFO. Other Haplocryolls that have a xeric moisture regime.

Xeric Haplocryolls

IDFP. Other Haplocryolls.

Typic Haplocryolls

Natricryolls

Key to Subgroups

IDBA. All Natricryolls.

Typic Natricryolls

Palecryolls

Key to Subgroups

IDCA. Palecryolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Palecryolls

IDCB. Other Palecryolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Palecryolls

IDCC. Other Palecryolls that have an argillic horizon that, with increasing depth, has a clay increase of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Palecryolls

IDCD. Other Palecryolls that have a mollic epipedon that is 40 cm or more thick and has a texture finer than loamy fine sand.

Pachic Palecryolls

IDCE. Other Palecryolls that have an ustic moisture regime.

Ustic Palecryolls

IDCF. Other Palecryolls that have a xeric moisture regime.

Xeric Palecryolls

IDCG. Other Palecryolls.

Typic Palecryolls

Rendolls

Key to Great Groups

ICA. Rendolls that have a cryic soil temperature regime. [Cryrendolls](#), p. 200

ICB. Other Rendolls.

[Haprendolls](#), p. 200

Cryrendolls

Key to Subgroups

ICAA. Cryrendolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryrendolls

ICAB. Other Cryrendolls.

Typic Cryrendolls

Haprendolls

Key to Subgroups

ICBA. Haprendolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haprendolls

ICBB. Other Haprendolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haprendolls

ICBC. Other Haprendolls that have a cambic horizon.

Inceptic Haprendolls

ICBD. Other Haprendolls that have a color value, dry, of 6 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick.

Entic Haprendolls

ICBE. Other Haprendolls.

Typic Haprendolls

Udolls

Key to Great Groups

IGA. Udolls that have a natric horizon.

[Natrudolls](#), p. 206

IGB. Other Udolls that:

1. Have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*
2. Do not have an argillic horizon above the calcic or petrocalcic horizon; *and*
3. In all parts above the calcic or petrocalcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, either are calcareous or have a texture of loamy fine sand or coarser.

[Calciudolls](#), p. 203

IGC. Other Udolls that have *one or more* of the following:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*
2. *All* of the following:
 - a. No densic, lithic, or paralithic contact within 150 cm of the mineral soil surface; *and*
 - b. Within 150 cm of the mineral soil surface, a clay decrease, with increasing depth, of less than 20 percent (relative) from the maximum clay content (noncarbonate clay); *and*
 - c. An argillic horizon with *one or more* of the following:
 - (1) In 50 percent or more of the matrix of one or more subhorizons in its lower half, hue of 7.5YR or redder and chroma of 5 or more; *or*
 - (2) In 50 percent or more of the matrix of horizons that total more than one-half the total thickness, hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, of 4 or less; *or*
 - (3) Many redox concentrations with hue of 5YR or redder or chroma of 6 or more, or both, in one or more subhorizons; *or*
3. A frigid temperature regime; *and both*
 - a. An argillic horizon that has its upper boundary 60 cm or more below the mineral soil surface; *and*
 - b. A texture finer than loamy fine sand in all horizons above the argillic horizon.

[Paleudolls](#), p. 207

IGD. Other Udolls that have an argillic horizon.

[Argiudolls](#), p. 201

IGE. Other Udolls that have a mollic epipedon that:

1. Either below an Ap horizon or below a depth of 18 cm from the mineral soil surface, contains 50 percent or more (by volume) wormholes, wormcasts, or filled animal burrows; *and*
2. Either rests on a lithic contact or has a transition zone to the underlying horizon in which 25 percent or more of the soil volume consists of discrete wormholes, wormcasts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.

[Vermudolls](#), p. 207

IGF. Other Udolls.

[Hapludolls](#), p. 204

Argiudolls

Key to Subgroups

IGDA. Argiudolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argiudolls

IGDB. Other Argiudolls that have *both*:

1. Aquic conditions for some time in normal years (or artificial drainage) *either*:
 - a. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*
 - b. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:
 - (1) A color value, moist, of 4 or more and redox depletions with chroma of 2 or less; *or*
 - (2) Hue of 10YR or redder and chroma of 2 or less; *or*
 - (3) Hue of 2.5Y or yellower and chroma of 3 or less; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a

densic, lithic, or paralithic contact, whichever is shallower.

Aquertic Argiudolls

IGDC. Other Argiudolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. In normal years saturation with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Oxyaquic Vertic Argiudolls

IGDD. Other Argiudolls that have:

1. A texture finer than loamy fine sand *and either*:
 - a. A frigid temperature regime and a mollic epipedon 40 cm or more thick; *or*
 - b. A mollic epipedon 50 cm or more thick; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Pachic Vertic Argiudolls

IGDE. Other Argiudolls that have:

1. Above the argillic horizon, an albic horizon or a horizon that has color values too high for a mollic epipedon and chroma too high for an albic horizon; *or*
2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletal

clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon; *and*

3. *Either*:

- a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
- b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Alfic Vertic Argiudolls

IGDF. Other Argiudolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argiudolls

IGDG. Other Argiudolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argiudolls

IGDH. Other Argiudolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Argiudolls

IGDI. Other Argiudolls that have aquic conditions for some time in normal years (or artificial drainage) *either*:

1. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*
2. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:
 - a. A color value, moist, of 4 or more and redox depletions with chroma of 2 or less; *or*
 - b. Hue of 10YR or redder and chroma of 2 or less; *or*
 - c. Hue of 2.5Y or yellower and chroma of 3 or less.

Aquic Argiudolls

IGDJ. Other Argiudolls that have a texture finer than loamy fine sand *and either*:

1. A frigid temperature regime and a mollic epipedon 40 cm or more thick; *or*
2. A mollic epipedon 50 cm or more thick.

Pachic Argiudolls

IGDK. Other Argiudolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Argiudolls

IGDL. Other Argiudolls that have an argillic horizon that:

1. Consists entirely of lamellae; *or*
2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*
3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:
 - a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*
 - b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Argiudolls

IGDM. Other Argiudolls that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or

throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Argiudolls

IGDN. Other Argiudolls that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Argiudolls

IGDO. Other Argiudolls that have an argillic horizon that, with increasing depth, has a clay increase of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Argiudolls

IGDP. Other Argiudolls that have:

1. Above the argillic horizon, an albic horizon or a horizon that has color values too high for a mollic epipedon and chroma too high for an albic horizon; *or*
2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletalans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Alfic Argiudolls

IGDQ. Other Argiudolls that have an apparent CEC of less than 24 cmol(+)/kg clay (by 1N NH₄OAc pH 7) in 50 percent or more either of the argillic horizon if less than 100 cm thick or of its upper 100 cm.

Oxic Argiudolls

IGDR. Other Argiudolls that have a calcic horizon within 100 cm of the mineral soil surface.

Calcic Argiudolls

IGDS. Other Argiudolls.

Typic Argiudolls

Calciudolls

Key to Subgroups

IGBA. Calciudolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciudolls

IGBB. Other Calciudolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or

wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Calcudolls

IGBC. Other Calcudolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Calcudolls

IGBD. Other Calcudolls that have a slope of less than 25 percent; *and either:*

1. An organic-carbon content of 0.3 percent or more at a depth of 125 cm below the mineral soil surface; *or*
2. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a lithic or paralithic contact if shallower.

Fluventic Calcudolls

IGBE. Other Calcudolls.

Typic Calcudolls

Hapludolls

Key to Subgroups

IGFA. Hapludolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapludolls

IGFB. Other Hapludolls that have *both:*

1. Aquic conditions for some time in normal years (or artificial drainage) *either:*
 - a. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*
 - b. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:
 - (1) A color value, moist, of 4 or more and redox depletions with chroma of 2 or less; *or*
 - (2) Hue of 10YR or redder and chroma of 2 or less; *or*
 - (3) Hue of 2.5Y or yellower and chroma of 3 or less; *and*
2. *One or both* of the following:

- a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

- b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquertic Hapludolls

IGFC. Other Hapludolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Hapludolls

IGFD. Other Hapludolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Hapludolls

IGFE. Other Hapludolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Hapludolls

IGFF. Other Hapludolls that have:

1. *Either:*

- a. A frigid soil temperature regime and a mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle-size class, and there is no densic or paralithic contact and no sandy or sandy-skeletal particle-size class at a depth between 40 and 50 cm from the mineral soil surface; *or*
 - b. A mollic epipedon 60 cm or more thick, of which 50 percent or more of the thickness has a texture finer than loamy fine sand; *and*
2. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
 3. A slope of 25 percent or less; *and*
 4. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Cumulic Hapludolls

IGFG. Other Hapludolls that have:

1. *Either*:
 - a. A frigid soil temperature regime and a mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle-size class, and there is no densic or paralithic contact and no sandy or sandy-skeletal particle-size class at a depth between 40 and 50 cm from the mineral soil surface; *or*
 - b. A mollic epipedon 60 cm or more thick, of which 50 percent or more of the thickness has a texture finer than loamy fine sand; *and*
2. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A slope of 25 percent or less.

Cumulic Hapludolls

IGFH. Other Hapludolls that have *both*:

1. Aquic conditions for some time in normal years (or artificial drainage) *either*:
 - a. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*
 - b. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

- (1) A color value, moist, of 4 or more and redox depletions with chroma of 2 or less; *or*
- (2) Hue of 10YR or redder and chroma of 2 or less; *or*
- (3) Hue of 2.5Y or yellower and chroma of 3 or less; *and*

2. A slope of less than 25 percent; *and either*

- a. An organic-carbon content of 0.3 percent or more at a depth of 125 cm below the mineral soil surface; *or*
- b. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluvaquentic Hapludolls

IGFI. Other Hapludolls that have aquic conditions for some time in normal years (or artificial drainage) *either*:

1. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*
2. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

- a. A color value, moist, of 4 or more and redox depletions with chroma of 2 or less; *or*
- b. Hue of 10YR or redder and chroma of 2 or less; *or*
- c. Hue of 2.5Y or yellower and chroma of 3 or less.

Aquic Hapludolls

IGFJ. Other Hapludolls that have a texture finer than loamy fine sand *and either*:

1. A frigid temperature regime and a mollic epipedon 40 cm or more thick; *or*
2. A mollic epipedon 50 cm or more thick.

Pachic Hapludolls

IGFK. Other Hapludolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Hapludolls

IGFL. Other Hapludolls that have a slope of less than 25 percent; *and either*

1. An organic-carbon content of 0.3 percent or more at a depth of 125 cm below the mineral soil surface; *or*
2. An irregular decrease in organic-carbon content from a

depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluventic Hapludolls

IGFM. Other Hapludolls that have *both*:

1. A mollic epipedon 60 cm or more thick that has a texture finer than loamy fine sand and contains 50 percent or more (by volume) wormholes, wormcasts, or filled animal burrows either below an Ap horizon or below a depth of 18 cm from the mineral soil surface; *and*

2. Either do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet all of the requirements for a cambic horizon, except for the color requirements, or have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

Vermic Hapludolls

IGFN. Other Hapludolls that have a calcic horizon within 100 cm of the mineral soil surface.

Calcic Hapludolls

IGFO. Other Hapludolls that *either*:

1. Do not have a cambic horizon and do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all of the requirements for a cambic horizon, except for the color requirements; *or*

2. Have free carbonates throughout the cambic horizon or in all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

Entic Hapludolls

IGFP. Other Hapludolls.

Typic Hapludolls

Natrudolls

Key to Subgroups

IGAA. Natrudolls that have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Natrudolls

IGAB. Other Natrudolls that have *both*:

1. Visible crystals of gypsum and/or more soluble salts within 40 cm of the mineral soil surface; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Leptic Vertic Natrudolls

IGAC. Other Natrudolls that have:

1. A glossic horizon or interfingering of albic materials into the natric horizon; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Glossic Vertic Natrudolls

IGAD. Other Natrudolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrudolls

IGAE. Other Natrudolls that have visible crystals of gypsum and/or more soluble salts within 40 cm of the mineral soil surface.

Leptic Natrudolls

IGAF. Other Natrudolls that have a glossic horizon or interfingering of albic materials into the natric horizon.

Glossic Natrudolls

IGAG. Other Natrudolls that have a calcic horizon within 100 cm of the mineral soil surface.

Calcic Natrudolls

IGAH. Other Natrudolls.

Typic Natrudolls

Paleudolls

Key to Subgroups

IGCA. Paleudolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Paleudolls

IGCB. Other Paleudolls that have a petrocalcic horizon within 150 cm of the mineral soil surface.

Petrocalcic Paleudolls

IGCC. Other Paleudolls that have, in one or more subhorizons within the upper 50 cm of the argillic horizon, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Paleudolls

IGCD. Other Paleudolls that have a texture finer than loamy fine sand and a mollic epipedon 50 cm or more thick.

Pachic Paleudolls

IGCE. Other Paleudolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Paleudolls

IGCF. Other Paleudolls that:

1. Have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*
2. In all parts above the calcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, either are calcareous or have a texture of loamy fine sand or coarser.

Calcic Paleudolls

IGCG. Other Paleudolls.

Typic Paleudolls

Vermudolls

Key to Subgroups

IGEA. Vermudolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vermudolls

IGEB. Other Vermudolls that have a mollic epipedon less than 75 cm thick.

Haplic Vermudolls

IGEC. Other Vermudolls.

Typic Vermudolls

Ustolls

Key to Great Groups

IFA. Ustolls that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

[Durustolls](#), p. 212

IFB. Other Ustolls that have a natric horizon.

[Natrustolls](#), p. 217

IFC. Other Ustolls that:

1. Have either a calcic or gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface or a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *and*
2. Do not have an argillic horizon above the calcic, gypsic, or petrocalcic horizon; *and*
3. In all parts above the calcic, gypsic, or petrocalcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, either are calcareous or have a texture of loamy fine sand or coarser.

[Calciustolls](#), p. 211

IFD. Other Ustolls that have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*
2. An argillic horizon that has *one or both* of the following:
 - a. With increasing depth, no clay decrease of 20 percent or more (relative) from the maximum clay content (noncarbonate clay) within 150 cm of the mineral soil surface (and there is no densic, lithic, or paralithic contact within that depth); *and either*

(1) Hue of 7.5YR or redder and chroma of 5 or more in the matrix; *or*

(2) Common redox concentrations with hue of 7.5YR or redder or chroma of 6 or more, or both; *or*

b. 35 percent or more clay in its upper part and a clay increase either of 20 percent or more (absolute) within a vertical distance of 7.5 cm or of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction (and there is no densic, lithic, or paralithic contact within 50 cm of the mineral soil surface).

[Paleustolls](#), p. 220

IFE. Other Ustolls that have an argillic horizon.

[Argiustolls](#), p. 208

IFF. Other Ustolls that have a mollic epipedon that:

1. Either below an Ap horizon or below a depth of 18 cm from the mineral soil surface, contains 50 percent or more (by volume) wormholes, wormcasts, or filled animal burrows; *and*

2. Either rests on a lithic contact or has a transition zone to the underlying horizon in which 25 percent or more of the soil volume consists of discrete wormholes, wormcasts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.

[Vermustolls](#), p. 222

IFG. Other Ustolls.

[Haplustolls](#), p. 213

Argiustolls

Key to Subgroups

IFEA. Argiustolls that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, have *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in

some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

(1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

(2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Lithic Argiustolls

IFEB. Other Argiustolls that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. Above the argillic horizon, either an albic horizon or a horizon that has color values too high for a mollic epipedon and chroma too high for an albic horizon.

Alfic Lithic Argiustolls

IFEC. Other Argiustolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argiustolls

IFED. Other Argiustolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. When neither irrigated nor fallowed to store moisture, have *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

- b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
- c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

- (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
- (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Torrertic Argiustolls

IFEE. Other Argiustolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udertic Argiustolls

IFEF. Other Argiustolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or

more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argiustolls

IFEG. Other Argiustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argiustolls

IFEH. Other Argiustolls that have *both*:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

(1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

(2) [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Argiustolls

IFEI. Other Argiustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Argiustolls

IFEJ. Other Argiustolls that have a texture finer than loamy fine sand *and either*:

1. A frigid temperature regime and a mollic epipedon 40 cm or more thick; *or*
2. A mollic epipedon 50 cm or more thick.

Pachic Argiustolls

IFEK. Other Argiustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Argiustolls

IFEL. Other Argiustolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Argiustolls

IFEM. Other Argiustolls that have *either*:

1. Above the argillic horizon, an albic horizon or a horizon that has color values too high for a mollic epipedon and chroma too high for an albic horizon; *or*
2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletalans of

clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Albic Argiustolls

IFEN. Other Argiustolls that have *both*:

1. A calcic horizon with its upper boundary within 100 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Calcic Argiustolls

IFEO. Other Argiustolls that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - a. Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a

depth of 50 cm below the soil surface is higher than 8 °C;
and

b. Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Argiustolls

IFEP. Other Argiustolls that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Argiustolls

IFEQ. Other Argiustolls that have a brittle horizon that is within 100 cm of the mineral soil surface, is 15 cm or more thick, and has either some opal coatings or 20 percent or more (by volume) durinodes.

Duric Argiustolls

IFER. Other Argiustolls.

Typic Argiustolls

Calciustolls

Key to Subgroups

IFCA. Calciustolls that have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

Salidic Calciustolls

IFCB. Other Calciustolls that have a petrocalcic horizon and a lithic contact within 50 cm of the mineral soil surface.

Lithic Petrocalcic Calciustolls

IFCC. Other Calciustolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciustolls

IFCD. Other Calciustolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or

wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a dense, lithic, or paralithic contact, whichever is shallower; *and*

2. When neither irrigated nor fallowed to store moisture, *one* of the following:

a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

(1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

(2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Torrertic Calciustolls

IFCE. Other Calciustolls that have *both*:

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a dense, lithic, or paralithic contact, whichever is shallower; *and*

2. When neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in

some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udertic Calciustolls

IFCF. Other Calciustolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Calciustolls

IFCG. Other Calciustolls that have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calciustolls

IFCH. Other Calciustolls that have a gypsic horizon with its upper boundary within 100 cm of the mineral soil surface.

Gypsic Calciustolls

IFCI. Other Calciustolls that have a texture finer than loamy fine sand *and either*:

1. A frigid temperature regime and a mollic epipedon 40 cm or more thick; *or*
2. A mollic epipedon 50 cm or more thick.

Pachic Calciustolls

IFCJ. Other Calciustolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Calciustolls

IFCK. Other Calciustolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*

2. 30 or more cumulative days.

Oxyaquic Calciustolls

IFCL. Other Calciustolls that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - a. Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Calciustolls

IFCM. Other Calciustolls that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for four-tenths or less of the consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Calciustolls

IFCN. Other Calciustolls.

Typic Calciustolls

Durustolls

Key to Subgroups

IFAA. Durustolls that have a natric horizon above the duripan.

Natric Durustolls

IFAB. Other Durustolls that:

1. Do not have an argillic horizon above the duripan; *and*
2. Have an aridic moisture regime that borders on ustic.

Haploduridic Durustolls

IFAC. Other Durustolls that have an aridic moisture regime that borders on ustic.

Argiduridic Durustolls

IFAD. Other Durustolls that do not have an argillic horizon above the duripan.

Entic Durustolls

IFAE. Other Durustolls that have a duripan that is strongly cemented or less cemented in all subhorizons.

Haplic Durustolls

IFAF. Other Durustolls.

Typic Durustolls

Haplustolls

Key to Subgroups

IFGA. Haplustolls that have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

Salidic Haplustolls

IFGB. Other Haplustolls that have, in part of each pedon, a lithic contact within 50 cm of the mineral soil surface.

Ruptic-Lithic Haplustolls

IFGC. Other Haplustolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplustolls

IFGD. Other Haplustolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control

section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:

- (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
- (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Torrertic Haplustolls

IFGE. Other Haplustolls that have *all* of the following:

1. A mollic epipedon with a texture finer than loamy fine sand; *and either*
 - a. A frigid temperature regime and a mollic epipedon 40 cm or more thick; *or*
 - b. A mollic epipedon 50 cm or more thick; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
3. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in

normal years is dry in some or all parts for fewer than 120 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Pachic Udertic Haplustolls

IFGF. Other Haplustolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udertic Haplustolls

IFGG. Other Haplustolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplustolls

IFGH. Other Haplustolls that have *both*:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:

a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years remains moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

2. An apparent CEC (by 1N NH₄OAc pH 7) of less than 24 cmol(+)/kg clay in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower. (If the ratio of [percent water retained at 1500 kPa tension minus percent organic carbon] to the percentage of measured clay is 0.6 or more, then the percentage of clay is considered to equal either the measured percentage of clay or three times [percent water retained at 1500 kPa tension minus percent organic carbon], whichever value is higher, but no more than 100.)

Torroxic Haplustolls

IFGL. Other Haplustolls that have an apparent CEC (by 1N NH₄OAc pH 7) of less than 24 cmol(+)/kg clay in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact if shallower. (If the ratio of [percent water retained at 1500 kPa tension minus percent organic carbon] to the percentage of measured clay is 0.6 or more, then the percentage of clay is considered to equal either the measured percentage of clay or three times [percent water retained at 1500 kPa tension minus percent organic carbon], whichever value is higher, but no more than 100.)

Oxic Haplustolls

IFGJ. Other Haplustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplustolls

IFGK. Other Haplustolls that have *both*:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

- a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
- b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - (1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - (2) [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrorrandic Haplustolls

IFGL. Other Haplustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

- a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
- b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haplustolls

IFGM. Other Haplustolls that have:

1. *Either*:
 - a. A frigid soil temperature regime and a mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle-size class, and there is no densic or paralithic contact and no sandy or sandy-skeletal particle-size class at a depth between 40 and 50 cm from the mineral soil surface; *or*
 - b. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand; *and*
2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A slope of less than 25 percent; *and*
4. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Cumulic Haplustolls

IFGN. Other Haplustolls that have:

1. *Either*:
 - a. A frigid soil temperature regime and a mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle-size class, and there is no densic or paralithic contact and no sandy or sandy-skeletal particle-size class at a depth between 40 and 50 cm from the mineral soil surface; *or*
 - b. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand; *and*
2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A slope of less than 25 percent.

Cumulic Haplustolls

IFGO. Other Haplustolls that have anthraquic conditions.

Anthraquic Haplustolls

IFGP. Other Haplustolls that have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A slope of less than 25 percent; *and either*
 - a. An organic-carbon content of 0.3 percent or more at a depth of 125 cm below the mineral soil surface; *or*
 - b. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluvaquentic Haplustolls

IFGQ. Other Haplustolls that have a texture finer than loamy fine sand *and either*:

1. A frigid temperature regime and a mollic epipedon 40 cm or more thick; *or*
2. A mollic epipedon 50 cm or more thick.

Pachic Haplustolls

IFGR. Other Haplustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haplustolls

IFGS. Other Haplustolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haplustolls

IFGT. Other Haplustolls that have *both*:

1. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil

temperature regime and a moisture control section that in normal years:

- (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*
2. A slope of less than 25 percent; *and either*
 - a. An organic-carbon content of 0.3 percent or more at a depth of 125 cm below the mineral soil surface; *or*
 - b. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Torrifluentic Haplustolls

IFGU. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture, have *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *and*
2. *Either*:
 - a. Do not have a cambic horizon and do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all of the requirements for a cambic horizon except color; *or*

- b. Have free carbonates throughout the cambic horizon or in all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

Torriorthentic Haplustolls

IFGV. Other Haplustolls that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - a. Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Haplustolls

IFGW. Other Haplustolls that have a slope of less than 25 percent; *and either*

1. An organic-carbon content of 0.3 percent or more at a depth of 125 cm below the mineral soil surface; *or*
2. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluventic Haplustolls

IFGX. Other Haplustolls that have a brittle horizon that is within 100 cm of the mineral soil surface, is 15 cm or more thick, and has either some opal coatings or 20 percent or more (by volume) durinodes.

Duric Haplustolls

IFGY. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture, have *either*:
 - a. A mesic or thermic soil temperature regime and a

moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*

2. Either do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon, except for the color requirements, or have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

Udorthentic Haplustolls

IFGZ. Other Haplustolls that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Haplustolls

IFGZa. Other Haplustolls that *either*:

1. Do not have a cambic horizon and do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all of the requirements for a cambic horizon except color; *or*
2. Have free carbonates throughout the cambic horizon or in all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

Entic Haplustolls

IFGZb. Other Haplustolls.

Typic Haplustolls

Natrustolls

Key to Subgroups

IFBA. Natrustolls that have *all* of the following:

1. Visible crystals of gypsum and/or more soluble salts within 40 cm of the mineral soil surface; *and*

2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower;
3. When neither irrigated nor fallowed to store moisture, have *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Leptic Torrertic Natrustolls

IFBB. Other Natrustolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. When neither irrigated nor fallowed to store moisture, have *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Torrertic Natrustolls

IFBC. Other Natrustolls that have *both* of the following:

1. Visible crystals of gypsum and/or more soluble salts within 40 cm of the mineral soil surface; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Leptic Vertic Natrustolls

IFBD. Other Natrustolls that have *both*:

1. A glossic horizon or interfingering of albic materials into a natric horizon; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or

more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Glossic Vertic Natrustolls

IFBE. Other Natrustolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrustolls

IFBF. Other Natrustolls that have *both*:

1. Visible crystals of gypsum or of more soluble salts, or both, within 40 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, have *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil

temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Leptic Natrustolls

IFBG. Other Natrustolls that have visible crystals of gypsum or of more soluble salts, or both, within 40 cm of the mineral soil surface.

Leptic Natrustolls

IFBH. Other Natrustolls that have, in one or more horizons at a depth between 50 and 100 cm from the mineral soil surface, aquic conditions for some time in normal years (or artificial drainage) and *one* of the following:

1. 50 percent or more chroma of 1 or less and hue of 2.5Y or yellow; *or*
2. 50 percent or more chroma of 2 or less and redox concentrations; *or*
3. 50 percent or more chroma of 2 or less and also a higher exchangeable sodium percentage (or sodium adsorption ratio) between the mineral soil surface and a depth of 25 cm than in the underlying horizon.

Aquic Natrustolls

IFBI. Other Natrustolls that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - a. Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Natrustolls

IFBJ. Other Natrustolls that have a horizon, 15 cm or more thick within 100 cm of the mineral soil surface, that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Natrustolls

IFBK. Other Natrustolls that have a glossic horizon or interfingering of albic materials into a natric horizon.

Glossic Natrustolls

IFBL. Other Natrustolls.

Typic Natrustolls

Paleustolls

Key to Subgroups

IFDA. Paleustolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. When neither irrigated nor fallowed to store moisture, *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for less than four-tenths of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil

temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Torrertic Paleustolls

IFDB. Other Paleustolls that have *both*:

1. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*
2. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udertic Paleustolls

IFDC. Other Paleustolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Paleustolls

IFDD. Other Paleustolls that have a texture finer than loamy fine sand and a mollic epipedon 50 cm or more thick.

Pachic Paleustolls

IFDE. Other Paleustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions

with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Paleustolls

IFDF. Other Paleustolls that have a petrocalcic horizon within 150 cm of the mineral soil surface.

Petrocalcic Paleustolls

IFDG. Other Paleustolls that:

1. Have a calcic horizon within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:
 - a. Sandy or sandy-skeletal and within 100 cm of the mineral soil surface; *or*
 - b. Clayey, clayey-skeletal, fine, or very-fine and within 50 cm of the mineral soil surface; *or*
 - c. Any other class and within 60 cm of the mineral soil surface; *and*
2. When neither irrigated nor fallowed to store moisture, have *one* of the following:
 - a. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for less than four-tenths of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - c. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - (1) Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - (2) Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Calcic Paleustolls

IFDH. Other Paleustolls that, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid temperature regime and a moisture control section that in normal years is dry in all parts for less than four-tenths of the cumulative days per year when the soil

temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*

2. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
3. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - a. Is moist in some or all parts for fewer than 90 consecutive days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some or all parts for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Paleustolls

IFDI. Other Paleustolls that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for four-tenths or less of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Paleustolls

IFDJ. Other Paleustolls have a calcic horizon within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

1. Sandy or sandy-skeletal and within 100 cm of the mineral soil surface; *or*
2. Clayey, clayey-skeletal, fine, or very-fine and within 50 cm of the mineral soil surface; *or*
3. Any other class and within 60 cm of the mineral soil surface.

Calcic Paleustolls

IFDK. Other Paleustolls that are calcareous throughout after the surface soil has been mixed to a depth of 18 cm.

Entic Paleustolls

IFDL. Other Paleustolls.

Typic Paleustolls

Vermustolls

Key to Subgroups

IFFA. Vermustolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vermustolls

IFFB. Other Vermustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Vermustolls

IFFC. Other Vermustolls that have a mollic epipedon 75 cm or more thick.

Pachic Vermustolls

IFFD. Other Vermustolls that have a mollic epipedon less than 50 cm thick.

Entic Vermustolls

IFFE. Other Vermustolls.

Typic Vermustolls

Xerolls

Key to Great Groups

IEA. Xerolls that have a duripan within 100 cm of the mineral soil surface.

[Durixerolls](#), p. 225

IEB. Other Xerolls that have a natric horizon.

[Natrixerolls](#), p. 230

IEC. Other Xerolls that have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*
2. An argillic horizon that has *one or both* of the following:
 - a. With increasing depth, no clay decrease of 20 percent or more (relative) from the maximum clay content (noncarbonate clay) within 150 cm of the mineral soil surface (and there is no densic, lithic, or paralithic contact within that depth); *and either*
 - (1) Hue of 7.5YR or redder and chroma of 5 or more in the matrix; *or*
 - (2) Common redox concentrations with hue

of 7.5YR or redder or chroma of 6 or more, or both; *or*

b. A clayey or clayey-skeletal particle-size class in its upper part and, at its upper boundary, a clay increase either of 20 percent or more (absolute) within a vertical distance of 7.5 cm or of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction (and there is no densic, lithic, or paralithic contact within 50 cm of the mineral soil surface).

[Palexerolls](#), p. 230

IED. Other Xerolls that:

1. Have a calcic or gypsic horizon that has its upper boundary within 150 cm of the mineral soil surface; *and*
2. In all parts above the calcic or gypsic horizon, after the surface soil has been mixed to a depth of 18 cm, either are calcareous or have a texture of loamy fine sand or coarser.

[Calcixerolls](#), p. 224

IEE. Other Xerolls that have an argillic horizon.

[Argixerolls](#), p. 222

IEF. Other Xerolls.

[Haploxerolls](#), p. 226

Argixerolls

Key to Subgroups

IEEA. Argixerolls that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either the mineral soil surface or an Ap horizon, whichever is deeper, and the lithic contact.

Lithic Ultic Argixerolls

IEEB. Other Argixerolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argixerolls

IEEC. Other Argixerolls that have *both*:

1. An aridic moisture regime; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

- b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Argixerolls

IEED. Other Argixerolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argixerolls

IEEE. Other Argixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argixerolls

IEEF. Other Argixerolls that have *both*:

1. An aridic moisture regime; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - (1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - (2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Argixerolls

IEEG. Other Argixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*

a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*

b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Argixerolls

IEEH. Other Argixerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquultic Argixerolls

IEEL. Other Argixerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Argixerolls

IEEJ. Other Argixerolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Argixerolls

IEEK. Other Argixerolls that have *either*:

1. Above the argillic horizon, an albic horizon or a horizon that has color values too high for a mollic epipedon and chroma too high for an albic horizon; *or*
2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletal of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Alfic Argixerolls

IEEL. Other Argixerolls that have *both*:

1. A calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

- a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*
 - b. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; *or*
 - c. Any other class and within 110 cm of the mineral soil surface; *and*
2. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand.

Calcic Pachic Argixerolls

IEEM. Other Argixerolls that have *both*:

1. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand; *and*
2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Pachic Ultic Argixerolls

IEEN. Other Argixerolls that have a mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand.

Pachic Argixerolls

IEEO. Other Argixerolls that have *both*:

1. An aridic moisture regime; *and*
2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Argiduridic Argixerolls

IEEP. Other Argixerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Argixerolls

IEEQ. Other Argixerolls that have *both*:

1. An aridic moisture regime; *and*
2. A calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:
 - a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*
 - b. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; *or*

- c. Any other class and within 110 cm of the mineral soil surface.

Calciargidic Argixerolls

IEER. Other Argixerolls that have an aridic moisture regime.

Aridic Argixerolls

IEES. Other Argixerolls that have a calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

1. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*
2. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; *or*
3. Any other class and within 110 cm of the mineral soil surface.

Calcic Argixerolls

IEET. Other Argixerolls that have a base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Ultic Argixerolls

IEEU. Other Argixerolls.

Typic Argixerolls

Calcixerolls

Key to Subgroups

IEDA. Calcixerolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calcixerolls

IEDB. Other Calcixerolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Calcixerolls

IEDC. Other Calcixerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Calcixerolls

IEDD. Other Calcixerolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Calcixerolls

IEDE. Other Calcixerolls that have a mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand.

Pachic Calcixerolls

IEDF. Other Calcixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, of which 5 percent or more is volcanic glass, and [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Calcixerolls

IEDG. Other Calcixerolls that have an aridic moisture regime.

Aridic Calcixerolls

IEDH. Other Calcixerolls that have a mollic epipedon that has, below any Ap horizon, 50 percent or more (by volume) wormholes, wormcasts, or filled animal burrows.

Vermic Calcixerolls

IEDI. Other Calcixerolls.

Typic Calcixerolls

Durixerolls

Key to Subgroups

IEAA. Durixerolls that have, above the duripan, *one or both* of the following:

1. Cracks that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and

slickensides or wedge-shaped aggregates in a layer 15 cm or more thick; *or*

2. A linear extensibility of 6.0 cm or more.

Vertic Durixerolls

IEAB. Other Durixerolls that have *both*:

1. An aridic moisture regime; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - (1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - (2) [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Durixerolls

IEAC. Other Durixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandid Durixerolls

IEAD. Other Durixerolls that have, in one or more horizons above the duripan, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Durixerolls

IEAE. Other Durixerolls that have:

1. An aridic moisture regime; *and*
2. An argillic horizon that, with increasing depth, has a clay increase either of 20 percent or more (absolute) within

a vertical distance of 7.5 cm or of 15 percent or more (absolute) within a vertical distance of 2.5 cm; *and*

3. A duripan that is neither very strongly cemented nor indurated in any subhorizon.

Paleargidic Durixerolls

IEAF. Other Durixerolls that have *both*:

1. An aridic moisture regime; *and*
2. An argillic horizon that, with increasing depth, has a clay increase either of 20 percent or more (absolute) within a vertical distance of 7.5 cm or of 15 percent or more (absolute) within a vertical distance of 2.5 cm.

Abruptic Argiduridic Durixerolls

IEAG. Other Durixerolls that:

1. Have an aridic moisture regime; *and*
2. Do not have an argillic horizon above the duripan; *and*
3. Have a duripan that is neither very strongly cemented nor indurated in any subhorizon.

Cambidic Durixerolls

IEAH. Other Durixerolls that:

1. Have an aridic moisture regime; *and*
2. Do not have an argillic horizon above the duripan.

Haploduridic Durixerolls

IEAI. Other Durixerolls that have:

1. An aridic moisture regime; *and*
2. A duripan that is neither very strongly cemented nor indurated in any subhorizon.

Argidic Durixerolls

IEAJ. Other Durixerolls that have an aridic moisture regime.

Argiduridic Durixerolls

IEAK. Other Durixerolls that have *both*:

1. An argillic horizon that, with increasing depth, has a clay increase either of 20 percent or more (absolute) within a vertical distance of 7.5 cm or of 15 percent or more (absolute) within a vertical distance of 2.5 cm; *and*
2. A duripan that is neither very strongly cemented nor indurated in any subhorizon.

Haplic Palexerollic Durixerolls

IEAL. Other Durixerolls that have an argillic horizon that, with increasing depth, has a clay increase either of 20 percent

or more (absolute) within a vertical distance of 7.5 cm or of 15 percent or more (absolute) within a vertical distance of 2.5 cm.

Palexerollic Durixerolls

IEAM. Other Durixerolls that:

1. Have a duripan that is neither very strongly cemented nor indurated in any subhorizon; *and*
2. Do not have an argillic horizon above the duripan.

Haplic Haploxerollic Durixerolls

IEAN. Other Durixerolls that do not have an argillic horizon above the duripan.

Haploxerollic Durixerolls

IEAO. Other Durixerolls that have a duripan that is neither very strongly cemented nor indurated in any subhorizon.

Haplic Durixerolls

IEAP. Other Durixerolls.

Typic Durixerolls

Haploxerolls

Key to Subgroups

IEFA. Haploxerolls that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either the mineral soil surface or an Ap horizon, whichever is deeper, and the lithic contact.

Lithic Ultic Haploxerolls

IEFB. Other Haploxerolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxerolls

IEFC. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*
2. *One or both* of the following:
 - a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
 - b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a

densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Haploxerolls

IEFD. Other Haploxerolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haploxerolls

IEFE. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:
 - a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - (1) In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - (2) [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrorrandic Haploxerolls

IEFF. Other Haploxerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haploxerolls

IEFG. Other Haploxerolls that have:

1. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand; *and*
2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A slope of less than 25 percent; *and*
4. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Cumulic Haploxerolls

IEFH. Other Haploxerolls that have:

1. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand; *and*
2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A slope of less than 25 percent; *and*
4. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Cumulic Ultic Haploxerolls

IEFI. Other Haploxerolls that have:

1. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand; *and*
2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower; *and*
3. A slope of less than 25 percent.

Cumulic Haploxerolls

IEFJ. Other Haploxerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A slope of less than 25 percent; *and either*
 - a. An organic-carbon content of 0.3 percent or more in all horizons within 125 cm of the mineral soil surface; *or*

- b. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluvaquentic Haploxerolls

IEFK. Other Haploxerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A horizon, 15 cm or more thick within 100 cm of the mineral soil surface, that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Aquic Duric Haploxerolls

IEFL. Other Haploxerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquultic Haploxerolls

IEFM. Other Haploxerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haploxerolls

IEFN. Other Haploxerolls that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haploxerolls

IEFO. Other Haploxerolls that have *both*:

1. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand; *and*
2. A calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:
 - a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*

- b. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; *or*

- c. Any other class and within 110 cm of the mineral soil surface.

Calcic Pachic Haploxerolls

IEFP. Other Haploxerolls that have *both*:

1. A mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand; *and*
2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Pachic Ultic Haploxerolls

IEFQ. Other Haploxerolls that have a mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand.

Pachic Haploxerolls

IEFR. Other Haploxerolls that have:

1. An aridic moisture regime; *and*
2. A slope of less than 25 percent; *and either*
 - a. An organic-carbon content of 0.3 percent or more in all horizons within 125 cm of the mineral soil surface; *or*
 - b. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Torrifluventic Haploxerolls

IEFS. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*
2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duridic Haploxerolls

IEFT. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*
2. A calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:
 - a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*

- b. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; *or*
- c. Any other class and within 110 cm of the mineral soil surface.

Calcic Haploxerolls

IEFU. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*
2. A sandy particle-size class in all horizons within 100 cm of the mineral soil surface.

Torrripsammentic Haploxerolls

IEFV. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*
2. *Either*:
 - a. Do not have a cambic horizon and do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all of the requirements for a cambic horizon except color; *or*
 - b. Have free carbonates throughout the cambic horizon or in all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

Torriorthetic Haploxerolls

IEFW. Other Haploxerolls that have an aridic moisture regime.

Aridic Haploxerolls

IEFX. Other Haploxerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Haploxerolls

IEFY. Other Haploxerolls that have a sandy particle-size class in all horizons within 100 cm of the mineral soil surface.

Psammentic Haploxerolls

IEFZ. Other Haploxerolls that have a slope of less than 25 percent; *and either*

1. An organic-carbon content of 0.3 percent or more in all horizons within 125 cm of the mineral soil surface; *or*
2. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluventic Haploxerolls

IEFZa. Other Haploxerolls that have a mollic epipedon that has granular structure and that has, below any Ap horizon, 50 percent or more (by volume) wormholes, wormcasts, or filled animal burrows.

Vermic Haploxerolls

IEFZb. Other Haploxerolls that have a calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

1. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*
2. Clayey, clayey-skeletal, fine, or very-fine and within 90 cm of the mineral soil surface; *or*
3. Any other class and within 110 cm of the mineral soil surface.

Calcic Haploxerolls

IEFZc. Other Haploxerolls that:

1. Do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet all of the requirements for a cambic horizon except color; *and*
2. Have a base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Entic Ultic Haploxerolls

IEFZd. Other Haploxerolls that have a base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Ultic Haploxerolls

IEFZe. Other Haploxerolls that *either*:

1. Do not have a cambic horizon and do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all of the requirements for a cambic horizon except color; *or*
2. Have free carbonates throughout the cambic horizon or in all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

Entic Haploxerolls

IEFZf. Other Haploxerolls.

Typic Haploxerolls

Natrixerolls

Key to Subgroups

IEBA. Natrixerolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrixerolls

IEBB. Other Natrixerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. A horizon, 15 cm or more thick within 100 cm of the mineral soil surface, that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Aquic Duric Natrixerolls

IEBC. Other Natrixerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Natrixerolls

IEBD. Other Natrixerolls that have an aridic moisture regime.

Aridic Natrixerolls

IEBE. Other Natrixerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Natrixerolls

IEBF. Other Natrixerolls.

Typic Natrixerolls

Palexerolls

Key to Subgroups

IECA. Palexerolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Palexerolls

IECB. Other Palexerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus $\frac{1}{2}$ Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Palexerolls

IECC. Other Palexerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Palexerolls

IECD. Other Palexerolls that have a mollic epipedon that is 50 cm or more thick and has a texture finer than loamy fine sand.

Pachic Palexerolls

IECE. Other Palexerolls that have *both*:

1. An aridic moisture regime; *and*
2. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Palexerolls

IECF. Other Palexerolls that have a horizon, 15 cm or more thick within 100 cm of the mineral soil surface, that either has 20 percent or more (by volume) durinodes or is brittle and has a firm rupture-resistance class when moist.

Duric Palexerolls

IECG. Other Palexerolls that have an aridic moisture regime.

Aridic Palexerolls

IECH. Other Palexerolls that have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Palexerolls

IECI. Other Palexerolls that have a base saturation of 75 percent or less in one or more subhorizons either within the

argillic horizon if more than 50 cm thick or within its upper 50 cm.

Ultic Palexerolls

IECJ. Other Palexerolls that have an argillic horizon that has *either*:

1. Less than 35 percent clay in the upper part; *or*
2. At its upper boundary, a clay increase that is both less than 20 percent (absolute) within a vertical distance of 7.5 cm and less than 15 percent (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.

Haplic Palexerolls

IECK. Other Palexerolls.

Typic Palexerolls

CHAPTER 13

Oxisols¹

Key to Suborders

EA. Oxisols that have aquic conditions for some time in normal years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface and have *one or more* of the following:

1. A histic epipedon; *or*
2. An epipedon with a color value, moist, of 3 or less and, directly below it, a horizon with chroma of 2 or less; *or*
3. Distinct or prominent redox concentrations within 50 cm of the mineral soil surface, an epipedon, and, directly below it, a horizon with *one or both* of the following:
 - a. 50 percent or more hue of 2.5Y or yellower; *or*
 - b. Chroma of 3 or less; *or*
4. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

[Aquox](#), p. 233

EB. Other Oxisols that have an aridic moisture regime.

[Torrox](#), p. 238

EC. Other Oxisols that have an ustic or xeric moisture regime.

[Ustox](#), p. 243

ED. Other Oxisols that have a perudic moisture regime.

[Perox](#), p. 234

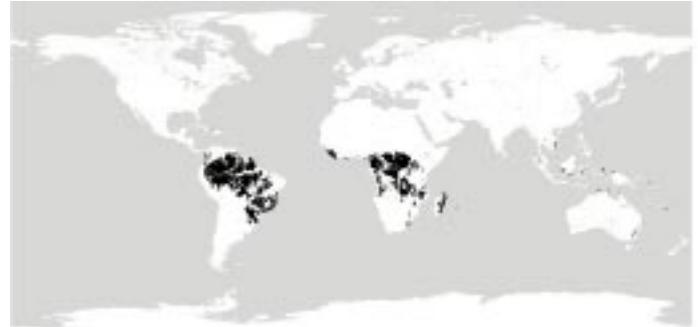
EE. Other Oxisols.

[Udox](#), p. 239

Aquox

Key to Great Groups

EAAA. Aquox that have, in one or more subhorizons of an oxic or kandic horizon within 150 cm of the mineral



soil surface, an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (in 1N KCl) of 5.0 or more.

[Acraquox](#), p. 233

EAB. Other Aquox that have plinthite forming a continuous phase within 125 cm of the mineral soil surface.

[Plinthaquox](#), p. 234

EAC. Other Aquox that have a base saturation (by NH₄OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

[Eutraquox](#), p. 234

EAD. Other Aquox.

[Haplaquox](#), p. 234

Acraquox

Key to Subgroups

EAAA. Acraquox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acraquox

EAAB. Other Acraquox that have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Acraquox

EAAC. Other Acraquox.

Typic Acraquox

¹ This chapter was rewritten in 1987 following recommendations of the International Committee on the Classification of Oxisols (ICOMOX), chaired by Hari Eswaran from 1978 to 1981 and then by S.W. Buol until completion of the task in 1987.

Eutraquox

Key to Subgroups

EACA. Eutraquox that have a histic epipedon.

Histic Eutraquox

EACB. Other Eutraquox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eutraquox

EACC. Other Eutraquox that have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Eutraquox

EACD. Other Eutraquox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eutraquox

EACE. Other Eutraquox.

Typic Eutraquox

Haplaquox

Key to Subgroups

EADA. Haplaquox that have a histic epipedon.

Histic Haplaquox

EADB. Other Haplaquox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Haplaquox

EADC. Other Haplaquox that have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Haplaquox

EADD. Other Haplaquox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Haplaquox

EADE. Other Haplaquox.

Typic Haplaquox

Plinthaquox

Key to Subgroups

EABA. Plinthaquox that have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Plinthaquox

EABB. Other Plinthaquox.

Typic Plinthaquox

Perox

Key to Great Groups

EDA. Perox that have a sombric horizon within 150 cm of the mineral soil surface.

[Sombriperox](#), p. 238

EDB. Other Perox that have, in one or more subhorizons of an oxic or kandic horizon within 150 cm of the mineral soil surface, an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more.

[Acroperox](#), p. 234

EDC. Other Perox that have a base saturation (by NH₄OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

[Europerox](#), p. 235

EDD. Other Perox that have a kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

[Kandiperox](#), p. 237

EDE. Other Perox.

[Haploperox](#), p. 236

Acroperox

Key to Subgroups

EDBA. Acroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Acroperox

EDBB. Other Acroperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Acroperox

EDBC. Other Acroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Acroperox

EDBD. Other Acruperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Acruperox

EDBE. Other Acruperox that have a delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick within 125 cm of the mineral soil surface.

Anionic Acruperox

EDBF. Other Acruperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acruperox

EDBG. Other Acruperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Acruperox

EDBH. Other Acruperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Acruperox

EDBI. Other Acruperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Acruperox

EDBJ. Other Acruperox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Acruperox

EDBK. Other Acruperox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Acruperox

EDBL. Other Acruperox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Acruperox

EDBM. Other Acruperox.

Typic Acruperox

Eutroperox

Key to Subgroups

EDCA. Eutroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Eutroperox

EDCB. Other Eutroperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Eutroperox

EDCC. Other Eutroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Eutroperox

EDCD. Other Eutroperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Eutroperox

EDCE. Other Eutroperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Eutroperox

EDCF. Other Eutroperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eutroperox

EDCG. Other Eutroperox that have, in one or more horizons

within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Eutroperox

EDCH. Other Eutroperox that have a kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Kandiudalfic Eutroperox

EDCI. Other Eutroperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. An oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Humic Inceptic Eutroperox

EDCJ. Other Eutroperox that have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Eutroperox

EDCK. Other Eutroperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Eutroperox

EDCL. Other Eutroperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Eutroperox

EDCM. Other Eutroperox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eutroperox

EDCN. Other Eutroperox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*

2. A value, moist, of 3 or less.

Rhodic Eutroperox

EDCO. Other Eutroperox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Eutroperox

EDCP. Other Eutroperox.

Typic Eutroperox

Haploperox

Key to Subgroups

EDEA. Haploperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferic Haploperox

EDEB. Other Haploperox that have a petroferic contact within 125 cm of the mineral soil surface.

Petroferic Haploperox

EDEC. Other Haploperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Haploperox

EDED. Other Haploperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Haploperox

EDEE. Other Haploperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthic Haploperox

EDEF. Other Haploperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Haploperox

EDEG. Other Haploperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haploperox

EDEH. Other Haploperox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploperox

EDEI. Other Haploperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Haploperox

EDEJ. Other Haploperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Haploperox

EDEK. Other Haploperox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Haploperox

EDEL. Other Haploperox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Haploperox

EDEM. Other Haploperox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Haploperox

EDEN. Other Haploperox.

Typic Haploperox

Kandiperox

Key to Subgroups

EDDA. Kandiperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Kandiperox

EDDB. Other Kandiperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Kandiperox

EDDC. Other Kandiperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Kandiperox

EDDD. Other Kandiperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Kandiperox

EDDE. Other Kandiperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Kandiperox

EDDF. Other Kandiperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Kandiperox

EDDG. Other Kandiperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Kandiperox

EDDH. Other Kandiperox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiperox

EDDI. Other Kandiperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Kandiperox

EDDJ. Other Kandiperox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Kandiperox

EDDK. Other Kandiperox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Kandiperox

EDDL. Other Kandiperox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Kandiperox

EDDM. Other Kandiperox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Kandiperox

EDDN. Other Kandiperox.

Typic Kandiperox

Sombriperox

Key to Subgroups

EDAA. Sombriperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Sombriperox

EDAB. Other Sombriperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Sombriperox

EDAC. Other Sombriperox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Sombriperox

EDAD. Other Sombriperox.

Typic Sombriperox

Torrox

Key to Great Groups

EBA. Torrox that have, in one or more subhorizons of an oxic or kandic horizon within 150 cm of the mineral soil surface, an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more.

[Acrotorrox](#), p. 238

EBB. Other Torrox that have a base saturation (by NH₄OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

[Eutrotorrox](#), p. 239

EBC. Other Torrox.

[Haplotorrox](#), p. 239

Acrotorrox

Key to Subgroups

EBAA. Acrotorrox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Acrotorrox

EBAB. Other Acrotorrox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Acrotorrox

EBAC. Other Acrotorrox.

Typic Acrotorrox

Eutrotorrox

Key to Subgroups

EBBA. Eutrotorrox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Eutrotorrox

EBBB. Other Eutrotorrox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Eutrotorrox

EBBC. Other Eutrotorrox.

Typic Eutrotorrox

Haplotorrox

Key to Subgroups

EBCA. Haplotorrox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Haplotorrox

EBCB. Other Haplotorrox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Haplotorrox

EBCC. Other Haplotorrox.

Typic Haplotorrox

Udox

Key to Great Groups

EEA. Udox that have a sombric horizon within 150 cm of the mineral soil surface.

[Sombriudox](#), p. 243

EEB. Other Udox that have, in one or more subhorizons of an oxic or kandic horizon within 150 cm of the mineral soil surface, an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more.

[Acrudox](#), p. 239

EEC. Other Udox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

[Eutrudox](#), p. 240

EED. Other Udox that have a kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

[Kandiudox](#), p. 242

EEE. Other Udox.

[Hapludox](#), p. 241

Acrudox

Key to Subgroups

EEBA. Acrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Acrudox

EEBB. Other Acrudox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Acrudox

EEBC. Other Acrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Acrudox

EEBD. Other Acrudox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Acrudox

EEBE. Other Acrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Anionic Aquic Acrudox

EEBF. Other Acrudox that have a delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick within 125 cm of the mineral soil surface.

Anionic Acrudox

EEBG. Other Acrudox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acrudox

EEBH. Other Acrudox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less

and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Acrudox

EEBI. Other Acrudox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutric Acrudox

EEBJ. Other Acrudox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Acrudox

EEBK. Other Acrudox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Acrudox

EEBL. Other Acrudox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Acrudox

EEBM. Other Acrudox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Acrudox

EEBN. Other Acrudox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Acrudox

EEBO. Other Acrudox.

Typic Acrudox

Eutrudox

Key to Subgroups

EECA. Eutrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Eutrudox

EECB. Other Eutrudox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Eutrudox

EECC. Other Eutrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Eutrudox

EECD. Other Eutrudox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Eutrudox

EECE. Other Eutrudox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthic Eutrudox

EECF. Other Eutrudox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eutrudox

EECG. Other Eutrudox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Eutrudox

EECH. Other Eutrudox that have a kandic horizon that

has its upper boundary within 150 cm of the mineral soil surface.

Kandiudalfic Eutradox

EECI. Other Eutradox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. An oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Humic Inceptic Eutradox

EECJ. Other Eutradox that have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Eutradox

EECK. Other Eutradox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Eutradox

EECL. Other Eutradox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Eutradox

EECM. Other Eutradox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eutradox

EECN. Other Eutradox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Eutradox

EECO. Other Eutradox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Eutradox

EECP. Other Eutradox.

Typic Eutradox

Hapludox

Key to Subgroups

EEEA. Hapludox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Hapludox

EEEB. Other Hapludox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Hapludox

EEEC. Other Hapludox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Hapludox

EEED. Other Hapludox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Hapludox

EEEE. Other Hapludox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Hapludox

EEEF. Other Hapludox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Hapludox

EEEG. Other Hapludox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Hapludox

EEEH. Other Hapludox that have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Hapludox

EEEE. Other Hapludox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Hapludox

EEEEJ. Other Hapludox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Hapludox

EEEEK. Other Hapludox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Hapludox

EEEL. Other Hapludox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Hapludox

EEEM. Other Hapludox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Hapludox

EEEN. Other Hapludox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Hapludox

EEEEO. Other Hapludox.

Typic Hapludox

Kandiudox

Key to Subgroups

EEDA. Kandiudox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Kandiudox

EEDB. Other Kandiudox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Kandiudox

EEDC. Other Kandiudox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Kandiudox

EEDD. Other Kandiudox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Kandiudox

EEDE. Other Kandiudox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Kandiudox

EEDF. Other Kandiudox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Kandiudox

EEDG. Other Kandiudox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Kandiudox

EEDH. Other Kandiudox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm

of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiudox

EEDI. Other Kandiudox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Kandiudox

EEDJ. Other Kandiudox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Kandiudox

EEDK. Other Kandiudox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Kandiudox

EEDL. Other Kandiudox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Kandiudox

EEDM. Other Kandiudox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Kandiudox

EEDN. Other Kandiudox.

Typic Kandiudox

Sombriudox

Key to Subgroups

EEAA. Sombriudox that have a petroferic contact within 125 cm of the mineral soil surface.

Petroferic Sombriudox

EEAB. Other Sombriudox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Sombriudox

EEAC. Other Sombriudox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Sombriudox

EEAD. Other Sombriudox.

Typic Sombriudox

Ustox

Key to Great Groups

ECA. Ustox that have a sombric horizon within 150 cm of the mineral soil surface.

[Sombriustox](#), p. 247

ECB. Other Ustox that have, in one or more subhorizons of an oxic or kandic horizon within 150 cm of the mineral soil surface, an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more.

[Acrustox](#), p. 243

ECC. Other Ustox that have a base saturation (by NH₄OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

[Eustrustox](#), p. 244

ECD. Other Ustox that have a kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

[Kandiustox](#), p. 246

ECE. Other Ustox.

[Haplustox](#), p. 245

Acrustox

Key to Subgroups

ECBA. Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferic Acrustox

ECBB. Other Acrustox that have a petroferic contact within 125 cm of the mineral soil surface.

Petroferic Acrustox

ECBC. Other Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Acrustox

ECBD. Other Acrustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Acrustox

ECBE. Other Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Anionic Aquic Acrustox

ECBF. Other Acrustox that have a delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick within 125 cm of the mineral soil surface.

Anionic Acrustox

ECBG. Other Acrustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acrustox

ECBH. Other Acrustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Acrustox

ECBI. Other Acrustox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutric Acrustox

ECBJ. Other Acrustox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*

- b. A value, moist, of 3 or less.

Humic Rhodic Acrustox

ECBK. Other Acrustox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Acrustox

ECBL. Other Acrustox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Acrustox

ECBM. Other Acrustox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Acrustox

ECBN. Other Acrustox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Acrustox

ECBO. Other Acrustox.

Typic Acrustox

Eustrustox

Key to Subgroups

ECCA. Eustrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Eustrustox

ECCB. Other Eustrustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Eustrustox

ECCC. Other Eustrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more

and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Eustrtox

ECCD. Other Eustrtox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Eustrtox

ECCE. Other Eustrtox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Eustrtox

ECCF. Other Eustrtox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eustrtox

ECCG. Other Eustrtox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Eustrtox

ECCH. Other Eustrtox that have a kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Kandiustalfic Eustrtox

ECCI. Other Eustrtox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. An oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Humic Inceptic Eustrtox

ECCJ. Other Eustrtox that have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Eustrtox

ECCK. Other Eustrtox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*

- b. A value, moist, of 3 or less.

Humic Rhodic Eustrtox

ECCL. Other Eustrtox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Eustrtox

ECCM. Other Eustrtox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eustrtox

ECCN. Other Eustrtox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Eustrtox

ECCO. Other Eustrtox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Eustrtox

ECCP. Other Eustrtox.

Typic Eustrtox

Haplustox

Key to Subgroups

ECEA. Haplustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Haplustox

ECEB. Other Haplustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Haplustox

ECEC. Other Haplustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more

and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Haplustox

ECED. Other Haplustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Haplustox

ECEE. Other Haplustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Haplustox

ECEF. Other Haplustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Haplustox

ECEG. Other Haplustox that have, within 125 cm of the mineral soil surface, *both*:

1. The lower boundary of the oxic horizon; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aqueptic Haplustox

ECEH. Other Haplustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplustox

ECEI. Other Haplustox that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haplustox

ECEJ. Other Haplustox that have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Haplustox

ECEK. Other Haplustox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

- a. Hue of 2.5YR or redder; *and*
- b. A value, moist, of 3 or less.

Humic Rhodic Haplustox

ECEL. Other Haplustox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Haplustox

ECEN. Other Haplustox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Haplustox

ECEN. Other Haplustox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Haplustox

ECEO. Other Haplustox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Haplustox

ECEP. Other Haplustox.

Typic Haplustox

Kandiustox

Key to Subgroups

ECDA. Kandiustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Petroferric Kandiustox

ECDB. Other Kandiustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Kandiustox

ECDC. Other Kandiuustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Lithic Kandiuustox

ECDD. Other Kandiuustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Kandiuustox

ECDE. Other Kandiuustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. 5 percent or more (by volume) plinthite; *and*
2. Redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Kandiuustox

ECDF. Other Kandiuustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Kandiuustox

ECDG. Other Kandiuustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Kandiuustox

ECDH. Other Kandiuustox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. In all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less.

Humic Rhodic Kandiuustox

ECDI. Other Kandiuustox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*
2. 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Kandiuustox

ECDJ. Other Kandiuustox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Kandiuustox

ECDK. Other Kandiuustox that have, in all horizons at a depth between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less.

Rhodic Kandiuustox

ECDL. Other Kandiuustox that have 50 percent or more hue of 7.5YR or yellower and a color value, moist, of 6 or more at a depth between 25 and 125 cm from the mineral soil surface.

Xanthic Kandiuustox

ECDM. Other Kandiuustox.

Typic Kandiuustox

Sombriustox

Key to Subgroups

ECAA. Sombriustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Sombriustox

ECAB. Other Sombriustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Sombriustox

ECAC. Other Sombriustox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Sombriustox

ECAD. Other Sombriustox.

Typic Sombriustox

CHAPTER 14

Spodosols¹

Key to Suborders

CA. Spodosols that have aquic conditions for some time in normal years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface and have *one or both* of the following:

1. A histic epipedon; *or*
2. Within 50 cm of the mineral soil surface, redoximorphic features in an albic or a spodic horizon. [Aquods](#), p. 249

CB. Other Spodosols that have a cryic soil temperature regime. [Cryods](#), p. 251

CC. Other Spodosols that have 6.0 percent or more organic carbon in a layer 10 cm or more thick within the spodic horizon. [Humods](#), p. 253

CD. Other Spodosols. [Orthods](#), p. 254

Aquods

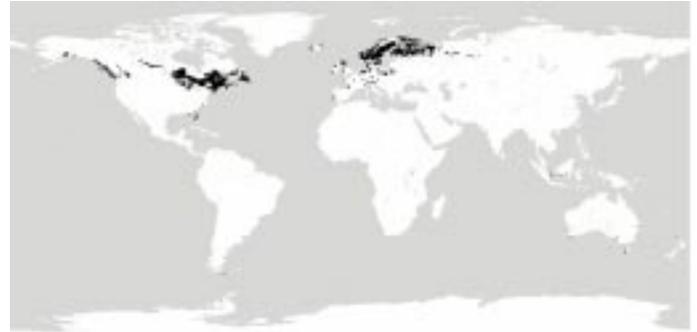
Key to Great Groups

CAA. Aquods that have a cryic soil temperature regime. [Cryaquods](#), p. 250

CAB. Other Aquods that have less than 0.10 percent iron (by ammonium oxalate) in 75 percent or more of the spodic horizon. [Alaquods](#), p. 249

CAC. Other Aquods that have a fragipan with its upper boundary within 100 cm of the mineral soil surface. [Fragiaquods](#), p. 251

CAD. Other Aquods that have a placic horizon within 100



cm of the mineral soil surface in 50 percent or more of each pedon. [Placaquods](#), p. 251

CAE. Other Aquods that have, in 90 percent or more of each pedon, a cemented soil layer that has its upper boundary within 100 cm of the mineral soil surface. [Duraquods](#), p. 250

CAF. Other Aquods that have episaturation. [Epiaquods](#), p. 251

CAG. Other Aquods. [Endoaquods](#), p. 251

Alaquods

Key to Subgroups

CABA. Alaquods that have a lithic contact within 50 cm of the mineral soil surface. **Lithic Alaquods**

CABB. Other Alaquods that have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air drying and has its upper boundary within 100 cm of the mineral soil surface. **Duric Alaquods**

CABC. Other Alaquods that have a histic epipedon. **Histic Alaquods**

CABD. Other Alaquods that have *both*:

¹ This chapter was rewritten in 1992 following recommendations of the International Committee on the Classification of Spodosols (ICOMOD), chaired initially by F. Ted Miller, then by Robert V. Rourke (since 1986).

1. Within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part; *and*
2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 75 to 125 cm.

Alfic Arenic Alaquods

CABE. Other Alaquods that have *both*:

1. An argillic or kandic horizon within 200 cm of the mineral soil surface; *and*
2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 75 to 125 cm.

Arenic Ultic Alaquods

CABF. Other Alaquods that have *both*:

1. An umbric epipedon; *and*
2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 75 cm or more.

Arenic Umbric Alaquods

CABG. Other Alaquods that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 75 to 125 cm.

Arenic Alaquods

CABH. Other Alaquods that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 125 cm or more.

Grossarenic Alaquods

CABI. Other Alaquods that have, within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Alaquods

CABJ. Other Alaquods that have an argillic or kandic horizon within 200 cm of the mineral soil surface.

Ultic Alaquods

CABK. Other Alaquods that have an ochric epipedon.

Aeric Alaquods

CABL. Other Alaquods.

Typic Alaquods**Cryaquods****Key to Subgroups**

CAAA. Cryaquods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryaquods

CAAB. Other Cryaquods that have a placic horizon within 100 cm of the mineral soil surface in 50 percent or more of each pedon.

Placic Cryaquods

CAAC. Other Cryaquods that have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air drying and has its upper boundary within 100 cm of the mineral soil surface.

Duric Cryaquods

CAAD. Other Cryaquods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Cryaquods

CAAE. Other Cryaquods that have a spodic horizon less than 10 cm thick in 50 percent or more of each pedon.

Entic Cryaquods

CAAF. Other Cryaquods.

Typic Cryaquods**Duraquods****Key to Subgroups**

CAEA. Duraquods that have a histic epipedon.

Histic Duraquods

CAEB. Other Duraquods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Duraquods

CAEC. Other Duraquods.

Typic Duraquods

Endoaquods

Key to Subgroups

CAGA. Endoaquods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Endoaquods

CAGB. Other Endoaquods that have a histic epipedon.

Histic Endoaquods

CAGC. Other Endoaquods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Endoaquods

CAGD. Other Endoaquods that have an argillic or kandic horizon within 200 cm of the mineral soil surface.

Argic Endoaquods

CAGE. Other Endoaquods that have an umbric epipedon.

Umbric Endoaquods

CAGF. Other Endoaquods.

Typic Endoaquods

Epiaquods

Key to Subgroups

CAFA. Epiaquods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Epiaquods

CAFB. Other Epiaquods that have a histic epipedon.

Histic Epiaquods

CAFC. Other Epiaquods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Epiaquods

CAFD. Other Epiaquods that have, within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Epiaquods

CAFE. Other Epiaquods that have an argillic or kandic horizon within 200 cm of the mineral soil surface.

Ultic Epiaquods

CAFF. Other Epiaquods that have an umbric epipedon.

Umbric Epiaquods

CAFG. Other Epiaquods.

Typic Epiaquods

Fragiaquods

Key to Subgroups

CACA. Fragiaquods that have a histic epipedon.

Histic Fragiaquods

CACB. Other Fragiaquods that have a surface horizon 30 cm or more thick that meets all of the requirements for a plaggén epipedon except thickness.

Plaggenhaptic Fragiaquods

CACC. Other Fragiaquods that have an argillic or kandic horizon within 200 cm of the mineral soil surface.

Argic Fragiaquods

CACD. Other Fragiaquods.

Typic Fragiaquods

Placaquods

Key to Subgroups

CADA. Placaquods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Placaquods

CADB. Other Placaquods.

Typic Placaquods

Cryods

Key to Great Groups

CBA. Cryods that have a placic horizon within 100 cm of the mineral soil surface in 50 percent or more of each pedon. [Placocryods](#), p. 253

CBB. Other Cryods that have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after

air drying and has its upper boundary within 100 cm of the mineral soil surface.

[Duricryods](#), p. 252

CBC. Other Cryods that have 6.0 percent or more organic carbon throughout a layer 10 cm or more thick within the spodic horizon.

[Humicryods](#), p. 252

CBD. Other Cryods.

[Haplocryods](#), p. 252

Duricryods

Key to Subgroups

CBBA. Duricryods that have *both*:

1. Redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Aquandic Duricryods

CBBB. Other Duricryods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Duricryods

CBBC. Other Duricryods that have redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Duricryods

CBBD. Other Duricryods that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Duricryods

CBBE. Other Duricryods that have 6.0 percent or more organic carbon throughout a layer 10 cm or more thick within the spodic horizon.

Humic Duricryods

CBBF. Other Duricryods.

Typic Duricryods

Haplocryods

Key to Subgroups

CBDA. Haplocryods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplocryods

CBDB. Other Haplocryods that have *both*:

1. Redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Aquandic Haplocryods

CBDC. Other Haplocryods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Haplocryods

CBDD. Other Haplocryods that have redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplocryods

CBDE. Other Haplocryods that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haplocryods

CBDF. Other Haplocryods that have 1.1 percent or less organic carbon in the upper 10 cm of the spodic horizon.

Entic Haplocryods

CBDG. Other Haplocryods.

Typic Haplocryods

Humicryods

Key to Subgroups

CBCA. Humicryods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Humicryods

CBCB. Other Humicryods that have *both*:

1. Redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Aquandic Humicryods

CBCC. Other Humicryods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Humicryods

CBCD. Other Humicryods that have redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Humicryods

CBCE. Other Humicryods that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Humicryods

CBCF. Other Humicryods.

Typic Humicryods

Placocryods

Key to Subgroups

CBAA. Placocryods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Placocryods

CBAB. Other Placocryods that have 6.0 percent or more organic carbon in a layer 10 cm or more thick within the spodic horizon.

Humic Placocryods

CBAC. Other Placocryods.

Typic Placocryods

Humods

Key to Great Groups

CCA. Humods that have a placic horizon within 100 cm of the mineral soil surface in 50 percent or more of each pedon.

[Placohumods](#), p. 254

CCB. Other Humods that have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air drying and has its upper boundary within 100 cm of the mineral soil surface.

[Durihumods](#), p. 253

CCC. Other Humods that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

[Fragihumods](#), p. 253

CCD. Other Humods.

[Haplohumods](#), p. 253

Durihumods

Key to Subgroups

CCBA. Durihumods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Durihumods

CCBB. Other Durihumods.

Typic Durihumods

Fragihumods

Key to Subgroups

CCCA. All Fragihumods (provisionally).

Typic Fragihumods

Haplohumods

Key to Subgroups

CCDA. Haplohumods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplohumods

CCDB. Other Haplohumods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the

top of an organic layer with andic soil properties, whichever is shallower.

Andic Haplohumods

CCDC. Other Haplohumods that have a surface horizon 30 cm or more thick that meets all of the requirements for a plaggen epipedon except thickness.

Plagganthreptic Haplohumods

CCDD. Other Haplohumods.

Typic Haplohumods

Placohumods

Key to Subgroups

CCAA. Placohumods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Placohumods

CCAB. Other Placohumods.

Typic Placohumods

Orthods

Key to Great Groups

CDA. Orthods that have, in 50 percent or more of each pedon, a placic horizon within 100 cm of the mineral soil surface.

[Placorthods](#), p. 257

CDB. Other Orthods that have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air drying and has its upper boundary within 100 cm of the mineral soil surface.

[Durorthods](#), p. 255

CDC. Other Orthods that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

[Fragiorthods](#), p. 255

CDD. Other Orthods that have less than 0.10 percent iron (by ammonium oxalate) in 75 percent or more of the spodic horizon.

[Alorthods](#), p. 254

CDE. Other Orthods.

[Haplorthods](#), p. 255

Alorthods

Key to Subgroups

CDDA. Alorthods that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Alorthods

CDDB. Other Alorthods that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 75 to 125 cm; *and*
2. An argillic or kandic horizon below the spodic horizon.

Arenic Ultic Alorthods

CDDC. Other Alorthods that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 75 to 125 cm.

Arenic Alorthods

CDDD. Other Alorthods that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 125 cm or more; *and*
2. In 10 percent or more of each pedon, less than 3.0 percent organic carbon in the upper 2 cm of the spodic horizon.

Entic Grossarenic Alorthods

CDDE. Other Alorthods that have, in 10 percent or more of each pedon, less than 3.0 percent organic carbon in the upper 2 cm of the spodic horizon.

Entic Alorthods

CDDF. Other Alorthods that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a spodic horizon at a depth of 125 cm or more.

Grossarenic Alorthods

CDDG. Other Alorthods that have a surface horizon 30 cm or more thick that meets all of the requirements for a plaggen epipedon except thickness.

Plagganthreptic Alorthods

CDDH. Other Alorthods that have, within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Alorthods

CDDI. Other Alorthods that have an argillic or kandic horizon within 200 cm of the mineral soil surface.

Ultic Alorthods

CDDJ. Other Alorthods.

Typic Alorthods

Durorthods

Key to Subgroups

CDBA. Durorthods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Durorthods

CDBB. Other Durorthods.

Typic Durorthods

Fragiorthods

Key to Subgroups

CDCA. Fragiorthods that have redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Fragiorthods

CDCB. Other Fragiorthods that:

1. Are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

- a. 20 or more consecutive days; *or*
- b. 30 or more cumulative days; *and*

2. Have, within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Oxyaquic Fragiorthods

CDCC. Other Fragiorthods that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*

2. 30 or more cumulative days.

Oxyaquic Fragiorthods

CDCD. Other Fragiorthods that have a surface horizon 30 cm or more thick that meets all of the requirements for a plaggen epipedon except thickness.

Plagganthreptic Fragiorthods

CDCE. Other Fragiorthods that have, within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Fragiorthods

CDCF. Other Fragiorthods that have an argillic or kandic horizon within 200 cm of the mineral soil surface.

Ultic Fragiorthods

CDCG. Other Fragiorthods that have a spodic horizon that has *one* of the following:

1. A texture of very fine sand, loamy very fine sand, or finer; *and*
 - a. A thickness of 10 cm or less; *and*
 - b. A weighted average of less than 1.2 percent organic carbon; *and*
 - c. Within the upper 7.5 cm, *either or both* a moist color value or chroma of 4 or more (crushed and smoothed sample); *or*
2. A texture of loamy fine sand, fine sand, or coarser and *either or both* a moist color value or chroma of 4 or more (crushed and smoothed sample) in the upper 2.5 cm.

Entic Fragiorthods

CDCH. Other Fragiorthods.

Typic Fragiorthods

Haplorthods

Key to Subgroups

CDEA. Haplorthods that have a lithic contact within 50 cm of the mineral soil surface; *and either*

1. A spodic horizon with a texture of very fine sand, loamy very fine sand, or finer; *and*
 - a. A thickness of 10 cm or less; *and*
 - b. A weighted average of less than 1.2 percent organic carbon; *and*
 - c. Within the upper 7.5 cm, *either or both* a moist color value or chroma of 4 or more (crushed and smoothed sample); *or*

2. A spodic horizon with a texture of loamy fine sand, fine sand, or coarser and *either or both* a moist color value or chroma of 4 or more (crushed and smoothed sample) in the upper 2.5 cm.

Entic Lithic Haplorthods

CDEB. Other Haplorthods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplorthods

CDEC. Other Haplorthods that have *both*:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. Redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage).

Fragiaquic Haplorthods

CDED. Other Haplorthods that have *both*:

1. Redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Aqualfic Haplorthods

CDEE. Other Haplorthods that have redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage); *and either*

1. A spodic horizon with a texture of very fine sand, loamy very fine sand, or finer; *and*
 - a. A thickness of 10 cm or less; *and*
 - b. A weighted average of less than 1.2 percent organic carbon; *and*
 - c. Within the upper 7.5 cm, *either or both* a moist color value or chroma of 4 or more (crushed and smoothed sample); *or*
2. A spodic horizon with a texture of loamy fine sand, fine sand, or coarser and *either or both* a moist color value or

chroma of 4 or more (crushed and smoothed sample) in the upper 2.5 cm.

Aquentic Haplorthods

CDEF. Other Haplorthods that have redoximorphic features in one or more horizons within 75 cm of the mineral soil surface and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplorthods

CDEG. Other Haplorthods that have:

1. Within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part; *and*
2. Saturation with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Alfic Oxyaquic Haplorthods

CDEH. Other Haplorthods that have:

1. Within 200 cm of the mineral soil surface, an argillic or kandic horizon; *and*
2. Saturation with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Oxyaquic Ultic Haplorthods

CDEI. Other Haplorthods that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Haplorthods

CDEJ. Other Haplorthods that, below the spodic horizon but not below an argillic horizon, have lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Haplorthods

CDEK. Other Haplorthods that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haplorthods

CDEL. Other Haplorthods that have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Haplorthods

CDEM. Other Haplorthods that have, within 200 cm of the mineral soil surface, an argillic or kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Haplorthods

CDEN. Other Haplorthods that have an argillic or kandic horizon within 200 cm of the mineral soil surface.

Ultic Haplorthods

CDEO. Other Haplorthods that have a spodic horizon that has *one* of the following:

1. A texture of very fine sand, loamy very fine sand, or finer; *and*

- a. A thickness of 10 cm or less; *and*
- b. A weighted average of less than 1.2 percent organic carbon; *and*
- c. Within the upper 7.5 cm, *either or both* a moist color value or chroma of 4 or more (crushed and smoothed sample); *or*

2. A texture of loamy fine sand, fine sand, or coarser and *either or both* a moist color value or chroma of 4 or more (crushed and smoothed sample) in the upper 2.5 cm.

Entic Haplorthods

CDEP. Other Haplorthods.

Typic Haplorthods

Placorthods

Key to Subgroups

CDAA. All Placorthods (provisionally).

Typic Placorthods

CHAPTER 15

Ultisols

Key to Suborders

HA. Ultisols that have aquic conditions for some time in normal years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface and *one or both* of the following:

1. Redoximorphic features in all layers between either the lower boundary of an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 40 cm and *one* of the following within the upper 12.5 cm of the argillic or kandic horizon:
 - a. Redox concentrations and 50 percent or more redox depletions with chroma of 2 or less either on faces of peds or in the matrix; *or*
 - b. 50 percent or more redox depletions with chroma of 1 or less either on faces of peds or in the matrix; *or*
 - c. Distinct or prominent redox concentrations and 50 percent or more hue of 2.5Y or 5Y in the matrix and also a thermic, isothermic, or warmer soil temperature regime; *or*
2. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

[Aquults](#), p. 259

HB. Other Ultisols that have *one or both* of the following:

1. 0.9 percent (by weighted average) or more organic carbon in the upper 15 cm of the argillic or kandic horizon; *or*
2. 12 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

[Humults](#), p. 263

HC. Other Ultisols that have a udic moisture regime.

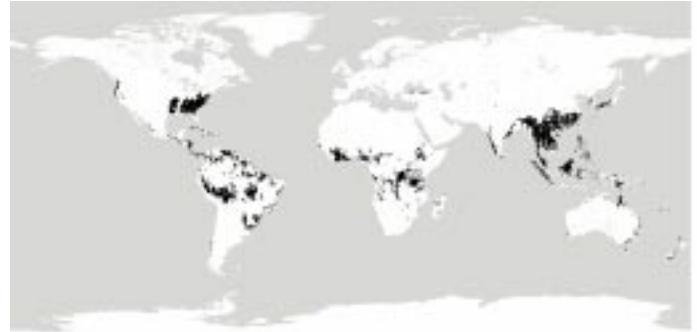
[Udults](#), p. 266

HD. Other Ultisols that have an ustic moisture regime.

[Ustults](#), p. 274

HE. Other Ultisols.

[Xerults](#), p. 278



Aquults

Key to Great Groups

HAA. Aquults that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one-half or more of the volume.

[Plinthaquults](#), p. 263

HAB. Other Aquults that have a fragipan with an upper boundary within 100 cm of the mineral soil surface.

[Fragiaquults](#), p. 261

HAC. Other Aquults that have an abrupt textural change between the ochric epipedon or albic horizon and the argillic or kandic horizon *and* have 0.4 cm/hr or slower (low or very low) saturated hydraulic conductivity in the argillic or kandic horizon.

[Albaquults](#), p. 260

HAD. Other Aquults that:

1. Do not have a densic, lithic, paralithic, or petroferic contact within 150 cm of the mineral soil surface; *and*
2. Have a kandic horizon; *and*
3. Within 150 cm of the mineral soil surface, *either*:
 - a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
 - b. Have 5 percent or more (by volume) clay depletions

on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Kandiaquults](#), p. 261

HAE. Other Aquults that have a kandic horizon.

[Kanhaplaquults](#), p. 262

HAF. Other Aquults that:

1. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*
2. Within 150 cm of the mineral soil surface, *either*:
 - a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
 - b. Have 5 percent or more (by volume) clay depletions on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Pleaquults](#), p. 262

HAG. Other Aquults that have an umbric or mollic epipedon.

[Umbraquults](#), p. 263

HAH. Other Aquults that have episaturation.

[Epiquults](#), p. 260

HAI. Other Aquults.

[Endoquults](#), p. 260

Albaquults

Key to Subgroups

HACA. Albaquults that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Albaquults

HACB. Other Albaquults that have a kandic horizon.

Kandic Albaquults

HACC. Other Albaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either

the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Albaquults

HACD. Other Albaquults.

Typic Albaquults

Endoquults

Key to Subgroups

HAIA. Endoquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Endoquults

HAIB. Other Endoquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Endoquults

HAIC. Other Endoquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Endoquults

HAID. Other Endoquults.

Typic Endoquults

Epiquults

Key to Subgroups

HAHA. Epiquults that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Epiquults

HAHB. Other Epiquults that have:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Fragic Epiaquults

HAHC. Other Epiaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Epiaquults

HAHD. Other Epiaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Epiaquults

HAHE. Other Epiaquults that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Epiaquults

HAHF. Other Epiaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Epiaquults

HAHG. Other Epiaquults.

Typic Epiaquults

Fragiaquults

Key to Subgroups

HABA. Fragiaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and the fragipan.

Aeric Fragiaquults

HABB. Other Fragiaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Fragiaquults

HABC. Other Fragiaquults that have a mollic or umbric epipedon.

Umbric Fragiaquults

HABD. Other Fragiaquults.

Typic Fragiaquults

Kandiaquults

Key to Subgroups

HADA. Kandiaquults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH₄OAc pH 7, plus 1N KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acraquoxic Kandiaquults

HADB. Other Kandiaquults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm; *and*

2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kandiaquults

HADC. Other Kandiaquults that:

1. Have a mollic or umbric epipedon; *and*

2. Have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm.

Arenic Umbric Kandiaquults

HADD. Other Kandiaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm.

Arenic Kandiaquults

HADE. Other Kandiaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 100 cm or more.

Grossarenic Kandiaquults

HADF. Other Kandiaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiaquults

HADG. Other Kandiaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either

the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Kandiaquults

HADH. Other Kandiaquults that have a mollic or umbric epipedon.

Umbric Kandiaquults

HADI. Other Kandiaquults.

Typic Kandiaquults

Kanhaplaquults

Key to Subgroups

HAEA. Kanhaplaquults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
3. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - a. In the 0.02 to 2.0 mm fraction, 5 percent or more volcanic glass; *and*
 - b. [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Kanhaplaquults

HAEB. Other Kanhaplaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kanhaplaquults

HAEC. Other Kanhaplaquults that:

1. Have a mollic or umbric epipedon; *and*
2. Have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Umbric Kanhaplaquults

HAED. Other Kanhaplaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either

the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Kanhaplaquults

HAEE. Other Kanhaplaquults that have a mollic or umbric epipedon.

Umbric Kanhaplaquults

HAEF. Other Kanhaplaquults.

Typic Kanhaplaquults

Paleaquults

Key to Subgroups

HAFA. Paleaquults that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Paleaquults

HAFB. Other Paleaquults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Paleaquults

H AFC. Other Paleaquults that:

1. Have a mollic or umbric epipedon; *and*
2. Have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Umbric Paleaquults

HAFD. Other Paleaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleaquults

HAFE. Other Paleaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the

mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleaquults

HAFF. Other Paleaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleaquults

HAFG. Other Paleaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Paleaquults

HAFH. Other Paleaquults that have a mollic or umbric epipedon.

Umbric Paleaquults

HAFI. Other Paleaquults.

Typic Paleaquults

Plinthaquults

Key to Subgroups

HAAA. Plinthaquults that have a kandic horizon or a CEC (by 1N NH₄OAc pH 7) of less than 24 cmol(+)/kg clay in 50 percent or more (by volume) of the argillic horizon if less than 100 cm thick or of its upper 100 cm.

Kandic Plinthaquults

HAAB. Other Plinthaquults.

Typic Plinthaquults

Umbraquults

Key to Subgroups

HAGA. Umbraquults that have 5 to 50 percent (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Umbraquults

HAGB. Other Umbraquults.

Typic Umbraquults

Humults

Key to Great Groups

HBA. Humults that have a sombric horizon within 100 cm of the mineral soil surface.

[Sombrihumults](#), p. 266

HBB. Other Humults that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one-half or more of the volume.

[Plinthohumults](#), p. 266

HBC. Other Humults that:

1. Do not have a densic, lithic, paralithic, or petroferic contact within 150 cm of the mineral soil surface; *and*
2. Have a kandic horizon; *and*
3. Within 150 cm of the mineral soil surface, *either*:
 - a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
 - b. Have 5 percent or more (by volume) clay depletions on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Kandihumults](#), p. 264

HBD. Other Humults that have a kandic horizon.

[Kanhaplohumults](#), p. 265

HBE. Other Humults that:

1. Do not have a densic, lithic, paralithic, or petroferic contact within 150 cm of the mineral soil surface; *and*
2. Within 150 cm of the mineral soil surface, *either*:
 - a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
 - b. Have 5 percent or more (by volume) clay depletions on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Palehumults](#), p. 265

HBF. Other Humults.

[Haplohumults](#), p. 263

Haplohumults

Key to Subgroups

HBFA. Haplohumults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplohumults

HBFB. Other Haplohumults that have *both*:

1. In one or more subhorizons within the upper 25 cm of

the argillic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Aquandic Haplohumults

HBFC. Other Haplohumults that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplohumults

HBFD. Other Haplohumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplohumults

HBFE. Other Haplohumults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Haplohumults

HBFF. Other Haplohumults that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Haplohumults

HBFG. Other Haplohumults that have an ustic moisture regime.

Ustic Haplohumults

HBFH. Other Haplohumults that have a xeric moisture regime.

Xeric Haplohumults

HBFI. Other Haplohumults.

Typic Haplohumults

Kandihumults

Key to Subgroups

HBCA. Kandihumults that meet *all* of the following:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, have a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *and*
2. In one or more horizons within 75 cm of the mineral soil surface, have redox concentrations, a color value, moist, of 4 or more, and hue that is 10YR or yellower and becomes redder with increasing depth within 100 cm of the mineral soil surface; *and*
3. In normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Andic Ombroaquic Kandihumults

HBCB. Other Kandihumults that have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *and*
2. An ustic moisture regime.

Ustandic Kandihumults

HBCB. Other Kandihumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandihumults

HBCD. Other Kandihumults that have, in one or more subhorizons within the upper 25 cm of the kandic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Kandihumults

HBCE. Other Kandihumults that:

1. Have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and hue that is 10YR or yellower and becomes redder with increasing depth within 100 cm of the mineral soil surface; *and*
2. In normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Ombroaquic Kandihumults

HBCF. Other Kandihumults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandihumults

HBCG. Other Kandihumults that have an ustic moisture regime.

Ustic Kandihumults

HBCH. Other Kandihumults that have a xeric moisture regime.

Xeric Kandihumults

HBCI. Other Kandihumults that have an anthropic epipedon.

Anthropic Kandihumults

HBCJ. Other Kandihumults.

Typic Kandihumults

Kanhaplohumults

Key to Subgroups

HBDA. Kanhaplohumults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplohumults

HBDB. Other Kanhaplohumults that have *both*:

1. An ustic moisture regime; *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Ustancic Kanhaplohumults

HBDC. Other Kanhaplohumults that have, throughout one or more horizons with a total thickness of 18 cm or more within

75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kanhaplohumults

HBDD. Other Kanhaplohumults that have, in one or more subhorizons within the upper 25 cm of the kandic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Kanhaplohumults

HBDE. Other Kanhaplohumults that:

1. Have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and hue that is 10YR or yellower and becomes redder with increasing depth within 100 cm of the mineral soil surface; *and*
2. In normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Ombroaquic Kanhaplohumults

HBDG. Other Kanhaplohumults that have an ustic moisture regime.

Ustic Kanhaplohumults

HBDG. Other Kanhaplohumults that have a xeric moisture regime.

Xeric Kanhaplohumults

HBDH. Other Kanhaplohumults that have an anthropic epipedon.

Anthropic Kanhaplohumults

HBDI. Other Kanhaplohumults.

Typic Kanhaplohumults

Palehumults

Key to Subgroups

HBEA. Palehumults that have *both*:

1. In one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Aquandic Palehumults

HBEB. Other Palehumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Palehumults

HBEC. Other Palehumults that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Palehumults

HBED. Other Palehumults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Palehumults

HBEE. Other Palehumults that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Palehumults

HBEF. Other Palehumults that have an ustic moisture regime.

Ustic Palehumults

HBEG. Other Palehumults that have a xeric moisture regime.

Xeric Palehumults

HBEH. Other Palehumults.

Typic Palehumults

Plinthohumults

Key to Subgroups

HBBA. All Plinthohumults.

Typic Plinthohumults

Sombrihumults

Key to Subgroups

HBAA. All Sombrihumults.

Typic Sombrihumults

Udults

Key to Great Groups

HCA. Udults that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one-half or more of the volume. [Plinthudults](#), p. 274

HCB. Other Udults that have a fragipan with an upper boundary within 100 cm of the mineral soil surface.

[Fragiudults](#), p. 267

HCC. Other Udults that:

1. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*
2. Have a kandic horizon; *and*
3. Within 150 cm of the mineral soil surface, *either*:
 - a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
 - b. Have 5 percent or more (by volume) clay depletions on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Kandiudults](#), p. 269

HCD. Other Udults that have a kandic horizon.

[Kanhapludults](#), p. 271

HCE. Other Udults that:

1. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*
2. Within 150 cm of the mineral soil surface, *either*:
 - a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
 - b. Have 5 percent or more (by volume) clay depletions on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Paleudults](#), p. 272

HCF. Other Udults that have *both*:

1. An epipedon that has a color value, moist, of 3 or less throughout; *and*
2. In all subhorizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 100 cm thick, more than 50 percent colors that have *all* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less; *and*
 - c. A dry value no more than 1 unit higher than the moist value.

[Rhodudults](#), p. 274

HCG. Other Udults.

[Hapludults](#), p. 267

Fragiudults

Key to Subgroups

HCBA. Fragiudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 to 100 cm.

Arenic Fragiudults

HCBB. Other Fragiudults that have *both* of the following:

1. In one or more horizons within 40 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthaquic Fragiudults

HCBC. Other Fragiudults that meet *both* of the following:

1. Meet *one or more* of the following:
 - a. Have a glossic horizon above the fragipan; *or*
 - b. Do not have, above the fragipan, an argillic or kandic horizon that has clay films on both vertical and horizontal surfaces of any structural aggregates; *or*
 - c. Between the argillic or kandic horizon and the fragipan, have one or more horizons with 50 percent or more chroma of 3 or less and with a clay content 3 percent or more (absolute, in the fine-earth fraction) lower than that in both the argillic or kandic horizon and the fragipan; *and*
2. In one or more horizons within 40 cm of the mineral

soil surface, have redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Glossaquic Fragiudults

H CBD. Other Fragiudults that have, in one or more subhorizons above the fragipan and within the upper 25 cm of the argillic or kandic horizon, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Fragiudults

H CB E. Other Fragiudults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Fragiudults

H C B F. Other Fragiudults that meet *one or more* of the following:

1. Have a glossic horizon above the fragipan; *or*
2. Do not have, above the fragipan, an argillic or kandic horizon that has clay films on both vertical and horizontal surfaces of any structural aggregates; *or*
3. Between the argillic or kandic horizon and the fragipan, have one or more horizons with 50 percent or more chroma of 3 or less and with a clay content 3 percent or more (absolute, in the fine-earth fraction) lower than that in both the argillic or kandic horizon and the fragipan.

Glossic Fragiudults

H C B G. Other Fragiudults that have a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) in *either*:

1. An Ap horizon that is 18 cm or more thick; *or*
2. The surface layer after mixing of the upper 18 cm.

Humic Fragiudults

H C B H. Other Fragiudults.

Typic Fragiudults

Hapludults

Key to Subgroups

H C G A. Hapludults that have *either or both*:

1. In each pedon, a discontinuous lithic contact within 50 cm of the mineral soil surface; *and*
2. In each pedon, a discontinuous argillic horizon that is interrupted by ledges of bedrock.

Lithic-Ruptic-Entic Hapludults

HCGB. Other Hapludults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapludults

HCGC. Other Hapludults that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Hapludults

HCGD. Other Hapludults that have *both*:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Fragiaquic Hapludults

HCGE. Other Hapludults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*
2. In one or more subhorizons within the upper 60 cm of the argillic horizon, redox concentrations with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Arenic Hapludults

HCGF. Other Hapludults that have, in one or more subhorizons within the upper 60 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Hapludults

HCGG. Other Hapludults that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Hapludults

HCGH. Other Hapludults that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Hapludults

HCGI. Other Hapludults that have an argillic horizon that:

1. Consists entirely of lamellae; *or*
2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*
3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:
 - a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*
 - b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Hapludults

HCGJ. Other Hapludults that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Hapludults

HCGK. Other Hapludults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Hapludults

HCGL. Other Hapludults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Hapludults

HCGM. Other Hapludults that have:

1. No densic, lithic, or paralithic contact within 50 cm of the mineral soil surface; *and*
2. An argillic horizon 25 cm or less thick.

Inceptic Hapludults

HCGN. Other Hapludults that have a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) in *either*:

1. An Ap horizon that is 18 cm or more thick; *or*
2. The surface layer after mixing of the upper 18 cm.

Humic Hapludults

HCGO. Other Hapludults.

Typic Hapludults

Kandiudults

Key to Subgroups

HCCA. Kandiudults that have:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*
3. In one or more layers either within 75 cm of the mineral soil surface or, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the kandic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Arenic Plinthaquic Kandiudults

HCCB. Other Kandiudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm; *and*
2. In one or more layers either within 75 cm of the mineral soil surface or, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the kandic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Arenic Kandiudults

HCCC. Other Kandiudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kandiudults

HCCD. Other Kandiudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm; *and*
2. In all subhorizons in the upper 75 cm of the kandic horizon or throughout the entire kandic horizon if it is less than 75 cm thick, more than 50 percent colors that have *all* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less; *and*
 - c. A dry value no more than 1 unit higher than the moist value.

Arenic Rhodic Kandiudults

HCCE. Other Kandiudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm.

Arenic Kandiudults

HCCF. Other Kandiudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 100 cm or more; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Kandiudults

HCCG. Other Kandiudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 100 cm or more.

Grossarenic Kandiudults

HCCH. Other Kandiudults that have *both*:

1. An ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH₄OAc pH 7, plus 1N KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface; *and*

2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Acrudoxic Plinthic Kandiudults

HCCI. Other Kandiudults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH₄OAc pH 7, plus 1N KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrudoxic Kandiudults

HCCJ. Other Kandiudults that have *both*:

1. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*
2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Kandiudults

HCCK. Other Kandiudults that have *both*:

1. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage); *and*
2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:
 - a. A fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *or*
 - b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent is cinders, pumice, and pumicelike fragments; *or*
 - c. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*
 - (1) In the 0.02 to 2.0 mm fraction, 5 percent (or more) volcanic glass; *and*
 - (2) [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Kandiudults

HCCL. Other Kandiudults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water

retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiudults

HCCM. Other Kandiudults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Kandiudults

HCCN. Other Kandiudults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiudults

HCCO. Other Kandiudults that:

1. Have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and hue that is 10YR or yellower and becomes redder with increasing depth within 100 cm of the mineral soil surface; *and*
2. In normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Ombroaquic Kandiudults

HCCP. Other Kandiudults that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Kandiudults

HCCQ. Other Kandiudults that have a sombric horizon within 150 cm of the mineral soil surface.

Sombric Kandiudults

HCCR. Other Kandiudults that have, in all subhorizons in the upper 75 cm of the kandic horizon or throughout the entire kandic horizon if it is less than 75 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less; *and*
3. A dry value no more than 1 unit higher than the moist value.

Rhodic Kandiudults

HCCS. Other Kandiuults.

Typic Kandiuults

Kanhapludults

Key to Subgroups

HCDA. Kanhapludults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhapludults

HCDB. Other Kanhapludults that have *both*:

1. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*
2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Kanhapludults

HCDC. Other Kanhapludults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kanhapludults

HCDD. Other Kanhapludults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm.

Arenic Kanhapludults

HCDE. Other Kanhapludults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH₄OAc pH 7, plus 1N KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrudoxic Kanhapludults

HCDF. Other Kanhapludults that have *both*:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or

more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Fragiaquic Kanhapludults

HCDG. Other Kanhapludults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kanhapludults

HCDH. Other Kanhapludults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Kanhapludults

HCDI. Other Kanhapludults that:

1. Have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and hue that is 10YR or yellower and becomes redder with increasing depth within 100 cm of the mineral soil surface; *and*
2. In normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Ombroaquic Kanhapludults

HCDJ. Other Kanhapludults that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Kanhapludults

HCDK. Other Kanhapludults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kanhapludults

HCDL. Other Kanhapludults that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Kanhapludults

HCDM. Other Kanhapludults that have, in all subhorizons in the upper 50 cm of the kandic horizon or throughout the entire kandic horizon if it is less than 50 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less; *and*
3. A dry value no more than 1 unit higher than the moist value.

Rhodic Kanhapludults

HCDN. Other Kanhapludults.

Typic Kanhapludults

Paleudults

Key to Subgroups

HCEA. Paleudults that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in normal years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*
2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Paleudults

HCEB. Other Paleudults that have a horizon 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*
2. Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*
3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Paleudults

HCEC. Other Paleudults that have:

1. In one or more layers either within 75 cm of the mineral soil surface or, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper

12.5 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more; *and*
3. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthaquic Paleudults

HCED. Other Paleudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon that is 50 cm or more below the mineral soil surface; *and*
2. In one or more layers either within 75 cm of the mineral soil surface or, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Aquic Arenic Paleudults

HCEE. Other Paleudults that have *both*:

1. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*
2. In one or more layers either within 75 cm of the mineral soil surface or, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Plinthaquic Paleudults

HCEF. Other Paleudults that have *both*:

1. Fragic soil properties:
 - a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
 - b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*
2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or

more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage).

Fragiaquic Paleudults

HCEG. Other Paleudults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Paleudults

HCEH. Other Paleudults that have anthraquic conditions.

Anthraquic Paleudults

HCEI. Other Paleudults that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Paleudults

HCEJ. Other Paleudults that have an argillic horizon that:

1. Consists entirely of lamellae; *or*
2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*
3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:
 - a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*
 - b. A combination of lamellae (that may or may not be part of the argillic horizon) and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Paleudults

HCEK. Other Paleudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Paleudults

HCEL. Other Paleudults that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or

throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Paleudults

HCEM. Other Paleudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Paleudults

HCEN. Other Paleudults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleudults

HCEO. Other Paleudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*
2. In all subhorizons in the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick, more than 50 percent colors that have *all* of the following:
 - a. Hue of 2.5YR or redder; *and*
 - b. A value, moist, of 3 or less; *and*
 - c. A dry value no more than 1 unit higher than the moist value.

Arenic Rhodic Paleudults

HCEP. Other Paleudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleudults

HCEQ. Other Paleudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleudults

HCER. Other Paleudults that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*
2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Paleudults

HCES. Other Paleudults that have, in all subhorizons in the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less; *and*
3. A dry value no more than 1 unit higher than the moist value.

Rhodic Paleudults

HCET. Other Paleudults.

Typic Paleudults

Plinthudults

Key to Subgroups

HCAA. All Plinthudults.

Typic Plinthudults

Rhodudults

Key to Subgroups

HCFA. Rhodudults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodudults

HCFB. Other Rhodudults that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Rhodudults

HCFC. Other Rhodudults.

Typic Rhodudults

Ustults

Key to Great Groups

HDA. Ustults that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one-half or more of the volume.

[Plinthustults](#), p. 277

HDB. Other Ustults that:

1. Do not have a densic, lithic, paralithic, or petroferic contact within 150 cm of the mineral soil surface; *and*
2. Have a kandic horizon; *and*

3. Within 150 cm of the mineral soil surface, *either*:

- a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
- b. Have 5 percent or more (by volume) skeletalans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Kandiustults](#), p. 275

HDC. Other Ustults that have a kandic horizon.

[Kanhaplustults](#), p. 276

HDD. Other Ustults that:

1. Do not have a densic, lithic, paralithic, or petroferic contact within 150 cm of the mineral soil surface; *and*

2. Within 150 cm of the mineral soil surface, *either*:

- a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
- b. Have 5 percent or more (by volume) skeletalans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Paleustults](#), p. 277

HDE. Other Ustults that have *both*:

1. An epipedon that has a color value, moist, of 3 or less throughout; *and*

2. In all subhorizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 100 cm thick, more than 50 percent colors that have *all* of the following:

- a. Hue of 2.5YR or redder; *and*
- b. A value, moist, of 3 or less; *and*
- c. A dry value no more than 1 unit higher than the moist value.

[Rhodustults](#), p. 278

HDF. Other Ustults.

[Haplustults](#), p. 274

Haplustults

Key to Subgroups

HDFa. Haplustults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplustults

HDFB. Other Haplustults that have a petroferic contact within 100 cm of the mineral soil surface.

Petroferic Haplustults

HDFC. Other Haplustults that have, in one or more layers both within the upper 12.5 cm of the argillic horizon and within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Haplustults

HDFD. Other Haplustults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more below the mineral soil surface.

Arenic Haplustults

HDFE. Other Haplustults that:

1. Have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and hue that is 10YR or yellower and becomes redder with increasing depth within 100 cm of the mineral soil surface; *and*
2. In normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Ombroaquic Haplustults

HDFF. Other Haplustults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Haplustults

HDFG. Other Haplustults that have a CEC (by 1N NH₄OAc pH 7) of less than 24 cmol(+)/kg clay in 50 percent or more of the entire argillic horizon if less than 100 cm thick or of its upper 100 cm.

Kanhaplic Haplustults

HDFH. Other Haplustults.

Typic Haplustults

Kandiustults

Key to Subgroups

HDBA. Kandiustults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH₄OAc pH 7,

plus 1N KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrustoxic Kandiustults

HDBB. Other Kandiustults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Kandiustults

HDBC. Other Kandiustults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 cm or more; *and*
2. 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kandiustults

HDBD. Other Kandiustults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 cm or more.

Arenic Kandiustults

HDBE. Other Kandiustults that have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0; *and*
2. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A mesic or thermic soil temperature regime and a moisture control section that is dry in some part for 135 or fewer of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udandic Kandiustults

HDBF. Other Kandiustults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water

retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiestults

HDBG. Other Kandiestults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiestults

HDBH. Other Kandiestults that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A thermic, mesic, or colder soil temperature regime and a moisture control section that in normal years is dry in some part for more than four-tenths of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - a. Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Kandiestults

HDBI. Other Kandiestults that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for 135 or fewer of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Kandiestults

HDBJ. Other Kandiestults that have, in all subhorizons in the upper 50 cm of the kandic horizon or throughout the entire kandic horizon if it is less than 75 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less; *and*

3. A dry value no more than 1 unit higher than the moist value.

Rhodic Kandiestults

HDBK. Other Kandiestults.

Typic Kandiestults

Kanhaplustults

Key to Subgroups

HDCA. Kanhaplustults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplustults

HDCB. Other Kanhaplustults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH₄OAc pH 7, plus 1N KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrostoxic Kanhaplustults

HDCC. Other Kanhaplustults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Kanhaplustults

HDCCD. Other Kanhaplustults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100 cm.

Arenic Kanhaplustults

HDCE. Other Kanhaplustults that have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus $\frac{1}{2}$ Fe percentages (by ammonium oxalate) totaling more than 1.0; *and*
2. When neither irrigated nor fallowed to store moisture, *either*:
 - a. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for 135 or fewer of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
 - b. A hyperthermic, isomesic, or warmer *iso* soil

temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udandic Kanhaplustults

HDCF. Other Kanhaplustults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kanhaplustults

HDCG. Other Kanhaplustults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kanhaplustults

HDCH. Other Kanhaplustults that:

1. Have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and hue that is 10YR or yellower and becomes redder with increasing depth within 100 cm of the mineral soil surface; *and*
2. In normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for *either or both*:
 - a. 20 or more consecutive days; *or*
 - b. 30 or more cumulative days.

Ombroaquic Kanhaplustults

HDCI. Other Kanhaplustults that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A thermic, mesic, or colder soil temperature regime and a moisture control section that in normal years is dry in some part for more than four-tenths of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years:
 - a. Is moist in some or all parts for fewer than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C; *and*
 - b. Is dry in some part for six-tenths or more of the cumulative days per year when the soil temperature

at a depth of 50 cm below the soil surface is higher than 5 °C.

Aridic Kanhaplustults

HDCJ. Other Kanhaplustults that, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime and a moisture control section that in normal years is dry in some part for 135 or fewer of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5 °C; *or*
2. A hyperthermic, isomesic, or warmer *iso* soil temperature regime and a moisture control section that in normal years is dry in some or all parts for fewer than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 °C.

Udic Kanhaplustults

HDCK. Other Kanhaplustults that have, in all subhorizons in the upper 50 cm of the kandic horizon or throughout the entire kandic horizon if it is less than 50 cm thick, more than 50 percent colors that have *all* of the following:

1. Hue of 2.5YR or redder; *and*
2. A value, moist, of 3 or less; *and*
3. A dry value no more than 1 unit higher than the moist value.

Rhodic Kanhaplustults

HDCL. Other Kanhaplustults.

Typic Kanhaplustults

Paleustults

Key to Subgroups

HDDA. All Paleustults.

Typic Paleustults

Plinthustults

Key to Subgroups

HDAA. Plinthustults that have:

1. A densic, lithic, paralithic, or petroferic contact within 150 cm of the mineral soil surface; *or*
2. Within 150 cm of the mineral soil surface, *both*:
 - a. With increasing depth, a clay decrease of 20 percent or more (relative) from the maximum clay content; *and*

b. Less than 5 percent (by volume) skeletal on faces of peds in the layer that has a 20 percent lower clay content *or*, below that layer, a clay increase of less than 3 percent (absolute) in the fine-earth fraction.

Haplic Plinthustults

HDAB. Other Plinthustults.

Typic Plinthustults

Rhodustults

Key to Subgroups

HDEA. Rhodustults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodustults

HDEB. Other Rhodustults that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Rhodustults

HDEC. Other Rhodustults.

Typic Rhodustults

Xerults

Key to Great Groups

HEA. Xerults that:

1. Do not have a densic, lithic, or paralithic contact within 150 cm of the mineral soil surface; *and*
2. Within 150 cm of the mineral soil surface, *either*:
 - a. With increasing depth, do not have a clay decrease of 20 percent or more (relative) from the maximum clay content; *or*
 - b. Have 5 percent or more (by volume) skeletal on faces of peds or 5 percent or more (by volume) plinthite, or both, in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

[Palexerults](#), p. 279

HEB. Other Xerults.

[Haploxerults](#), p. 278

Haploxerults

Key to Subgroups

HEBA. Haploxerults that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*
2. In each pedon, a discontinuous argillic or kandic horizon that is interrupted by ledges of bedrock.

Lithic Ruptic-Inceptic Haploxerults

HEBB. Other Haploxerults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxerults

HEBC. Other Haploxerults that have, in one or more subhorizons within the upper 25 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Haploxerults

HEBD. Other Haploxerults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus 1/2 Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploxerults

HEBE. Other Haploxerults that have an argillic or kandic horizon that:

1. Consists entirely of lamellae; *or*
2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*
3. Consists of one or more subhorizons that are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there are *either*:
 - a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic or kandic horizon); *or*
 - b. A combination of lamellae (that may or may not be part of the argillic or kandic horizon) and one or more parts of the argillic or kandic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Haploxerults

HEBF. Other Haploxerults that have a sandy particle-size class throughout the upper 75 cm of the argillic or kandic horizon or throughout the entire horizon if it is less than 75 cm thick.

Psammentic Haploxerults

HEBG. Other Haploxerults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 to 100 cm.

Arenic Haploxerults

HEBH. Other Haploxerults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 100 cm or more.

Grossarenic Haploxerults

HEBI. Other Haploxerults.

Typic Haploxerults

Palaxerults

Key to Subgroups

HEAA. Palaxerults that have *both*:

1. In one or more subhorizons within the upper 25 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in normal years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus ¹/₂ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Aquandic Palaxerults

HEAB. Other Palaxerults that have, in one or more subhorizons within the upper 25 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and chroma of 2 or less, accompanied by redox concentrations and by aquic conditions for some time in normal years (or artificial drainage).

Aquic Palaxerults

HEAC. Other Palaxerults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm³ or less, measured at 33 kPa water retention, and Al plus ¹/₂ Fe percentages (by ammonium oxalate) totaling more than 1.0.

Andic Palaxerults

HEAD. Other Palaxerults.

Typic Palaxerults

CHAPTER 16

Vertisols¹

Key to Suborders

FA. Vertisols that have, in one or more horizons within 50 cm of the mineral soil surface, aquic conditions for some time in normal years (or artificial drainage) and *one or both* of the following:

1. In more than half of each pedon, either on faces of peds or in the matrix if peds are absent, 50 percent or more chroma of *either*:
 - a. 2 or less if redox concentrations are present; *or*
 - b. 1 or less; *or*
2. Enough active ferrous iron (Fe^{2+}) to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

[Aaquerts](#), p. 281

FB. Other Vertisols that have a cryic soil temperature regime.
[Cryverts](#), p. 285

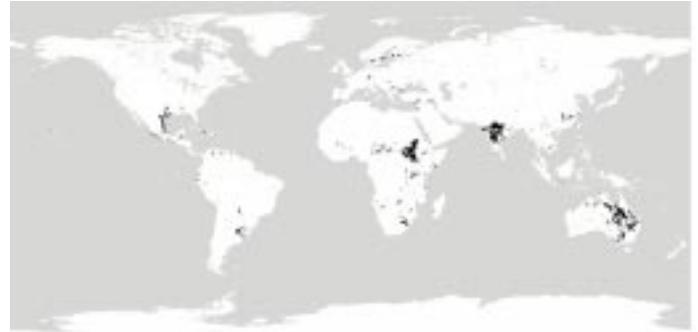
FC. Other Vertisols that in normal years have *both*:

1. A thermic, mesic, or frigid soil temperature regime; *and*
2. If not irrigated during the year, cracks that remain *both*:
 - a. 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*
 - b. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

[Xererts](#), p. 291

FD. Other Vertisols that, if not irrigated during the year, have cracks in normal years that remain closed for less than 60 consecutive days during a period when the soil temperature at a depth of 50 cm from the soil surface is higher than 8 °C.
[Torreerts](#), p. 285

FE. Other Vertisols that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide,



through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

[Usterts](#), p. 288

FF. Other Vertisols.

[Uderts](#), p. 286

Aaquerts

Key to Great Groups

FAA. Aaquerts that have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.
[Salaaquerts](#), p. 284

FAB. Other Aaquerts that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.
[Duraaquerts](#), p. 282

FAC. Other Aaquerts that have a natric horizon or have an exchangeable sodium percentage of 15 percent or more (or a sodium adsorption ratio of 13 or more) within 100 cm of the mineral soil surface.
[Natraaquerts](#), p. 284

FAD. Other Aaquerts that have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.
[Calciaaquerts](#), p. 282

FAE. Other Aaquerts that have, throughout one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, *both*:

¹This chapter was rewritten in 1992 following the recommendations of the International Committee on the Classification of Vertisols (ICOMERT), chaired by Dr. Juan Comerma.

1. An electrical conductivity in the saturation extract of less than 4.0 dS/m at 25 °C; *and*
2. A pH value of 4.5 or less in 0.01 M CaCl₂ (5.0 or less in 1:1 water).

[Dystraquerts](#), p. 282

FAF. Other Aquerts that have episaturation.

[Epiaquerts](#), p. 284

FAG. Other Aquerts.

[Endoaquerts](#), p. 283

Calciaquerts

Key to Subgroups

FADA. Calciaquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or the upper boundary of a duripan if shallower, 50 percent or more colors as follows:

1. Hue of 2.5Y or redder and *either*:
 - a. A color value, moist, of 6 or more and chroma of 3 or more; *or*
 - b. A color value, moist, of 5 or less and chroma of 2 or more; *or*
2. Hue of 5Y and chroma of 3 or more; *or*
3. Chroma of 2 or more and no redox concentrations.

Aeric Calciaquerts

FADB. Other Calciaquerts.

Typic Calciaquerts

Duraquerts

Key to Subgroups

FABA. Duraquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Duraquerts

FABB. Other Duraquerts that have a thermic, mesic, or frigid soil temperature regime and that, if not irrigated during the year, have cracks in normal years that remain *both*:

1. 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*

2. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xeric Duraquerts

FABC. Other Duraquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Duraquerts

FABD. Other Duraquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or the upper boundary of the duripan if shallower, 50 percent or more colors as follows:

1. Hue of 2.5Y or redder and *either*:
 - a. A color value, moist, of 6 or more and chroma of 3 or more; *or*
 - b. A color value, moist, of 5 or less and chroma of 2 or more; *or*
2. Hue of 5Y and chroma of 3 or more; *or*
3. Chroma of 2 or more and no redox concentrations.

Aeric Duraquerts

FABE. Other Duraquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more.

Chromic Duraquerts

FABF. Other Duraquerts.

Typic Duraquerts

Dystraquerts

Key to Subgroups

FAEA. Dystraquerts that have, in one or more horizons within 100 cm of the mineral soil surface, jarosite concentrations and a pH value of 4.0 or less (1:1 water, air-dried slowly in shade).

Sulfaqueptic Dystraquerts

FAEB. Other Dystraquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Dystraquerts

FAEC. Other Dystraquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Dystraquerts

FAED. Other Dystraquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, 50 percent or more colors as follows:

1. Hue of 2.5Y or redder and *either*:
 - a. A color value, moist, of 6 or more and chroma of 3 or more; *or*
 - b. A color value, moist, of 5 or less and chroma of 2 or more; *or*
2. Hue of 5Y and chroma of 3 or more; *or*
3. Chroma of 2 or more and no redox concentrations.

Aeric Dystraquerts

FAEE. Other Dystraquerts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Dystraquerts

FAEF. Other Dystraquerts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Dystraquerts

FAEG. Other Dystraquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more.

Chromic Dystraquerts

FAEH. Other Dystraquerts.

Typic Dystraquerts

Endoaquerts

Key to Subgroups

FAGA. Endoaquerts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (saturated paste) for 6 or more months in normal years.

Halic Endoaquerts

FAGB. Other Endoaquerts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable

sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Endoaquerts

FAGC. Other Endoaquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Endoaquerts

FAGD. Other Endoaquerts that have a thermic, mesic, or frigid soil temperature regime and that, if not irrigated during the year, have cracks in normal years that remain *both*:

1. 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*
2. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xeric Endoaquerts

FAGE. Other Endoaquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Endoaquerts

FAGF. Other Endoaquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, 50 percent or more colors as follows:

1. Hue of 2.5Y or redder and *either*:
 - a. A color value, moist, of 6 or more and chroma of 3 or more; *or*
 - b. A color value, moist, of 5 or less and chroma of 2 or more; *or*
2. Hue of 5Y and chroma of 3 or more; *or*
3. Chroma of 2 or more and no redox concentrations.

Aeric Endoaquerts

FAGG. Other Endoaquerts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Endoaquerts

FAGH. Other Endoaquerts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Endoaquerts

FAGI. Other Endoaquerts that have, in one or more horizons

within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more.

Chromic Endoaquerts

FAGJ. Other Endoaquerts.

Typic Endoaquerts

Epiaquerts

Key to Subgroups

FAFA. Epiaquerts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (saturated paste) for 6 or more months in normal years.

Halic Epiaquerts

FAFB. Other Epiaquerts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Epiaquerts

FAFC. Other Epiaquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Epiaquerts

FAFD. Other Epiaquerts that have a thermic, mesic, or frigid soil temperature regime and that, if not irrigated during the year, have cracks in normal years that remain *both*:

1. 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*
2. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xeric Epiaquerts

FAFE. Other Epiaquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Epiaquerts

FAFF. Other Epiaquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, 50 percent or more colors as follows:

1. Hue of 2.5Y or redder and *either*:
 - a. A color value, moist, of 6 or more and chroma of 3 or more; *or*
 - b. A color value, moist, of 5 or less and chroma of 2 or more; *or*
2. Hue of 5Y and chroma of 3 or more; *or*
3. Chroma of 2 or more and no redox concentrations.

Aeric Epiaquerts

FAFG. Other Epiaquerts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Epiaquerts

FAFH. Other Epiaquerts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Epiaquerts

FAFI. Other Epiaquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more.

Chromic Epiaquerts

FAFJ. Other Epiaquerts.

Typic Epiaquerts

Natraquerts

Key to Subgroups

FACA. All Natraquerts.

Typic Natraquerts

Salaquerts

Key to Subgroups

FAAA. Salaquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Salaquerts

FAAB. Other Salaquerts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Salaquerts

FAAC. Other Salaquerts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Salaquerts

FAAD. Other Salaquerts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Salaquerts

FAAE. Other Salaquerts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Salaquerts

FAAF. Other Salaquerts.

Typic Salaquerts

Cryerts

Key to Great Groups

FBA. Cryerts that have 10 kg/m² or more organic carbon between the mineral soil surface and a depth of 50 cm.

[Humicryerts](#), p. 285

FBB. Other Cryerts.

[Haplocryerts](#), p. 285

Haplocryerts

Key to Subgroups

FBBA. Haplocryerts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Haplocryerts

FBBB. Other Haplocryerts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Haplocryerts

FBBC. Other Haplocryerts.

Typic Haplocryerts

Humicryerts

Key to Subgroups

FBAA. Humicryerts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Humicryerts

FBAB. Other Humicryerts.

Typic Humicryerts

Torrerts

Key to Great Groups

FDA. Torrerts that have a salic horizon that has its upper boundary within 100 cm of the soil surface.

[Salitorrerts](#), p. 286

FDB. Other Torrerts that have a gypsic horizon that has its upper boundary within 100 cm of the soil surface.

[Gypsitorrerts](#), p. 286

FDC. Other Torrerts that have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

[Calcitorrerts](#), p. 285

FDD. Other Torrerts.

[Haplotorrerts](#), p. 286

Calcitorrerts

Key to Subgroups

FDCA. Calcitorrerts that have a petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

Petrocalcic Calcitorrerts

FDCB. Other Calcitorrerts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the soil surface.

Leptic Calcitorrerts

FDCC. Other Calcitorrerts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the soil surface.

Entic Calcitorrerts

FDCD. Other Calcitorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Calcitorrerts

FDCE. Other Calcitorrerts.

Typic Calcitorrerts**Gypsiteorrerts****Key to Subgroups**

FDDBA. Gypsiteorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Gypsiteorrerts

FDDBB. Other Gypsiteorrerts.

Typic Gypsiteorrerts**Haplotorrerts****Key to Subgroups**

FDDBA. Haplotorrerts that have, throughout a layer 15 cm or more thick within 100 cm of the soil surface, an electrical conductivity of 15 dS/m or more (saturated paste) for 6 or more months in normal years.

Halic Haplotorrerts

FDDBB. Other Haplotorrerts that have, in one or more horizons within 100 cm of the soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Haplotorrerts

FDDBC. Other Haplotorrerts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the soil surface.

Leptic Haplotorrerts

FDDBD. Other Haplotorrerts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the soil surface.

Entic Haplotorrerts

FDDBE. Other Haplotorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Haplotorrerts

FDDBF. Other Haplotorrerts.

Typic Haplotorrerts**Salitorrerts****Key to Subgroups**

FDDBAA. Salitorrerts that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in normal years (or artificial drainage) and *either*:

1. Redoximorphic features; *or*
2. Enough active ferrous iron (Fe^{2+}) to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Salitorrerts

FDDBAB. Other Salitorrerts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the soil surface.

Leptic Salitorrerts

FDDBAC. Other Salitorrerts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the soil surface.

Entic Salitorrerts

FDDBAD. Other Salitorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Salitorrerts

FDDBAE. Other Salitorrerts.

Typic Salitorrerts**Uderts****Key to Great Groups**

FDDBFA. Uderts that have, throughout one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, *both*:

1. An electrical conductivity in the saturation extract of less than 4.0 dS/m at 25 °C; *and*
2. A pH value of 4.5 or less in 0.01 M CaCl₂ (5.0 or less in saturated paste).

[Dystruderts](#), p. 287

FFB. Other Uderts.

[Hapluderts](#), p. 287

Dystruderts

Key to Subgroups

FFAA. Dystruderts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in normal years (or artificial drainage) and *either*:

1. Redoximorphic features; *or*
2. Enough active ferrous iron (Fe²⁺) to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Dystruderts

FFAB. Other Dystruderts that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for *either or both*:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Dystruderts

FFAC. Other Dystruderts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Dystruderts

FFAD. Other Dystruderts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Dystruderts

FFAE. Other Dystruderts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Dystruderts

FFAF. Other Dystruderts.

Typic Dystruderts

Hapluderts

Key to Subgroups

FFBA. Hapluderts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapluderts

FFBB. Other Hapluderts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in normal years (or artificial drainage) and *either*:

1. Redoximorphic features; *or*
2. Enough active ferrous iron (Fe²⁺) to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Hapluderts

FFBC. Other Hapluderts that are saturated with water in one or more layers within 100 cm of the mineral soil surface in normal years for:

1. 20 or more consecutive days; *or*
2. 30 or more cumulative days.

Oxyaquic Hapluderts

FFBD. Other Hapluderts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Hapluderts

FFBE. Other Hapluderts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Hapluderts

FFBF. Other Hapluderts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Hapluderts

FFBG. Other Hapluderts.

Typic Hapluderts

Usterts

Key to Great Groups

FEA. Usterts that have, throughout one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, *both*:

1. An electrical conductivity in the saturation extract of less than 4.0 dS/m at 25 °C; *and*
2. A pH value of 4.5 or less in 0.01 M CaCl₂ (5.0 or less in saturated paste).

[Dystrusterts](#), p. 288

FEB. Other Usterts that have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

[Salusterts](#), p. 291

FEC. Other Usterts that have a gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

[Gypsiusterts](#), p. 289

FED. Other Usterts that have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

[Calciusterts](#), p. 288

FEE. Other Usterts.

[Haplusterts](#), p. 289

Calciusterts

Key to Subgroups

FEDA. Calciusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciusterts

FEDB. Other Calciusterts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (saturated paste) for 6 or more months in normal years.

Halic Calciusterts

FEDC. Other Calciusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Calciusterts

FEDD. Other Calciusterts that have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calciusterts

FEDE. Other Calciusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Calciusterts

FEDF. Other Calciusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Udic Calciusterts

FEDG. Other Calciusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Calciusterts

FEDH. Other Calciusterts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Calciusterts

FEDI. Other Calciusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Calciusterts

FEDJ. Other Calciusterts.

Typic Calciusterts

Dystrusterts

Key to Subgroups

FEAA. Dystrusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystrusterts

FEAB. Other Dystrusterts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in normal years (or artificial drainage) and *either*:

1. Redoximorphic features; *or*
2. Enough active ferrous iron (Fe²⁺) to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Dystrusterts

FEAC. Other Dystrusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Dystrusterts

FEAD. Other Dystrusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days.

Udic Dystrusterts

FEAE. Other Dystrusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Dystrusterts

FEAF. Other Dystrusterts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Dystrusterts

FEAG. Other Dystrusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Dystrusterts

FEAH. Other Dystrusterts.

Typic Dystrusterts

Gypsiusterts

Key to Subgroups

FECA. Gypsiusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Gypsiusterts

FECE. Other Gypsiusterts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (saturated paste) for 6 or more months in normal years.

Halic Gypsiusterts

FECD. Other Gypsiusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable

sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Gypsiusterts

FECD. Other Gypsiusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Gypsiusterts

FECE. Other Gypsiusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Udic Gypsiusterts

FECE. Other Gypsiusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the mineral soil surface.

Leptic Gypsiusterts

FECE. Other Gypsiusterts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Gypsiusterts

FECH. Other Gypsiusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Gypsiusterts

FECI. Other Gypsiusterts.

Typic Gypsiusterts

Haplusterts

Key to Subgroups

FEEA. Haplusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplusterts

FEEB. Other Haplusterts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an

electrical conductivity of 15 dS/m or more (saturated paste) for 6 or more months in normal years.

Halic Haplusterts

FEEC. Other Haplusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Haplusterts

FEED. Other Haplusterts that have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Haplusterts

FEEE. Other Haplusterts that have a gypsic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Gypsic Haplusterts

FEEF. Other Haplusterts that have a calcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Calcic Haplusterts

FEEG. Other Haplusterts that have *both*:

1. A densic, lithic, or paralithic contact within 100 cm of the mineral soil surface; *and*
2. If not irrigated during the year, cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Leptic Haplusterts

FEEH. Other Haplusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Haplusterts

FEEI. Other Haplusterts that have *both*:

1. A densic, lithic, or paralithic contact within 100 cm of the mineral soil surface; *and*
2. If not irrigated during the year, cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Leptic Udic Haplusterts

FEEJ. Other Haplusterts that have *both*:

1. A layer 25 cm or more thick that contains less than 27

percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface; *and*

2. If not irrigated during the year, cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Entic Udic Haplusterts

FEEK. Other Haplusterts that have *both*:

1. In one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

- a. A color value, moist, of 4 or more; *or*
- b. A color value, dry, of 6 or more; *or*
- c. Chroma of 3 or more; *and*

2. If not irrigated during the year, cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Chromic Udic Haplusterts

FEEL. Other Haplusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Udic Haplusterts

FEEM. Other Haplusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Haplusterts

FEEO. Other Haplusterts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Haplusterts

FEEQ. Other Haplusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Haplusterts

FEEP. Other Haplusterts.

Typic Haplusterts

Salusterts

Key to Subgroups

FEBA. Salusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Salusterts

FEBB. Other Salusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Salusterts

FEBC. Other Salusterts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in normal years (or artificial drainage) and *either*:

1. Redoximorphic features; *or*
2. Enough active ferrous iron (Fe^{2+}) to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Salusterts

FEBD. Other Salusterts that, if not irrigated during the year, have cracks in normal years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Salusterts

FEBE. Other Salusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the mineral soil surface.

Leptic Salusterts

FEBF. Other Salusterts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Salusterts

FEBG. Other Salusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Salusterts

FEBH. Other Salusterts.

Typic Salusterts

Xererts

Key to Great Groups

FCA. Xererts that have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

[Durixererts](#), p. 292

FCB. Other Xererts that have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

[Calcixererts](#), p. 291

FCC. Other Xererts.

[Haploxererts](#), p. 292

Calcixererts

Key to Subgroups

FCBA. Calcixererts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calcixererts

FCBB. Other Calcixererts that have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calcixererts

FCBC. Other Calcixererts that, if not irrigated during the year, have cracks in normal years that remain 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 180 or more consecutive days.

Aridic Calcixererts

FCBD. Other Calcixererts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Calcixererts

FCBE. Other Calcixererts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Calcixererts

FCBF. Other Calcixererts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Calcixererts

FCBG. Other Calcixererts.

Typic Calcixererts

Durixererts

Key to Subgroups

FCAA. Durixererts that have, throughout a layer 15 cm or more thick above the duripan, an electrical conductivity of 15 dS/m or more (saturated paste) for 6 or more months in normal years.

Halic Durixererts

FCAB. Other Durixererts that have, in one or more horizons above the duripan, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Durixererts

FCAC. Other Durixererts that have, in one or more horizons above the duripan, aquic conditions for some time in normal years (or artificial drainage) and *either*:

1. Redoximorphic features; *or*
2. Enough active ferrous iron (Fe^{2+}) to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Durixererts

FCAD. Other Durixererts that, if not irrigated during the year, have cracks in normal years that remain 5 mm or more wide, through a thickness of 25 cm or more above the duripan, for 180 or more consecutive days.

Aridic Durixererts

FCAE. Other Durixererts that, if not irrigated during the year, have cracks in normal years that remain 5 mm or more wide, through a thickness of 25 cm or more above the duripan, for less than 90 consecutive days.

Udic Durixererts

FCAF. Other Durixererts that have a duripan that is not indurated in any subhorizon.

Haplic Durixererts

FCAG. Other Durixererts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*

3. Chroma of 3 or more.

Chromic Durixererts

FCAH. Other Durixererts.

Typic Durixererts

Haploxererts

Key to Subgroups

FCCA. Haploxererts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxererts

FCCB. Other Haploxererts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (saturated paste) for 6 or more months in normal years.

Halic Haploxererts

FCCC. Other Haploxererts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months in normal years.

Sodic Haploxererts

FCCD. Other Haploxererts that, if not irrigated during the year, have cracks in normal years that remain 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 180 or more consecutive days.

Aridic Haploxererts

FCCE. Other Haploxererts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in normal years (or artificial drainage) and *either*:

1. Redoximorphic features; *or*
2. Enough active ferrous iron (Fe^{2+}) to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated.

Aquic Haploxererts

FCCF. Other Haploxererts that, if not irrigated during the year, have cracks in normal years that remain 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 90 consecutive days.

Udic Haploxererts

FCCG. Other Haploxererts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Haploxererts

FCCH. Other Haploxererts that have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Haploxererts

FCCI. Other Haploxererts that have, in one or more horizons

within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*
2. A color value, dry, of 6 or more; *or*
3. Chroma of 3 or more.

Chromic Haploxererts

FCCJ. Other Haploxererts.

Typic Haploxererts

CHAPTER 17

Family and Series Differentiae and Names

Families and series serve purposes that are largely pragmatic, the series name is abstract, and the technical family name is descriptive. In this chapter the descriptive terms used in the names of families are defined, the control sections to which the terms apply are given, and the criteria, including the taxa in which they are used, are indicated.

Family Differentiae for Mineral Soils and Mineral Layers of Some Organic Soils

The following differentiae are used to distinguish families of mineral soils and the mineral layers of some organic soils within a subgroup. The class names of these components are used to form the family name. The components are listed and defined in the same sequence in which the components appear in the family names.

- Particle-size classes
- Mineralogy classes
- Cation-exchange activity classes
- Calcareous and reaction classes
- Soil temperature classes
- Soil depth classes
- Rupture-resistance classes
- Classes of coatings
- Classes of cracks

Particle-Size Classes and Their Substitutes

Definition of Particle-Size Classes and Their Substitutes for Mineral Soils

The first part of the family name is the name of either a particle-size class or a substitute for a particle-size class. The term particle-size class is used to characterize the grain-size composition of the whole soil, including both the fine earth and the rock and pararock fragments up to the size of a pedon, but it excludes organic matter and salts more soluble than gypsum. Substitutes for particle-size classes are used for soils that have andic soil properties or a high content of volcanic glass, pumice, or cinders.

The particle-size classes of this taxonomy represent a compromise between conventional divisions in pedologic and

engineering classifications. Engineering classifications have set the limit between sand and silt at a diameter of 74 microns, while pedologic classifications have set it at either 50 or 20 microns. Engineering classifications have been based on grain-size percentages, by weight, in the soil fraction less than 74 mm in diameter, while textural classes in pedologic classifications have been based on percentages, by weight, in the fraction less than 2.0 mm in diameter. In engineering classifications, the separate very fine sand (diameter between 50 and 100 microns or 0.05 and 0.1 mm) has been subdivided at 74 microns. In defining the particle-size classes for this taxonomy, a similar division has been made, but in a different way. Soil materials that have a texture of fine sand or loamy fine sand normally have an appreciable amount of very fine sand, most of which is coarser than 74 microns. A silty sediment, such as loess, may also contain an appreciable amount of very fine sand, most of which is finer than 74 microns. Thus, in the design of particle-size classes for this taxonomy, the very fine sand has been allowed to “float.” It is included with the sand if the texture (fine-earth fraction) of a soil is sand, loamy fine sand, or coarser. It is treated as silt, however, if the texture is very fine sand, loamy very fine sand, sandy loam, silt loam, or finer.

No single set of particle-size classes seems adequate to serve as family differentiae for all of the different kinds of soil. Thus, this taxonomy provides 2 generalized and 11 more narrowly defined classes, which permit relatively fine distinctions between families of soils for which particle size is important, while providing broader groupings for soils in which narrowly defined particle-size classes would produce undesirable separations. Thus, the term “clayey” is used for some soil families to indicate a clay content of 35 percent (30 percent in Vertisols) or more in specific horizons, while in other families the more narrowly defined terms “fine” and “very-fine” indicate that these horizons have a clay content either of 35 (30 percent in Vertisols) to 60 percent or of 60 percent or more in their fine-earth fraction. Fine earth refers to particles smaller than 2.0 mm in diameter. Rock fragments are particles 2.0 mm or more in diameter that are strongly cemented or more resistant to rupture and include all particles with horizontal dimensions smaller than the size of a pedon. Cemented fragments 2.0 mm or more in diameter that are in a rupture-resistance class that is less cemented than the strongly

cemented class are referred to as pararock fragments. Pararock fragments, like rock fragments, include all particles between 2.0 mm and a horizontal dimension smaller than the size of a pedon. Most pararock fragments are broken into fragments 2.0 mm or less in diameter during the preparation of samples for particle-size analysis in the laboratory. Therefore, pararock fragments are generally included with the fine earth in the particle-size classes, although cinders, pumice, and pumicelike fragments are treated as fragments in the substitutes for classes, regardless of their rupture-resistance class.

Substitutes for particle-size classes are used for soils that have andic soil properties or a high content of volcanic glass, pumice, or cinders. These materials cannot be readily dispersed, and the results of dispersion vary. Consequently, normal particle-size classes do not adequately characterize these components. Substitutes for particle-size class names are used for those parts of soils that have andic soil properties or a high amount of volcanic glass, pumice, or cinders, as is the case with Andisols and many Andic and Vitrandic subgroups of other soil orders. Some Spodosols, whether identified in Andic subgroups or not, have andic soil properties in some horizons within the particle-size control section, and particle-size substitute class names are used for these horizons.

Neither a particle-size class name nor a substitute for a particle-size class name is used for Psamments, Psammaquents, and Psammentic subgroups that are in a sandy particle-size class. These taxa have, by definition, either a sandy particle-size class or an ashy substitute class. The sandy particle-size class is considered redundant in the family name. The ashy substitute class, however, is named, if appropriate in these taxa.

Particle-size class names are applied, although with reservations, to spodic horizons and other horizons that do not have andic soil properties but contain significant amounts of allophane, imogolite, ferrihydrite, or aluminum-humus complexes. The isotopic mineralogy class (defined below) is helpful in identifying these particle-size classes.

In general, the weighted average particle-size class of the whole particle-size control section (defined below) determines what particle-size class name is used as a component of the family name.

Strongly Contrasting Particle-Size Classes

If the particle-size control section consists of two parts with strongly contrasting particle-size or substitute classes (listed below), if both parts are 12.5 cm or more thick (including parts not in the control section), and if the transition zone between them is less than 12.5 cm thick, both class names are used. For example, the family particle-size class is sandy over clayey if all of the following criteria are met: the soil meets criterion D (listed below) under the control section for particle-size classes or their substitutes; any Ap horizon is less than 30 cm thick; the weighted average particle-size class of the upper 30 cm of the soil is sandy; the weighted average of the lower part is

clayey; and the transition zone is less than 12.5 cm thick. If a substitute name applies to one or more parts of the particle-size control section and the parts are not strongly contrasting classes, the name of the thickest part (cumulative) is used as the soil family name.

Aniso Class

If the particle-size control section includes more than one pair of the strongly contrasting classes, listed below, then the soil is assigned to an aniso class named for the pair of adjacent classes that contrast most strongly. The aniso class is considered part of the particle-size class name and is set off by commas after the particle-size name. An example is a sandy over clayey, aniso, mixed, active, mesic Aridic Haplustoll.

Generalized Particle-Size Classes

Two generalized particle-size classes, loamy and clayey, are used for shallow classes (defined below) and for soils in Arenic, Grossarenic, and Lithic subgroups. The clayey class is used for all strongly contrasting particle-size classes with more than 35 percent clay (30 percent in Vertisols). The loamy particle-size class is used for contrasting classes, where appropriate, to characterize the lower part of the particle-size control section. The generalized classes, where appropriate, are also used for all strongly contrasting particle-size classes that include a substitute class. For example, loamy over pumiceous or cindery (not fine-loamy over pumiceous or cindery) is used.

Six generalized classes, defined later in this chapter, are used for Terric subgroups of Histosols and Histels.

Control Section for Particle-Size Classes or Their Substitutes in Mineral Soils

The particle-size and substitute class names listed below are applied to certain horizons, or to the soil materials within specific depth limits, that have been designated as the particle-size control section. The lower boundary of the control section may be at a specified depth (in centimeters) below the mineral soil surface or below the upper boundary of an organic layer with andic soil properties, or it may be at the upper boundary of a root-limiting layer. Unless otherwise indicated, the following are considered root-limiting layers in this chapter: a duripan; a fragipan; petrocalcic, petrogypsic, and placic horizons; continuous ortstein; and densic, lithic, paralithic, and petroferic contacts. The following list of particle-size control sections for particular kinds of mineral soils is arranged as a key. This key, like other keys in this taxonomy, is designed in such a way that the reader makes the correct classification by going through the key systematically, starting at the beginning and eliminating one by one all classes that include criteria that do not fit the soil in question. The soil belongs to the first class for which it meets all of the criteria listed. The upper boundary of an argillic, natric, or kandic horizon is used in the following key. This boundary is not always obvious. If one of these horizons is present but the

upper boundary is irregular or broken, as in an A/B or B/A horizon, the depth at which half or more of the volume has the fabric of an argillic, natric, or kandic horizon should be considered the upper boundary.

Key to the Control Section for Particle-Size Classes or Their Substitutes in Mineral Soils

A. For mineral soils that have a root-limiting layer (listed above) within 36 cm of the mineral soil surface or below the upper boundary of organic soil materials with andic soil properties, whichever is shallower: From the mineral soil surface or the upper boundary of the organic soil materials with andic soil properties, whichever is shallower, to the root-limiting layer; *or*

B. For Andisols: Between either the mineral soil surface or the upper boundary of an organic layer with andic soil properties, whichever is shallower, and the shallower of the following: (a) a depth 100 cm below the starting point or (b) a root-limiting layer; *or*

C. For those Alfisols, Ultisols, and great groups of Aridisols and Mollisols, excluding soils in Lamellic subgroups, 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, use 1 through 4 below. For other soils, go to D below.

1. Strongly contrasting particle-size classes (defined and listed later) within or below the argillic, kandic, or natric horizon and within 100 cm of the mineral soil surface: The upper 50 cm of the argillic, kandic, or natric horizon or to a depth of 100 cm, whichever is deeper, but not below the upper boundary of a root-limiting layer; *or*

2. All parts of the argillic, kandic, or natric horizon in or below a fragipan: Between a depth of 25 cm from the mineral soil surface and the top of the fragipan; *or*

3. A fragipan at a depth of less than 50 cm below the top of the argillic, kandic, or natric horizon: Between the upper boundary of the argillic, kandic, or natric horizon and the top of the fragipan; *or*

4. Other soils that meet C above: Either the whole 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.

D. For those Alfisols, Ultisols, and great groups of Aridisols and Mollisols that are in a Lamellic subgroup or 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 the lower boundary of an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and 100 cm below

the mineral soil surface or a root-limiting layer, whichever is shallower; *or*

E. 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 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*

F. All other mineral soils: Between the lower boundary of an Ap horizon or a depth of 25 cm below the mineral soil surface, whichever is deeper, and the shallower of the following: (a) a depth of 100 cm below the mineral soil surface or (b) a root-limiting layer.

Key to the Particle-Size and Substitute Classes of Mineral Soils

This key, like other keys in this taxonomy, is designed in such a way that the reader makes the correct classification by going through the key systematically, starting at the beginning and eliminating one by one all classes that include criteria that do not fit the soil or layer in question. The class or substitute name for each layer within the control section must be determined from the key. If any two layers meet the criteria for strongly contrasting particle-size classes (listed below), the soil is named for that strongly contrasting class. If more than one pair meets the criteria for strongly contrasting classes, the soil is also in an aniso class named for the pair of adjacent classes that contrast most strongly. If the soil has none of the strongly contrasting classes, the weighted average soil materials within the particle-size control section generally determine the class. Exceptions are soils that are not strongly contrasting and that have a substitute class name for one or more parts of the control section. In these soils the class or substitute name of the thickest (cumulative) part within the control section is used to determine the family name.

A. Mineral soils that have, in the thickest part of the control section (if the control section is not in one of the strongly contrasting particle-size classes listed below), *or* in a part of the control section that qualifies as an element in one of the strongly contrasting particle-size classes listed below, *or* throughout the control section, a fine-earth component (including associated medium and finer pores) of less than 10 percent of the total volume *and* that meet one of the following sets of substitute class criteria:

1. Have, in the whole soil, more than 60 percent (by weight) volcanic ash, cinders, lapilli, pumice, and pumicelike¹ fragments *and*, in the fraction coarser than 2.0

¹ Pumicelike—vesicular pyroclastic materials other than pumice that have an apparent specific gravity (including vesicles) of less than 1.0 g/cm³.

mm, two-thirds or more (by volume) pumice and/or pumicelike fragments.

Pumiceous

or

2. Have, in the whole soil, more than 60 percent (by weight) volcanic ash, cinders, lapilli, pumice, and pumicelike fragments *and*, in the fraction coarser than 2.0 mm, less than two-thirds (by volume) pumice and pumicelike fragments.

Cindery

or

3. Other mineral soils that have a fine-earth component of less than 10 percent (including associated medium and finer pores) of the total volume.

Fragmental

or

B. Other mineral soils that have a fine-earth component of 10 percent or more (including associated medium and finer pores) of the total volume and meet, in the thickest part of the control section (if the control section is not in one of the strongly contrasting particle-size classes listed below), *or* in a part of the control section that qualifies as an element in one of the strongly contrasting particle-size classes listed below, *or* throughout the control section, one of the following sets of substitute class criteria:

1. They:

- a. Have andic soil properties and have a water content at 1500 kPa tension of less than 30 percent on undried samples and less than 12 percent on dried samples; *or*
- b. Do not have andic soil properties, have a total of 30 percent or more of the fine-earth fraction in the 0.02 to 2.0 mm fraction, and have (by grain count) 30 percent or more of that fraction consisting of volcanic glass, glass aggregates, glass-coated grains, and other vitric volcanoclastics; *and*
- c. Have one of the following;
 - (1) A total of 35 percent or more (by volume) rock and pararock fragments, of which two-thirds or more (by volume) is pumice or pumicelike fragments.

Ashy-pumiceous

or

- (2) 35 percent or more (by volume) rock fragments.

Ashy-skeletal

or

(3) Less than 35 percent (by volume) rock fragments.

Ashy

or

2. Have a fine-earth fraction that has andic soil properties *and* that has a water content at 1500 kPa tension of 12 percent or more on air-dried samples or of 30 to 100 percent on undried samples; *and*

- a. Have a total of 35 percent or more (by volume) rock and pararock fragments, of which two-thirds or more (by volume) is pumice or pumicelike fragments.

Medial-pumiceous

or

- b. Have 35 percent or more (by volume) rock fragments.

Medial-skeletal

or

- c. Have less than 35 percent (by volume) rock fragments.

Medial

or

3. Have a fine-earth fraction that has andic soil properties and that has a water content at 1500 kPa tension of 100 percent or more on undried samples; *and*

- a. Have a total of 35 percent or more (by volume) rock and pararock fragments, of which two-thirds or more (by volume) is pumice or pumicelike fragments.

Hydrous-pumiceous

or

- b. Have 35 percent or more (by volume) rock fragments.

Hydrous-skeletal

or

- c. Have less than 35 percent (by volume) rock fragments.

Hydrous

or

Note: In the following classes, “clay” excludes clay-size carbonates. Carbonates of clay size are treated as silt. If the ratio of percent water retained at 1500 kPa tension to the percentage of measured clay is 0.25 or less or 0.6 or more in half or more of the particle-size control section or part of the particle-size control section in strongly contrasting classes,

then the percentage of clay is estimated by the following formula: Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon).

C. Other mineral soils that, in the thickest part of the control section (if part of the control section has a substitute for particle-size class and is not in one of the strongly contrasting particle-size classes listed below), *or* in a part of the control section that qualifies as an element in one of the strongly contrasting particle-size classes listed below, *or* throughout the control section, meet one of the following sets of particle-size class criteria:

1. Have 35 percent or more (by volume) rock fragments *and* a fine-earth fraction with a texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand.

Sandy-skeletal

or

2. Have 35 percent or more (by volume) rock fragments *and* less than 35 percent (by weight) clay.

Loamy-skeletal

or

3. Have 35 percent or more (by volume) rock fragments.

Clayey-skeletal

or

4. Have a texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand in the fine-earth fraction.

Sandy

or

5. Have a texture of loamy very fine sand, very fine sand, or finer, including less than 35 percent (by weight) clay in the fine-earth fraction (excluding Vertisols), and are in a shallow family (defined below) or in a Lithic, Arenic, or Grossarenic subgroup, or the layer is an element in a strongly contrasting particle-size class (listed below) and the layer is the lower element or the other element is a substitute for particle-size class.

Loamy

or

6. Have, in the fraction less than 75 mm in diameter, 15 percent or more (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter) *and*, in the fine-earth fraction, less than 18 percent (by weight) clay.

Coarse-loamy

or

7. Have, in the fraction less than 75 mm in diameter, 15

percent or more (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter) *and* 18 to 35 percent (by weight) clay (Vertisols are excluded).

Fine-loamy

or

8. Have, in the fraction less than 75 mm in diameter, less than 15 percent (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter) *and*, in the fine-earth fraction, less than 18 percent (by weight) clay.

Coarse-silty

or

9. Have, in the fraction less than 75 mm in diameter, less than 15 percent (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter) *and*, in the fine-earth fraction, 18 to 35 percent (by weight) clay (Vertisols are excluded).

Fine-silty

or

10. Have 35 percent or more (by weight) clay (more than 30 percent in Vertisols) and are in a shallow family (defined below) or in a Lithic, Arenic, or Grossarenic subgroup, or the layer is an element in a strongly contrasting particle-size class (listed below).

Clayey

or

11. Have (by weighted average) less than 60 percent (by weight) clay in the fine-earth fraction.

Fine

or

12. Have 60 percent or more clay.

Very-fine

Strongly Contrasting Particle-Size Classes

The purpose of strongly contrasting particle-size classes is to identify changes in pore-size distribution or composition that are not identified in higher soil categories and that seriously affect the movement and retention of water and/or nutrients.

The following particle-size or substitute classes are considered strongly contrasting if both parts are 12.5 cm or more thick (including parts not in the particle-size control section; however, substitute class names are used only if the soil materials to which they apply extend 10 cm or more into the upper part of the particle-size control section) and if the transition zone between the two parts of the particle-size control section is less than 12.5 cm thick.

Some classes, such as sandy and sandy-skeletal, have been combined in the following list. In those cases the combined

name is used as the family class if part of the control section meets the criteria for either class.

1. Ashy over clayey
2. Ashy over clayey-skeletal
3. Ashy over loamy-skeletal
4. Ashy over loamy
5. Ashy over medial-skeletal
6. Ashy over medial (if the water content at 1500 kPa tension in dried samples of the fine-earth fraction is 10 percent or less for the ashy materials and 15 percent or more for the medial materials)
7. Ashy over pumiceous or cindery
8. Ashy over sandy or sandy-skeletal
9. Ashy-skeletal over fragmental or cindery (if the volume of the fine-earth fraction is 35 percent or more [absolute] greater in the ashy-skeletal part than in the fragmental or cindery part)
10. Cindery over loamy
11. Cindery over medial-skeletal
12. Cindery over medial
13. Clayey over fine-silty (if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section)
14. Clayey over fragmental
15. Clayey over loamy (if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section)
16. Clayey over loamy-skeletal (if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section)
17. Clayey over sandy or sandy-skeletal
18. Clayey-skeletal over sandy or sandy-skeletal
19. Coarse-loamy over clayey
20. Coarse-loamy over fragmental
21. Coarse-loamy over sandy or sandy-skeletal (if the coarse-loamy material contains less than 50 percent fine sand or coarser sand)
22. Coarse-silty over clayey
23. Coarse-silty over sandy or sandy-skeletal
24. Fine-loamy over clayey (if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section)
25. Fine-loamy over fragmental
26. Fine-loamy over sandy or sandy-skeletal
27. Fine-silty over clayey (if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section)
28. Fine-silty over fragmental
29. Fine-silty over sandy or sandy-skeletal
30. Hydrous over clayey-skeletal
31. Hydrous over clayey
32. Hydrous over fragmental
33. Hydrous over loamy-skeletal
34. Hydrous over loamy
35. Hydrous over sandy or sandy-skeletal
36. Loamy over sandy or sandy-skeletal (if the loamy material contains less than 50 percent fine sand or coarser sand)
37. Loamy over pumiceous or cindery
38. Loamy-skeletal over cindery (if the volume of the fine-earth fraction is 35 percent or more [absolute] greater in the loamy-skeletal part than in the cindery part)
39. Loamy-skeletal over clayey (if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section)
40. Loamy-skeletal over fragmental (if the volume of the fine-earth fraction is 35 percent or more [absolute] greater in the loamy-skeletal part than in the fragmental part)
41. Loamy-skeletal over sandy or sandy-skeletal (if the loamy material has less than 50 percent fine sand or coarser sand)
42. Medial over ashy (if the water content at 1500 kPa tension in dried samples of the fine-earth fraction is 15 percent or more for the medial materials and 10 percent or less for the ashy materials)
43. Medial over ashy-pumiceous or ashy-skeletal (if the water content at 1500 kPa tension in dried samples of the fine-earth fraction is 15 percent or more for the medial materials and 10 percent or less for the ashy part)
44. Medial over clayey-skeletal
45. Medial over clayey
46. Medial over fragmental
47. Medial over hydrous (if the water content at 1500 kPa tension in undried samples of the fine-earth fraction is 75 percent or less for the medial materials)

48. Medial over loamy-skeletal
49. Medial over loamy
50. Medial over pumiceous or cindery
51. Medial over sandy or sandy-skeletal
52. Medial-skeletal over fragmental or cindery (if the volume of the fine-earth fraction is 35 percent or more [absolute] greater in the medial-skeletal part than the fragmental or cindery part)
53. Pumiceous or ashy-pumiceous over loamy
54. Pumiceous or ashy-pumiceous over medial-skeletal
55. Pumiceous or ashy-pumiceous over medial
56. Pumiceous or ashy-pumiceous over sandy or sandy-skeletal
57. Sandy over clayey
58. Sandy over loamy (if the loamy material contains less than 50 percent fine sand or coarser sand)
59. Sandy-skeletal over loamy (if the loamy material contains less than 50 percent fine sand or coarser sand)

Mineralogy Classes

The mineralogy of soils is known to be useful in making predictions about soil behavior and responses to management. Some mineralogy classes occur or are important only in certain taxa or particle-size classes, and others are important in all particle-size classes. The following key to mineralogy classes is designed to make those distinctions.

Control Section for Mineralogy Classes

The control section for mineralogy classes is the same as that defined for the particle-size classes and their substitutes.

Key to Mineralogy Classes

This key, like other keys in this taxonomy, is designed in such a way that the reader makes the correct classification by going through the key systematically, starting at the beginning and eliminating one by one any classes that include criteria that do not fit the soil in question. The soil belongs to the first class for which it meets all of the required criteria. The user should first check the criteria in section A and, if the soil in question does not meet the criteria listed there, proceed on to sections B, C, D, and E, until the soil meets the criteria listed. All criteria are based on a weighted average.

For soils with strongly contrasting particle-size classes, the mineralogy for both named particle-size classes or substitutes are given, unless they are the same. Examples are an ashy over

clayey, mixed (if both the ashy and clayey parts are mixed), superactive, mesic Typic Vitraquand and a clayey over sandy or sandy-skeletal, smectitic over mixed, thermic Vertic Haplustept.

A. Oxisols and “kandi” and “kanhap” great groups of Alfisols and Ultisols that in the mineralogy control section have:

1. More than 40 percent iron oxide (more than 28 percent Fe), by dithionite citrate, in the fine-earth fraction.

Ferritic

or

2. More than 40 percent gibbsite in the fine-earth fraction.

Gibbsitic

or

3. Both:

- a. 18 to 40 percent iron oxide (12.6 to 28 percent Fe), by dithionite citrate, in the fine-earth fraction; *and*

- b. 18 to 40 percent gibbsite in the fine-earth fraction.

Sesquic

or

4. 18 to 40 percent iron oxide (12.6 to 28 percent Fe), by dithionite citrate, in the fine-earth fraction.

Ferruginous

or

5. 18 to 40 percent gibbsite in the fine-earth fraction.

Allitic

or

6. More than 50 percent (by weight) kaolinite plus halloysite, dickite, nacrite, and other 1:1 and nonexpanding 2:1 layer minerals and gibbsite in the fraction less than 0.002 in size and more kaolinite than halloysite.

Kaolinitic

or

7. More than 50 percent (by weight) halloysite plus kaolinite and allophane in the fraction less than 0.002 in size.

Halloysitic

or

8. All other properties.

Mixed

or

- B. Other soil layers or horizons, in the mineralogy control

section, that have a substitute class that replaces the particle-size class and that:

1. Have a sum of 8 times the Si (percent by weight extracted by acid oxalate) plus 2 times the Fe (percent by weight extracted by acid oxalate) of 5 or more, and 8 times the Si is more than 2 times the Fe.

Amorphic

or

2. Other soils that have a sum of 8 times the Si (percent by weight extracted by acid oxalate) plus 2 times the Fe (percent by weight extracted by acid oxalate) of 5 or more.

Ferrihydritic

or

3. Other soils that have 30 percent or more (by grain count) volcanic glass in the 0.02 to 2.0 mm fraction.

Glassy

or

4. All other soils that have a substitute class.

Mixed

or

C. Other mineral soil layers or horizons, in the mineralogy control section, in all other mineral soil orders and in Terric subgroups of Histosols and Histels that have:

1. Any particle-size class and more than 40 percent (by weight) carbonates (expressed as CaCO_3) plus gypsum, with gypsum constituting more than 35 percent of the total weight of carbonates plus gypsum, either in the fine-earth fraction or in the fraction less than 20 mm in size, whichever has a higher percentage of carbonates plus gypsum.

Gypsic

or

2. Any particle-size class and more than 40 percent (by weight) carbonates (expressed as CaCO_3) plus gypsum, either in the fine-earth fraction or in the fraction less than 20 mm in size, whichever has a higher percentage of carbonates plus gypsum.

Carbonatic

or

3. Any particle-size class, except for fragmental, and more than 40 percent (by weight) iron oxide (extractable by dithionite citrate), reported as Fe_2O_3 (or 28 percent reported as Fe), in the fine-earth fraction.

Ferritic

or

4. Any particle-size class, except for fragmental, and more than 40 percent (by weight) hydrated aluminum oxides, reported as gibbsite and bohemite, in the fine-earth fraction.

Gibbsitic

or

5. Any particle-size class, except for fragmental, and more than 40 percent (by weight) magnesium-silicate minerals, such as the serpentine minerals (antigorite, chrysotile, and lizardite) plus talc, olivines, Mg-rich pyroxenes, and Mg-rich amphiboles, in the fine-earth fraction.

Magnesian

or

6. Any particle-size class, except for fragmental, and a total iron oxide, by weight (Fe extracted by citrate-dithionite times 1.43 is used to determine the iron oxide), plus percent (by weight) gibbsite of more than 10 percent in the fine-earth fraction.

Parasesquic

or

7. Any particle-size class, except for fragmental, and more than 20 percent (by weight) glauconitic pellets in the fine-earth fraction.

Glauconitic

or

D. Other mineral soil layers or horizons, in the mineralogy control section, of soils in all other mineral orders and in Terric subgroups of Histosols and Histels, in a clayey, clayey-skeletal, fine or very-fine particle-size class, that in the fraction less than 0.002 mm in size:

1. Have more than one-half (by weight) halloysite plus kaolinite and allophane and more halloysite than any other single mineral.

Halloysitic

or

2. Have more than one-half (by weight) kaolinite plus halloysite, dickite, and nacrite, and other 1:1 or nonexpanding 2:1 layer minerals or gibbsite, and less than 10 percent (by weight) smectite.

Kaolinitic

or

3. Have more smectite (montmorillonite, beidellite, and nontronite), by weight, than any other single kind of clay mineral.

Smectitic

or

4. Have more than one-half (by weight) illite (hydrous mica) and commonly more than 4 percent K_2O .

Illitic*or*

5. Have more vermiculite than any other single kind of clay mineral.

Vermiculitic*or*

6. In more than one-half of the thickness, meet all of the following:

- a. Have no free carbonates; *and*
- b. The pH of a suspension of 1 g soil in 50 ml 1 M NaF is more than 8.4 after 2 minutes; *and*
- c. The ratio of 1500 kPa water to measured clay is 0.6 or more.

Isotic*or*

7. All other soils in this category.

Mixed*or*

- E. All other mineral soil layers or horizons, in the mineralogy control section, that have:

1. More than 40 percent (by weight) (80 percent by grain count) mica and stable mica pseudomorphs in the 0.02 to 2.0 mm fraction.

Micaceous*or*

2. More than 25 percent (by weight) (65 percent by grain count) mica and stable mica pseudomorphs in the 0.02 to 2.0 mm fraction.

Paramicaceous*or*

3. In more than one-half of the thickness, all of the following:

- a. No free carbonates; *and*
- b. The pH of a suspension of 1 g soil in 50 ml 1 M NaF is more than 8.4 after 2 minutes; *and*
- c. A ratio of 1500 kPa water to measured clay of 0.6 or more.

Isotic*or*

4. More than 90 percent (by weight) silica minerals (quartz, chalcedony, or opal) and other extremely durable

minerals that are resistant to weathering, in the 0.02 to 2.0 mm fraction.

Siliceous*or*

5. All other properties.

Mixed

Cation-Exchange Activity Classes

The cation-exchange activity classes help in making interpretations of mineral assemblages and of the nutrient-holding capacity of soils in mixed and siliceous mineralogy classes of clayey, clayey-skeletal, coarse-loamy, coarse-silty, fine, fine-loamy, fine-silty, loamy, loamy-skeletal, and very-fine particle-size classes. Cation-exchange activity classes are not assigned to Histosols and Histels, and they are not assigned to Oxisols and “kandi” and “kanhap” great groups and subgroups of Alfisols and Ultisols because assigning such classes to them would be redundant. Cation-exchange activity classes are not assigned to the sandy, sandy-skeletal, or fragmental particle-size class because the low clay content causes cation-exchange activity classes to be less useful and less reliable.

The cation-exchange capacity (CEC) is determined by NH_4OAc at pH 7 on the fine-earth fraction. The CEC of the organic matter, sand, silt, and clay is included in the determination. The criteria for the classes use ratios of CEC to the percent, by weight, of silicate clay, both by weighted average in the control section. In the following classes “clay” excludes clay-size carbonates. If the ratio of percent water retained at 1500 kPa tension to the percentage of measured clay is 0.25 or less or 0.6 or more in half or more of the particle-size control section (or part in contrasting families), then the percentage of clay is estimated by the following formula: Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon).

Control Section for Cation-Exchange Activity Classes

The control section for cation-exchange activity classes is the same as that used to determine the particle-size and mineralogy classes. For soils with strongly contrasting particle-size classes, where both named parts of the control section use a cation-exchange activity class, the class associated with the particle-size class that has the most clay is named. For example, in a pedon with a classification of loamy over clayey, mixed, active, calcareous, thermic Typic Udorthent, the cation-exchange activity class “active” is associated with the clayey part of the control section.

Key to Cation-Exchange Activity Classes

- A. Soils that are not Histosols, Histels, or Oxisols, that are not in “kandi” or “kanhap” great groups or subgroups of Alfisols and Ultisols, that are in either a mixed or siliceous

mineralogy class, that are not in a fragmental, sandy, or sandy-skeletal particle-size class or any substitute for a particle-size class, and that have a ratio of cation-exchange capacity (by NH_4OAc at pH 7) to clay (percent by weight) of:

1. 0.60 or more.

Superactive

2. 0.40 to 0.60.

Active

3. 0.24 to 0.40.

Semiactive

4. Less than 0.24.

Subactive

or

B. All other soils: No cation-exchange activity classes used.

Calcareous and Reaction Classes of Mineral Soils

The presence or absence of carbonates, soil reaction, and the presence of high concentrations of aluminum in mineral soils are treated together because they are so intimately related. There are four classes—calcareous, acid, nonacid, and allic. These are defined later in the key to calcareous and reaction classes. The classes are not used in all taxa, nor is more than one used in the same taxa.

Use of the Calcareous and Reaction Classes

The calcareous, acid, and nonacid classes are used in the names of the families of Entisols, Aquands, and Aquepts, except they are not used in any of the following:

1. Duraquands and Placaquands
2. Sulfaquepts, Fraguaquepts, and Petraquepts
3. Sandy, sandy-skeletal, cindery, pumiceous, or fragmental families
4. Families with carbonatic or gypsic mineralogy

The calcareous class, in addition to those listed above, is used in the names of the families of Aquolls, except it is not used with any of the following:

1. Calciaquolls, Natraquolls, and Argiaquolls
2. Cryaquolls and Duraquolls that have an argillic horizon
3. Families with carbonatic or gypsic mineralogy

The allic class is used only in families of Oxisols.

Control Section for Calcareous and Reaction Classes

The control section for the calcareous class is one of the following:

1. Soils with a root-limiting layer that is 25 cm or less below the mineral soil surface: A 2.5-cm-thick layer directly above the root-limiting layer.

2. Soils with a root-limiting layer that is 26 to 50 cm below the mineral soil surface: The layer between a depth of 25 cm below the mineral soil surface and the root-limiting layer.

3. All other listed soils: Between a depth of 25 and 50 cm below the mineral soil surface.

The control section for the acid, nonacid, and allic classes is the same as that for particle-size classes.

Key to Calcareous and Reaction Classes

A. Oxisols that have a layer, 30 cm or more thick within the control section, that contains more than 2 cmol(+) of KCl-extractable Al per kg soil in the fine-earth fraction.

Allic

B. Other listed soils that, in the fine-earth fraction, effervesce (in cold dilute HCl) in all parts of the control section.

Calcareous

C. Other listed soils with a pH of less than 5.0 in 0.01 M CaCl_2 (1:2) (about pH 5.5 in H_2O , 1:1) throughout the control section.

Acid

D. Other listed soils with a pH of 5.0 or more in 0.01 M CaCl_2 (1:2) in some or all layers in the control section.

Nonacid

It should be noted that a soil containing dolomite is calcareous and that effervescence of dolomite, when treated with cold dilute HCl, is slow.

The calcareous, acid, nonacid, and allic classes are listed in the family name, when appropriate, following the mineralogy class.

Soil Temperature Classes

Soil temperature classes, as named and defined here, are used as part of the family name in both mineral and organic soils. Temperature class names are used as part of the family name unless the criteria for a higher taxon carry the same limitation. Thus, frigid is implied in all cryic suborders, great groups, and subgroups and would be redundant if used in the names of families within these classes.

The Celsius (centigrade) scale is the standard. It is assumed that the temperature is that of a soil that is not being irrigated.

Control Section for Soil Temperature

The control section for soil temperature either is at a depth of 50 cm from the soil surface or is at the upper boundary of a

root-limiting layer, whichever is shallower. The soil temperature classes, defined in terms of the mean annual soil temperature and the difference between mean summer and mean winter temperatures, are determined by the following key.

Key to Soil Temperature Classes

A. Gelisols that have a mean annual soil temperature as follows:

1. $-10\text{ }^{\circ}\text{C}$ or lower.

or

Hypergelic

2. $-4\text{ }^{\circ}\text{C}$ to $-10\text{ }^{\circ}\text{C}$.

or

Pergelic

3. $+1\text{ }^{\circ}\text{C}$ to $-4\text{ }^{\circ}\text{C}$.

or

Subgelic

B. Other soils that have a difference in soil temperature of $5\text{ }^{\circ}\text{C}$ or more between mean summer (June, July, and August in the Northern Hemisphere) and mean winter (December, January, and February in the Northern Hemisphere) and a mean annual soil temperature of:

1. Lower than $8\text{ }^{\circ}\text{C}$ ($47\text{ }^{\circ}\text{F}$).

or

Frigid

2. $8\text{ }^{\circ}\text{C}$ ($47\text{ }^{\circ}\text{F}$) to $15\text{ }^{\circ}\text{C}$ ($59\text{ }^{\circ}\text{F}$).

or

Mesic

3. $15\text{ }^{\circ}\text{C}$ ($59\text{ }^{\circ}\text{F}$) to $22\text{ }^{\circ}\text{C}$ ($72\text{ }^{\circ}\text{F}$).

or

Thermic

4. $22\text{ }^{\circ}\text{C}$ ($72\text{ }^{\circ}\text{F}$) or higher.

or

Hyperthermic

C. All other soils that have a mean annual soil temperature as follows:

1. Lower than $8\text{ }^{\circ}\text{C}$ ($47\text{ }^{\circ}\text{F}$).

or

Isofrigid

2. $8\text{ }^{\circ}\text{C}$ ($47\text{ }^{\circ}\text{F}$) to $15\text{ }^{\circ}\text{C}$ ($59\text{ }^{\circ}\text{F}$).

or

Isomesic

3. $15\text{ }^{\circ}\text{C}$ ($59\text{ }^{\circ}\text{F}$) to $22\text{ }^{\circ}\text{C}$ ($72\text{ }^{\circ}\text{F}$).

or

Isothermic

4. $22\text{ }^{\circ}\text{C}$ ($72\text{ }^{\circ}\text{F}$) or higher.

Isohyperthermic

Soil Depth Classes

Soil depth classes are used in all families that have a root-limiting layer at a specified depth from the mineral soil surface, except for those families in Lithic subgroups and those with a fragipan. The root-limiting layers included in soil depth classes are duripans; petrocalcic, petrogypsic, and placic horizons; continuous ortstein (90 percent or more); and densic, lithic, paralithic, and petroferric contacts. Soil depth classes for Histosols and Histels are given later in this chapter. One soil depth class name, "shallow," is used to characterize certain mineral soil families that have one of the depths indicated in the following key.

Key to Soil Depth Classes

A. Oxisols that are less than 100 cm deep (from the mineral soil surface) to a root-limiting layer and are not in a Lithic subgroup.

Shallow

or

B. Soils in all other mineral soil orders that are less than 50 cm deep (from the mineral soil surface) to a root-limiting layer and are not in a Lithic subgroup.

Shallow

or

C. All other mineral soils: No soil depth class used.

Rupture-Resistance Classes

In this taxonomy, some partially cemented soil materials, such as durinodes, serve as differentiae in categories above the family, while others, such as partially cemented spodic materials (ortstein), do not. No single family, however, should include soils both with and without partially cemented horizons. In Spodosols, a partially cemented spodic horizon is used as a family differentia. The following rupture-resistance class is defined for families of Spodosols:

A. Spodosols that have an ortstein horizon.

Ortstein

or

B. All other soils: No rupture-resistance class used.

Classes of Coatings (on Sands)

Despite the emphasis given to particle-size classes in this taxonomy, variability remains in the sandy particle-size class, which includes sands and loamy sands. Some sands are very clean, i.e., almost completely free of silt and clay, while others are mixed with appreciable amounts of finer grains. Clay is more efficient at coating sand than is silt. A weighted average silt (by weight) plus 2 times the weighted average clay (by weight) of more than 5 makes a reasonable division of the sands at the family level. Two classes of Quartzipsamments are defined in terms of their content of silt plus 2 times their content of clay.

Control Section for Classes of Coatings

The control section for classes of coatings is the same as that for particle-size classes or their substitutes and for mineralogy classes.

Key to Classes of Coatings

A. Quartzipsamments that have a sum of the weighted average silt (by weight) plus 2 times the weighted average clay of more than 5.

Coated

or

B. Other Quartzipsamments.

Uncoated

Classes of Permanent Cracks

Some Hydraquents consolidate or shrink after drainage and become Fluvaquents or Humaquepts. In the process they can form polyhedrons roughly 12 to 50 cm in diameter, depending on their *n* value and texture. These polyhedrons are separated by cracks that range in width from 2 mm to more than 1 cm. The polyhedrons may shrink and swell with changes in the moisture content of the soils, but the cracks are permanent and can persist for several hundreds of years, even if the soils are cultivated. The cracks permit rapid movement of water through the soils, either vertically or laterally. Such soils may have the same texture, mineralogy, and other family properties as soils that do not form cracks or that have cracks that open and close with the seasons. Soils with permanent cracks are very rare in the United States.

Control Section for Classes of Permanent Cracks

The control section for classes of permanent cracks is from the base of any plow layer or 25 cm from the soil surface, whichever is deeper, to 100 cm below the soil surface.

Key to Classes of Permanent Cracks

A. Fluvaquents or Humaquepts that have, throughout a layer 50 cm or more thick, continuous, permanent, lateral and vertical cracks 2 mm or more wide, spaced at average lateral intervals of less than 50 cm.

Cracked

or

B. All other Fluvaquents and Humaquepts: No class of permanent cracks used.

Family Differentiae for Histosols and Histels

Most of the differentiae that are used to distinguish families of Histosols and Histels have already been defined, either because they are used as differentiae in mineral soils as well as Histosols and Histels or because their definitions are used for the classification of some Histosols and Histels in categories higher than the family. In the following descriptions, differentiae not previously mentioned are defined and the classes in which they are used are enumerated.

The order in which family classes, if appropriate for a particular family, are placed in the technical family names of Histosols and Histels is as follows:

- Particle-size classes
- Mineralogy classes, including the nature of limnic deposits in Histosols
- Reaction classes
- Soil temperature classes
- Soil depth classes (used only in Histosols)

Particle-Size Classes

Particle-size classes are used only for the family names of Terric subgroups of Histosols and Histels. The classes are determined from the properties of the mineral soil materials in the control section through use of the key to particle-size classes. The classes are more generalized than those for soils in other orders.

Control Section for Particle-Size Classes

The particle-size control section is the upper 30 cm of the mineral layer or of that part of the mineral layer that is within the control section for Histosols and Histels (given in chapter 3), whichever is thicker.

Key to Particle-Size Classes of Histosols and Histels

A. Terric subgroups of Histosols and Histels that

have (by weighted average) in the particle-size control section:

1. A fine-earth component of less than 10 percent (including associated medium and finer pores) of the total volume.

Fragmental

or

2. A texture (of the fine earth) of sand or loamy sand, including less than 50 percent (by weight) very fine sand in the fine-earth fraction.

Sandy or sandy-skeletal

or

3. Less than 35 percent clay in the fine-earth fraction and a content of rock fragments of 35 percent or more of the total volume.

Loamy-skeletal

or

4. A content of rock fragments of 35 percent or more of the total volume.

Clayey-skeletal

or

5. A clay content of 35 percent or more in the fine-earth fraction.

Clayey

or

6. All other Terric subgroups of Histosols and Histels.

Loamy

or

B. All other Histosols and Histels: No particle-size class used.

Mineralogy Classes

There are three different kinds of mineralogy classes recognized for families in certain great groups and subgroups of Histosols. The first kind is the ferrihumic soil material defined below. The second is three types of limnic materials—coprogenous earth, diatomaceous earth, and marl, defined in chapter 3. The third is mineral layers of Terric subgroups. The key to mineralogy classes for these mineral layers is the same as that for mineral soils. Terric subgroups of Histels also have the same mineralogy classes as those for mineral soils.

Ferrihumic Mineralogy Class

Ferrihumic soil material, i.e., bog iron, is an authigenic (formed in place) deposit consisting of hydrated iron oxide

mixed with organic matter, either dispersed and soft or cemented into large aggregates, in a mineral or organic layer that has all of the following characteristics:

1. Saturation with water for more than 6 months per year (or artificial drainage);
2. 2 percent or more (by weight) iron concretions having lateral dimensions ranging from less than 5 to more than 100 mm and containing 10 percent or more (by weight) free iron oxide (7 percent or more Fe) and 1 percent or more (by weight) organic matter; *and*
3. A dark reddish or brownish color that changes little on drying.

The ferrihumic mineralogy class is used for families of Fibrists, Hemists, and Saprists, but it is not used for Sphagnofibrists and Sphagnic subgroups of other great groups. If the ferrihumic class is used in the family name of a Histosol, no other mineralogy classes are used in that family because the presence of iron is considered to be by far the most important mineralogical characteristic.

Mineralogy Classes Applied Only to Limnic Subgroups

Limnic materials (defined in chapter 3) with a thickness of 5 cm or more are mineralogy class criteria if the soil does not also have ferrihumic mineralogy. The following family classes are used: coprogenous, diatomaceous, and marly.

Control Section for the Ferrihumic Mineralogy Class and Mineralogy Classes Applied to Limnic Subgroups

The control section for the ferrihumic mineralogy class and the classes applied to Limnic subgroups is the same as the control section for Histosols.

Mineralogy Classes Applied Only to Terric Subgroups

For Histosols and Histels in Terric subgroups, use the same key to mineralogy classes as that used for mineral soils unless a Histosol also has ferrihumic mineralogy.

Control Section for Mineralogy Classes Applied Only to Terric Subgroups

For Terric subgroups of Histosols and Histels, use the same control section for mineralogy classes as that used for the particle-size classes.

Key to Mineralogy Classes

A. Histosols (except for Folists), Sphagnofibrists, and Sphagnic subgroups of other great groups that have ferrihumic soil material within the control section for Histosols.

Ferrihumic

or

B. Other Histosols that have, within the control section for

Histosols, limnic materials, 5 cm or more thick, that consist of:

1. Coprogenous earth.

Coprogenous

or

2. Diatomaceous earth.

Diatomaceous

or

3. Marl.

Marly

or

C. Histels and other Histosols in Terric subgroups: Use the key to mineralogy classes for mineral soils.

or

D. All other Histels and Histosols: No mineralogy class used.

Reaction Classes

Reaction classes are used in all families of Histosols and Histels. The two classes recognized are defined in the following key:

A. Histosols and Histels that have a pH value, on undried samples, of 4.5 or more (in 0.01 M CaCl₂) in one or more layers of organic soil materials within the control section for Histosols.

Euic

or

B. All other Histosols and Histels.

Dysic

Soil Temperature Classes

The soil temperature classes of Histosols are determined through use of the same key and definitions as those used for mineral soils. Histels have the same temperature classes as other Gelisols.

Soil Depth Classes

Soil depth classes refer to the depth to a root-limiting layer, a fragmental particle-size class, or a cindery or pumiceous substitute class. The root-limiting layers included in soil depth classes of Histosols are duripans; petrocalcic, petrogypsic, and placic horizons; continuous ortstein; and densic, lithic, paralithic, and petroferic contacts. The following key is used for families in all subgroups of Histosols. The shallow class is not used in the suborder Folists.

Key to Soil Depth Classes

A. Histosols that are less than 18 cm deep to a root-limiting layer, to a fragmental particle-size class, or to a cindery or pumiceous substitute class.

Micro

or

B. Other Histosols, excluding Folists, that have a root-limiting layer, a fragmental particle-size class, or a cindery or pumiceous substitute class at a depth between 18 and 50 cm from the soil surface.

Shallow

or

C. All other Histosols: No soil depth class used.

Series Differentiae Within a Family

The function of the series is pragmatic, and differences within a family that affect the use of a soil should be considered in classifying soil series. The separation of soils at the series level of this taxonomy can be based on any property that is used as criteria at higher levels in the system. The criteria most commonly used include presence of, depth to, thickness of, and expression of horizons and properties diagnostic for the higher categories and differences in texture, mineralogy, soil moisture, soil temperature, and amounts of organic matter. The limits of the properties used as differentiae must be more narrowly defined than the limits for the family. The properties used, however, must be reliably observable or be inferable from other soil properties or from the setting or vegetation.

The differentiae used must be within the series control section. Differences in soil or regolith that are outside the series control section and that have not been recognized as series differentiae but are relevant to potential uses of certain soils are considered as a basis for phase distinctions.

Control Section for the Differentiation of Series

The control section for the soil series is similar to that for the family, but it differs in a few important respects. The particle-size and mineralogy control sections for families end at the upper boundary of a fragipan, duripan, or petrocalcic horizon because these horizons have few roots. In contrast to the control section for the series, the thickness of such horizons is not taken into account in the control sections for the family. The series control section includes materials starting at the soil surface and also the first 25 cm below a densic or paralithic contact if its upper boundary is less than 125 cm below the mineral soil surface. Properties of horizons and layers below the particle-size control section, a depth between 100 and 150

cm (or to 200 cm if in a diagnostic horizon) from the mineral soil surface, also are considered.

Key to the Control Section for the Differentiation of Series

The part of a soil to be considered in differentiating series within a family is as follows:

A. Mineral soils that have permafrost within 150 cm of the soil surface: From the soil surface to the shallowest of the following:

1. A lithic or petroferric contact; *or*
2. A depth of 100 cm if the depth to permafrost is less than 75 cm; *or*
3. 25 cm below the upper boundary of permafrost if that boundary is 75 cm or more below the soil surface; *or*
4. 25 cm below a densic or paralithic contact; *or*
5. A depth of 150 cm; *or*

B. Other mineral soils: From the soil surface to the shallowest of the following:

1. A lithic or petroferric contact; *or*
2. A depth of either 25 cm below a densic or paralithic

contact or 150 cm below the soil surface, whichever is shallower, if there is a densic or paralithic contact within 150 cm; *or*

3. A depth of 150 cm if the bottom of the deepest diagnostic horizon is less than 150 cm from the soil surface; *or*

4. The lower boundary of the deepest diagnostic horizon or a depth of 200 cm, whichever is shallower, if the lower boundary of the deepest diagnostic horizon is 150 cm or more below the soil surface; *or*

C. Organic soils (Histosols and Histels): From the soil surface to the shallowest of the following:

1. A lithic or petroferric contact; *or*
2. A depth of 25 cm below a densic or paralithic contact; *or*
3. A depth of 100 cm if the depth to permafrost is less than 75 cm; *or*
4. 25 cm below the upper boundary of permafrost if that boundary is between a depth of 75 and 125 cm below the soil surface; *or*
5. The base of the bottom tier

CHAPTER 18

Designations for Horizons and Layers

This chapter describes soil layers and genetic soil horizons. The genetic horizons are not the equivalent of the diagnostic horizons of *Soil Taxonomy*. While designations of genetic horizons express a qualitative judgment about the kinds of changes that are believed to have taken place in a soil, diagnostic horizons are quantitatively defined features that are used to differentiate between taxa. A diagnostic horizon may encompass several genetic horizons, and the changes implied by genetic horizon designations may not be large enough to justify recognition of different diagnostic horizons.

Master Horizons and Layers

The capital letters O, A, E, B, C, R, and W represent the master horizons and layers of soils. These letters are the base symbols to which other characters are added to complete the designations. Most horizons and layers are given a single capital-letter symbol; some require two.

O horizons or layers: *Layers dominated by organic material. Some are saturated with water for long periods or were once saturated but are now artificially drained; others have never been saturated.*

Some O layers consist of undecomposed or partially decomposed litter (such as leaves, needles, twigs, moss, and lichens) that has been deposited on the surface. They may be on top of either mineral or organic soils. Other O layers consist of organic material that was deposited under saturated conditions and has decomposed to varying stages. The mineral fraction of such material constitutes only a small percentage of the volume of the material and generally much less than half of its weight. Some soils consist entirely of materials designated as O horizons or layers.

An O layer may be on the surface of a mineral soil, or it may be at any depth below the surface if it is buried. A horizon formed by the illuviation of organic material into a mineral subsoil is not an O horizon, although some horizons that have formed in this manner contain considerable amounts of organic matter.

A horizons: *Mineral horizons that have formed at the surface or below an O horizon. They exhibit obliteration of all or much of the original rock structure¹ and show one or both of*

the following: (1) an accumulation of humified organic matter closely mixed with the mineral fraction and not dominated by properties characteristic of E or B horizons (defined below) or (2) properties resulting from cultivation, pasturing, or similar kinds of disturbance.

If a surface horizon has properties of both A and E horizons but the feature emphasized is an accumulation of humified organic matter, it is designated as an A horizon. In some areas, such as areas of warm, arid climates, the undisturbed surface horizon is less dark than the adjacent underlying horizon and contains only small amounts of organic matter. It has a morphology distinct from the C layer, although the mineral fraction is unaltered or only slightly altered by weathering. Such a horizon is designated as an A horizon because it is at the surface. Recent alluvial or eolian deposits that retain fine stratification are not considered to be A horizons unless cultivated.

E horizons: *Mineral horizons in which the main feature is the loss of silicate clay, iron, aluminum, or some combination of these, leaving a concentration of sand and silt particles. These horizons exhibit obliteration of all or much of the original rock structure.*

An E horizon is most commonly differentiated from an underlying B horizon in the same sequum by a color of higher value or lower chroma, or both, by coarser texture, or by a combination of these properties. In some soils the color of the E horizon is that of the sand and silt particles, but in many soils coatings of iron oxides or other compounds mask the color of the primary particles. An E horizon is most commonly differentiated from an overlying A horizon by its lighter color. It generally contains less organic matter than the A horizon. An E horizon is commonly near the surface, below an O or A horizon and above a B horizon, but eluvial horizons that are within or between parts of the B horizon or extend to depths greater than those of normal observation can be assigned the letter E if they are pedogenic.

B horizons: *Horizons that have formed below an A, E, or O horizon. They are dominated by the obliteration of all or much of the original rock structure and show one or more of the following:*

1. Illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination;
2. Evidence of the removal or addition of carbonates;

¹ Rock structure includes fine stratification in unconsolidated soil materials as well as pseudomorphs of weathered minerals that retain their positions relative to each other and to unweathered minerals in saprolite.

3. Residual concentration of oxides;
4. Coatings of sesquioxides that make the horizon conspicuously lower in color value, higher in chroma, or redder in hue, without apparent illuviation of iron;
5. Alteration that forms silicate clay or liberates oxides, or both, and that forms a granular, blocky, or prismatic structure if volume changes accompany changes in moisture content;
6. Brittleness; *or*
7. Strong gleying.

All of the different kinds of B horizons are, or were originally, subsurface horizons. Included as B horizons, where contiguous to other genetic horizons, are layers of illuvial concentration of carbonates, gypsum, or silica that are the result of pedogenic processes (and may or may not be cemented) and brittle layers that show other evidence of alteration, such as prismatic structure or illuvial accumulation of clay.

Examples of layers that are not B horizons are layers in which clay films either coat rock fragments or cover finely stratified unconsolidated sediments, regardless of whether the films were formed in place or by illuviation; layers into which carbonates have been illuviated but that are not contiguous to an overlying genetic horizon; and layers with gleying but no other pedogenic changes.

C horizons or layers: *Horizons or layers, excluding strongly cemented and harder bedrock, that are little affected by pedogenic processes and lack the properties of O, A, E, or B horizons. Most are mineral layers. The material of C layers may be either like or unlike the material from which the solum has presumably formed. The C horizon may have been modified, even if there is no evidence of pedogenesis.*

Included as C layers are sediment, saprolite, bedrock, and other geologic materials that are moderately cemented or less cemented. The excavation difficulty in these materials commonly is low or moderate. Some soils form in material that is already highly weathered, and if such material does not meet the requirements for A, E, or B horizons, it is designated by the letter C. Changes that are not considered pedogenic are those not related to the overlying horizons. Some layers that have accumulations of silica, carbonates, gypsum, or more soluble salts are included in C horizons, even if cemented. If a cemented layer formed through pedogenic processes, however, it is considered a B horizon.

R layers: *Strongly cemented to indurated bedrock.*

Granite, basalt, quartzite, limestone, and sandstone are examples of bedrock designated by the letter R. The excavation difficulty commonly exceeds high. The R layer is sufficiently coherent when moist to make hand-digging with a spade impractical, although the layer may be chipped or scraped. Some R layers can be ripped with heavy power equipment. The bedrock may have cracks, but these are generally too few and

too small to allow root penetration. The cracks may be coated or filled with clay or other material.

W layers: *Water*

This symbol indicates water layers within or beneath the soil. The water layer is designated as *W_f* if it is permanently frozen and as *W* if it is not permanently frozen. The *W* (or *W_f*) designation is not used for shallow water, ice, or snow above the soil surface.

Transitional and Combination Horizons

Horizons dominated by properties of one master horizon but having subordinate properties of another.—Two capital-letter symbols are used for such transitional horizons, e.g., AB, EB, BE, or BC. The first of these symbols indicates that the properties of the horizon so designated dominate the transitional horizon. An AB horizon, for example, has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A horizon than the B horizon.

In some cases a horizon can be designated as transitional even if one of the master horizons to which it presumably forms a transition is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil from which the overlying E horizon has not been removed by erosion. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent materials.

Horizons with two distinct parts that have recognizable properties of the two kinds of master horizons indicated by the capital letters.—The two capital letters designating such combination horizons are separated by a virgule (/), e.g., E/B, B/E, or B/C. Most of the individual parts of one horizon component are surrounded by the other. The designation may be used even when horizons similar to one or both of the components are not present, provided that the separate components can be recognized in the combination horizon. The first symbol is that of the horizon with the greater volume.

Single sets of horizon designators do not cover all situations; therefore, some improvising is needed. For example, Argic Udipsamments have lamellae that are separated from each other by eluvial layers. Because it is generally not practical to describe each lamella and eluvial layer as a separate horizon, the horizons can be combined but the components described separately. One horizon then has several lamellae and eluvial layers and can be designated an “E and Bt” horizon. The complete horizon sequence for these soils could be: Ap-Bw-E and Bt1-E and Bt2-C.

Suffix Symbols

Lowercase letters are used as suffixes to designate specific kinds of master horizons and layers. The term “accumulation” is used in many of the definitions of such horizons to indicate

that these horizons must contain more of the material in question than is presumed to have been present in the parent material. The suffix symbols and their meanings are as follows:

a *Highly decomposed organic material*

This symbol is used with O to indicate the most highly decomposed organic materials, which have a fiber content of less than 17 percent (by volume) after rubbing.

b *Buried genetic horizon*

This symbol is used in mineral soils to indicate identifiable buried horizons with major genetic features that were developed before burial. Genetic horizons may or may not have formed in the overlying material, which may be either like or unlike the assumed parent material of the buried soil. This symbol is not used in organic soils, nor is it used to separate an organic layer from a mineral layer.

c *Concretions or nodules*

This symbol indicates a significant accumulation of concretions or nodules. Cementation is required. The cementing agent commonly is iron, aluminum, manganese, or titanium. It cannot be silica, dolomite, calcite, or more soluble salts.

d *Physical root restriction*

This symbol indicates noncemented, root-restricting layers in naturally occurring or human-made sediments or materials. Examples are dense basal till, plowpans, and other mechanically compacted zones.

e *Organic material of intermediate decomposition*

This symbol is used with O to indicate organic materials of intermediate decomposition. The fiber content of these materials is 17 to 40 percent (by volume) after rubbing.

f *Frozen soil or water*

This symbol indicates that a horizon or layer contains permanent ice. The symbol is not used for seasonally frozen layers or for dry permafrost.

ff *Dry permafrost*

This symbol indicates a horizon or layer that is continually colder than 0°C and does not contain enough ice to be cemented by ice. This suffix is not used for horizons or layers that have a temperature warmer than 0°C at some time of the year.

g *Strong gleying*

This symbol indicates either that iron has been reduced and removed during soil formation or that saturation with stagnant water has preserved it in a

reduced state. Most of the affected layers have chroma of 2 or less, and many have redox concentrations. The low chroma can represent either the color of reduced iron or the color of uncoated sand and silt particles from which iron has been removed. The symbol g is not used for materials of low chroma that have no history of wetness, such as some shales or E horizons. If g is used with B, pedogenic change in addition to gleying is implied. If no other pedogenic change besides gleying has taken place, the horizon is designated Cg.

h *Illuvial accumulation of organic matter*

This symbol is used with B to indicate the accumulation of illuvial, amorphous, dispersible complexes of organic matter and sesquioxides if the sesquioxide component is dominated by aluminum but is present only in very small quantities. The organo-sesquioxide material coats sand and silt particles. In some horizons these coatings have coalesced, filled pores, and cemented the horizon. The symbol h is also used in combination with s as “Bhs” if the amount of the sesquioxide component is significant but the color value and chroma, moist, of the horizon are 3 or less.

i *Slightly decomposed organic material*

This symbol is used with O to indicate the least decomposed of the organic materials. The fiber content of these materials is 40 percent or more (by volume) after rubbing.

j *Accumulation of jarosite*

Jarosite is a potassium or iron sulfate mineral that is commonly an alteration product of pyrite that has been exposed to an oxidizing environment. Jarosite has hue of 2.5YR or yellower and normally has chroma of 6 or more, although chromas as low as 3 or 4 have been reported.

jj *Evidence of cryoturbation*

Evidence of cryoturbation includes irregular and broken horizon boundaries, sorted rock fragments, and organic soil materials occurring as bodies and broken layers within and/or between mineral soil layers. The organic bodies and layers are most commonly at the contact between the active layer and the permafrost.

k *Accumulation of carbonates*

This symbol indicates an accumulation of alkaline-earth carbonates, commonly calcium carbonate.

m *Cementation or induration*

This symbol indicates continuous or nearly continuous cementation. It is used only for horizons that are more than 90 percent cemented, although they may be

fractured. The cemented layer is physically root-restrictive. The predominant cementing agent (or the two dominant cementing agents) may be indicated by adding defined letter suffixes, singly or in pairs. The horizon suffix km indicates cementation by carbonates; qm, cementation by silica; sm, cementation by iron; ym, cementation by gypsum; kqm, cementation by lime and silica; and zm, cementation by salts more soluble than gypsum.

n *Accumulation of sodium*

This symbol indicates an accumulation of exchangeable sodium.

o *Residual accumulation of sesquioxides*

This symbol indicates a residual accumulation of sesquioxides.

p *Tillage or other disturbance*

This symbol indicates a disturbance of the surface layer by mechanical means, pasturing, or similar uses. A disturbed organic horizon is designated Op. A disturbed mineral horizon is designated Ap even though it is clearly a former E, B, or C horizon.

q *Accumulation of silica*

This symbol indicates an accumulation of secondary silica.

r *Weathered or soft bedrock*

This symbol is used with C to indicate cemented layers (moderately cemented or less cemented). Examples are weathered igneous rock and partly consolidated sandstone, siltstone, or shale. The excavation difficulty is low to high.

s *Illuvial accumulation of sesquioxides and organic matter*

This symbol is used with B to indicate an accumulation of illuvial, amorphous, dispersible complexes of organic matter and sesquioxides if both the organic-matter and sesquioxide components are significant and if either the color value or chroma, moist, of the horizon is 4 or more. The symbol is also used in combination with h as “Bhs” if both the organic-matter and sesquioxide components are significant and if the color value and chroma, moist, are 3 or less.

ss *Presence of slickensides*

This symbol indicates the presence of slickensides. Slickensides result directly from the swelling of clay minerals and shear failure, commonly at angles of 20 to 60 degrees above horizontal. They are indicators that

other vertic characteristics, such as wedge-shaped peds and surface cracks, may be present.

t *Accumulation of silicate clay*

This symbol indicates an accumulation of silicate clay that either has formed within a horizon and subsequently has been translocated within the horizon or has been moved into the horizon by illuviation, or both. At least some part of the horizon should show evidence of clay accumulation either as coatings on surfaces of peds or in pores, as lamellae, or as bridges between mineral grains.

v *Plinthite*

This symbol indicates the presence of iron-rich, humus-poor, reddish material that is firm or very firm when moist and hardens irreversibly when exposed to the atmosphere and to repeated wetting and drying.

w *Development of color or structure*

This symbol is used with B to indicate the development of color or structure, or both, with little or no apparent illuvial accumulation of material. It should not be used to indicate a transitional horizon.

x *Fragipan character*

This symbol indicates a genetically developed layer that has a combination of firmness and brittleness and commonly a higher bulk density than the adjacent layers. Some part of the layer is physically root-restrictive.

y *Accumulation of gypsum*

This symbol indicates an accumulation of gypsum.

z *Accumulation of salts more soluble than gypsum*

This symbol indicates an accumulation of salts that are more soluble than gypsum.

Conventions for Using Letter Suffixes

Many master horizons and layers that are symbolized by a single capital letter have one or more lowercase letter suffixes. The following rules apply:

1. Letter suffixes should directly follow the capital letter.
2. More than three suffixes are rarely used.
3. If more than one suffix is needed, the following letters, if used, are written first: a, d, e, h, i, r, s, t, and w. Except in the Bhs or Crt² horizon designations, none of these letters are used in combination in a single horizon.
4. If more than one suffix is needed and the horizon is not

²Indicates weathered bedrock or saprolite in which clay films are present.

buried, the following symbols, if used, are written last: c, f, g, m, v, and x. Some examples: Btc, Bkm, and Bsv.

5. If a horizon is buried, the suffix b is written last. It is used only for buried mineral soils.

A B horizon that has a significant accumulation of clay and also shows evidence of a development of color or structure, or both, is designated Bt (t has precedence over w, s, and h). A B horizon that is gleyed or has accumulations of carbonates, sodium, silica, gypsum, or salts more soluble than gypsum or residual accumulations of sesquioxides carries the appropriate symbol: g, k, n, q, y, z, or o. If illuvial clay also is present, t precedes the other symbol: Bto.

Unless needed for explanatory purposes, the suffixes h, s, and w are not used with g, k, n, q, y, z, or o.

Vertical Subdivision

Commonly, a horizon or layer identified by a single letter or a combination of letters has to be subdivided. For this purpose, Arabic numerals are added to the letters of the horizon designation. These numerals follow all the letters. Within a C horizon, for example, successive layers may be designated C1, C2, C3, etc. If the lower part is gleyed and the upper part is not gleyed, the layers may be designated C1-C2-Cg1-Cg2 or C-Cg1-Cg2-R.

These conventions apply whatever the purpose of the subdivision. In many soils a horizon that could be identified by a single set of letters is subdivided because of the need to recognize differences in morphological features, such as structure, color, or texture. These divisions are numbered consecutively with Arabic numerals, but the numbering starts again with 1 wherever in the profile any letter of the horizon symbol changes, e.g., Bt1-Bt2-Btk1-Btk2 (not Bt1-Bt2-Btk3-Btk4). The numbering of vertical subdivisions within a horizon is not interrupted at a discontinuity (indicated by a numerical prefix) if the same letter combination is used in both materials, e.g., Bs1-Bs2-2Bs3-2Bs4 (not Bs1-Bs2-2Bs1-2Bs2).

During sampling for laboratory analyses, thick soil horizons are sometimes subdivided even though differences in morphology are not evident in the field. These subdivisions are identified by Arabic numerals that follow the respective horizon designations. For example, four layers of a Bt horizon sampled by 10-cm increments are designated Bt1, Bt2, Bt3, and Bt4. If the horizon has already been subdivided because of differences in morphological features, the set of Arabic numerals that identifies the additional sampling subdivisions follows the first numeral. For example, three layers of a Bt2 horizon sampled by 10-cm increments are designated Bt21, Bt22, and Bt23. The descriptions for each of these sampling subdivisions can be the same, and a statement indicating that the horizon has been subdivided only for sampling purposes can be added.

Discontinuities

Arabic numerals are used as prefixes to horizon designations (preceding the letters A, E, B, C, and R) to indicate discontinuities in mineral soils. These prefixes are distinct from the Arabic numerals that are used as suffixes denoting vertical subdivisions.

A discontinuity that can be identified by a number prefix is a significant change in particle-size distribution or mineralogy that indicates a difference in the material from which the horizons have formed and/or a significant difference in age, unless that difference in age is indicated by the suffix b. Symbols that identify discontinuities are used only when they can contribute substantially to an understanding of the relationships among horizons. The stratification common to soils that formed in alluvium is not designated as a discontinuity, unless particle-size distribution differs markedly from layer to layer (i.e., particle-size classes are strongly contrasting), even though genetic horizons may have formed in the contrasting layers.

Where a soil has formed entirely in one kind of material, the whole profile is understood to be material 1 and the number prefix is omitted from the symbol. Similarly, the uppermost material in a profile consisting of two or more contrasting materials is understood to be material 1, but the number is omitted. Numbering starts with the second layer of contrasting material, which is designated 2. Underlying contrasting layers are numbered consecutively. Even when the material of a layer below material 2 is similar to material 1, it is designated 3 in the sequence; the numbers indicate a change in materials, not types of material. Where two or more consecutive horizons have formed in the same kind of material, the same prefix number is applied to all the designations of horizons in that material: Ap-E-Bt1-2Bt2-2Bt3-2BC. The suffix numbers designating subdivisions of the Bt horizon continue in consecutive order across the discontinuity.

If an R layer is present below a soil that has formed in residuum and if the material of the R layer is judged to be like the material from which the soil has developed, the Arabic-number prefix is not used. The prefix is used, however, if it is thought that the R layer would produce material unlike that in the solum, e.g., A-Bt-C-2R or A-Bt-2R. If part of the solum has formed in residuum, the symbol R is given the appropriate prefix: Ap-Bt1-2Bt2-2Bt3-2C1-2C2-2R.

A buried horizon (designated by the letter b) presents special problems. It is obviously not in the same deposit as the overlying horizons. Some buried horizons, however, have formed in material that is lithologically like the overlying deposit. A prefix is not used to distinguish material of such a buried horizon. If the material in which a horizon of a buried soil has formed is lithologically unlike the overlying material, however, the discontinuity is indicated by a number prefix and the symbol for the buried horizon also is used, e.g., Ap-Bt1-Bt2-BC-C-2ABb-2Btb1-2Btb2-2C.

Discontinuities between different kinds of layers in organic soils are not identified. In most cases such differences are identified either by letter-suffix designations if the different layers are organic or by the master symbol if the different layers are mineral.

Use of the Prime Symbol

If two or more horizons of the same kind are separated by one or more horizons of a different kind in a pedon, identical letter and number symbols can be used for those horizons that have the same characteristics. For example, the sequence A-E-Bt-E-Btx-C identifies a soil that has two E horizons. To emphasize this characteristic, the prime symbol (´) is added

after the master-horizon symbol of the lower of the two horizons that have identical designations, e.g., A-E-Bt-E´-Btx-C. The prime symbol, when appropriate, is applied to the capital-letter horizon designation, and any lowercase letter symbols follow it: B´t. The prime symbol is used only when the letter designations of the two layers in question are completely identical. In the rare cases when three layers have identical letter symbols, double prime symbols can be used for the lowest of these layers: E´´.

The same principle applies in designating layers of organic soils. The prime symbol is used only to distinguish two or more horizons that have identical symbols, e.g., Oi-C-O´i-C´ (when the soil has two identical Oi layers) or Oi-C-Oe-C´ (when the two C layers are of the same kind).

Appendix

SI unit conversion table

CEC and ECEC: 1 meq/100 g soil = 1 cmol(+)/kg soil

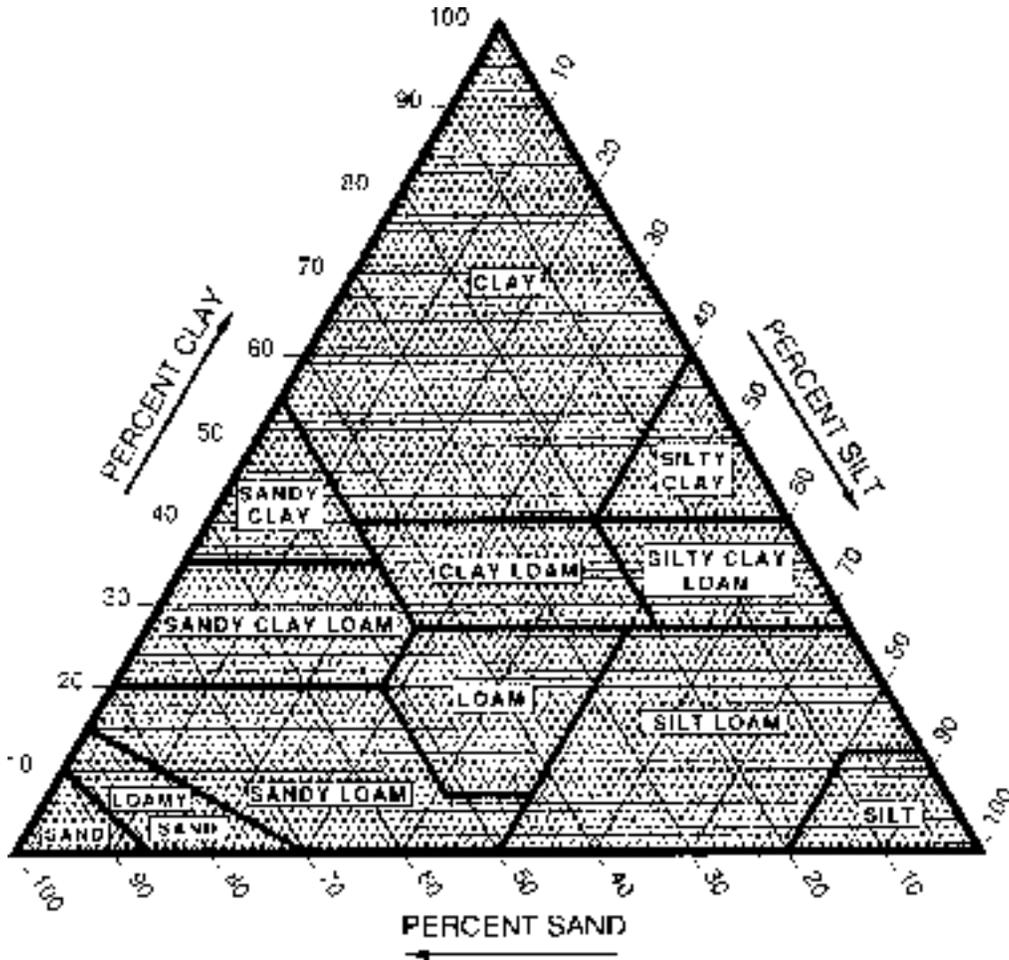
Pressure:

15-bar water = 1500 kPa water retention

Conductivity: 1 mmho/cm = 1 dS/m

1/3-bar water = 33 kPa water retention

Percentages of clay (less than 0.002 mm), silt (0.002 to 0.05 mm), and sand (0.05 to 2.0 mm) in the basic soil textural classes



*Index***A**

A horizons. <i>See</i> Horizons and layers.	
Abrupt textural change	21
Acraquox	233
Acroperox	234
Acrotorrox	238
Acrudox	239
Acrustox	243
Agric horizon	16
Alaquods	249
Albaqualfs	42
Albaquults	260
Albic horizon	16
Albic materials	22
Albolls	192
Alfisols	41
Alorthods	254
Andic soil properties	22
Andisols	83
Anhydrous conditions	22
Anhyorthels	151
Anhyturbels	154
Aniso class	296
Anthracambids	114
Anthrepts	165
Anthropic epipedon	13
Aqualfs	41
Aquands	83
Aquepts	130
Aquepts	166
Aquerts	281
Aquic conditions	30
Aquic moisture regime. <i>See</i> Soil moisture regimes.	
Aquicambids	114
Aquisalids	128
Aquiturbels	154
Aquods	249
Aquolls	193
Aquorthels	151
Aquox	233
Aquults	259
Arents	133
Argialbolls	192
Argiaquolls	193

Argicryids	118
Argicryolls	197
Argids	103
Argidurids	121
Argigypsis	124
Argillic horizon	17
Argiorthels	152
Argiudolls	201
Argiustolls	208
Argixerolls	222
Aridic moisture regime. <i>See</i> Soil moisture regimes.	
Aridisols	103

B

B horizons. <i>See</i> Horizons and layers.	
Bottom tier	29
Buried soils	10

C

C horizons or layers. <i>See</i> Horizons and layers.	
Calcareous and reaction classes for mineral soils	304
Calciquerts	282
Calciquolls	194
Calciargids	104
Calcic horizon	17
Calcicryids	119
Calcicryolls	198
Calcids	111
Calcigypsis	125
Calcitorrerts	285
Calciudolls	203
Calciustepts	178
Calciusterts	288
Calciustolls	211
Calcixerepts	184
Calcixererts	291
Calcixerolls	224
Cambic horizon	18
Cambids	114
Cation-exchange activity classes for mineral soils	303
Coatings (classes) on sands	306
Coefficient of linear extensibility (COLE)	22
Control section of Histosols and Histels	29

Coprogenous earth. <i>See</i> Organic soil material.		Durudands	91
Cryalfs	50	Durudepts	173
Cryands	86	Durustalfs	66
Cryaqualfs	43	Durustands	97
Cryaquands	84	Durustepts	179
Cryaquents	130	Durustolls	212
Cryaquepts	166	Dystraquerts	282
Cryaquods	250	Dystrocryepts	171
Cryaquolls	194	Dystroxerepts	185
Cryepts	171	Dystrudepts	173
Cryerts	285	Dystruderts	287
Cryic temperature regime. <i>See</i> Soil temperature regimes.		Dystrustepts	179
Cryids	118	Dystrusterts	288
Cryods	251		
Cryofibrists	159	E	
Cryofluvents	134	E horizons. <i>See</i> Horizons and layers.	
Cryofolists	161	Endoaqualfs	43
Cryochemists	161	Endoaquands	84
Cryolls	197	Endoaquents	130
Cryopsamments	144	Endoaquepts	167
Cryorthents	139	Endoaquerts	283
Cryosapristis	162	Endoaquods	251
Cryoturbation	31	Endoaquolls	195
Cryrendolls	200	Endoaquults	260
		Entisols	129
D		Epiaqualfs	45
Densic contact	31	Epiaquands	85
Densic materials	31	Epiaquents	131
Diagnostic subsurface horizons	16	Epiaquepts	168
Diagnostic surface horizons	13	Epiaquerts	284
Diatomaceous earth. <i>See</i> Organic soil material.		Epiaquods	251
Discontinuities identified by horizon designators	315	Epiaquolls	196
Duraqualfs	43	Epiaquults	260
Duraquands	84	Epipedon	13
Duraquerts	282	Eutraquox	234
Duraquods	250	Eutrocryepts	172
Duraquolls	194	Eutroperox	235
Duricryands	87	Eutrotorrox	239
Duricryods	252	Eutrudepts	176
Duricryolls	198	Eutrudox	240
Durids	121	Eustrustox	244
Durihumods	253		
Durinodes	23	F	
Duripan	18	Family differentiae for Histosols and Histels	306
Duritorrands	90	Family differentiae for mineral soils	295
Durixeralfs	77	Ferrudalfs	55
Durixerepts	185	Fibers. <i>See</i> Organic soil material.	
Durixererts	292	Fibric soil materials. <i>See</i> Organic soil material.	
Durixerolls	225	Fibristels	149
Durorthods	255	Fibrists	159

Fluvaquents	131	Haplocryolls	198
Fluvents	134	Haplodurids	122
Folistels	150	Haplofibrists	160
Folistic epipedon	13	Haplogypsids	125
Folists	160	Haplohemists	161
Fragiaqualfs	47	Haplohumods	253
Fragiaquepts	169	Haplohumults	263
Fragiaquods	251	Haploperox	236
Fragiaquults	261	Haploorthels	152
Fragic soil properties	23	Haploorthods	255
Fragihumods	253	Haplosalids	128
Fragiorthods	255	Haplosaprists	162
Fragipan	18	Haplotorrands	90
Fragiudalfs	55	Haplotorrerts	286
Fragiudepts	177	Haplotorrox	239
Fragiudults	267	Haploturbels	155
Fragixeralfs	78	Haploxeralfs	78
Fragixerepts	187	Haploxerands	100
Fraglossudalfs	55	Haploxerepts	187
Frigid temperature regime. <i>See</i> Soil temperature regimes.		Haploxererts	292
Fulvicryands	87	Haploxerolls	226
Fulvudands	91	Haploxerults	278
G		Hapludalfs	58
Gelic materials	32	Hapludands	92
Gelisols	149	Hapluderts	287
Glacic layer	32	Hapludolls	204
Glacistels	150	Hapludox	241
Glossaqualfs	48	Hapludults	267
Glossic horizon	18	Haplustalfs	66
Glossocryalfs	50	Haplustands	98
Glossudalfs	56	Haplustepts	180
Gypsiargids	105	Haplusterts	289
Gypsic horizon	19	Haplustolls	213
Gypsicryids	119	Haplustox	245
Gypsids	124	Haplustults	274
Gypsitorrerts	286	Haprendolls	200
Gypsiusterts	289	Hemic soil materials. <i>See</i> Organic soil material.	
H		Hemistels	150
Halaquepts	169	Hemists	161
Haplanthrepts	165	Histels	149
Haplaquox	234	Histic epipedon	14
Haplargids	106	Historthels	152
Haplocalcids	111	Histosols	159
Haplocambids	115	Histoturbels	155
Haplocryalfs	52	Horizons and layers	311
Haplocryands	87	A horizons	311
Haplocryerts	285	B horizons	311
Haplocryids	120	C horizons or layers	312
Haplocryods	252	E horizons	311
		O horizons or layers	311
		R layers	312
		W layers	312
		Humaquepts	170

Humicryerts	285
Humicryods	252
Humilluvic material. <i>See</i> Organic soil material.	
Humods	253
Humults	263
Hydraquents	132
Hydrocryands	88
Hydrudands	94
Hyperthermic temperature regime. <i>See</i> Soil temperature regimes.	

I

Identifiable secondary carbonates	23
Inceptisols	165
Interfingering of albic materials	24
Isofrigid temperature regime. <i>See</i> Soil temperature regimes.	
Isohyperthermic temperature regime. <i>See</i> Soil temperature regimes.	
Isomesic temperature regime. <i>See</i> Soil temperature regimes.	
Isothermic temperature regime. <i>See</i> Soil temperature regimes.	

K

Kandiaqualfs	48
Kandiaquults	261
Kandic horizon	19
Kandihumults	264
Kandiperox	237
Kandiudalfts	61
Kandiudox	242
Kandiudults	269
Kandiustalfts	69
Kandiustox	246
Kandiustults	275
Kanhaplaquults	262
Kanhaplohumults	265
Kanhapludalfts	62
Kanhapludults	271
Kanhaplustalfts	70
Kanhaplustults	276
Key to soil orders	37

L

Lamellae	24
Limnic materials. <i>See</i> Organic soil material.	
Linear extensibility (LE)	24
Lithic contact	32
Lithologic discontinuities	24
Luvihemists	162

M

Marl. <i>See</i> Organic soil material.	
Melanaquands	85
Melanic epipedon	14
Melanocryands	89
Melanoxerands	101
Melanudands	95
Mesic temperature regime. <i>See</i> Soil temperature regimes.	
Mineral soil material	11
Mineral soils	12
Mineralogy classes for Histosols and Histels	307
Mineralogy classes for mineral soils	301
Mollic epipedon	14
Mollisols	191
Molliturbels	155
Mollorthels	152

N

<i>n</i> value	25
Natralbolls	193
Natraqualfs	49
Natraquerts	284
Natraquolls	197
Natrargids	108
Natric horizon	19
Natricryolls	200
Natridurids	123
Natrigypsidis	126
Natrixeralfs	80
Natrixerolls	230
Natrudalfts	62
Natrudolls	206
Natrustalfts	71
Natrustolls	217
Normal years	33

O

O horizons or layers. <i>See</i> Horizons and layers.	
Ochric epipedon	15
Organic soil material	11
Fibers	27
Fibric soil materials	27
Hemic soil materials	28
Humilluvic material	28
Limnic materials	28
Coprogenous earth	28
Diatomaceous earth	29
Marl	29
Sapric soil materials	28
Organic soils	12

Orthels	150	Plinthohumults	266
Orthents	139	Plinthoxeralfs	82
Orthods	254	Plinthudults	274
Ortstein	20	Plinthustalfs	76
Oxic horizon	20	Plinthustults	277
Oxisols	233	Prime symbol in horizon designators	316
P			
Paleaquults	262	Psammaquents	132
Paleargids	109	Psamments	144
Palecryalfs	53	Psammorthels	153
Palecryolls	200	Psammoturbels	156
Palehumults	265	Q	
Paleudalfs	63	Quartzipsamments	145
Paleudolls	207	R	
Paleudults	272	R layers. <i>See</i> Horizons and layers.	
Paleustalfs	73	Reaction classes for Histosols and Histels	308
Paleustolls	220	Rendolls	200
Paleustults	277	Resistant minerals	26
Palexeralfs	80	Rhodoxeralfs	82
Palexerolls	230	Rhodudalfs	65
Palexerults	279	Rhodudults	274
Paralithic contact	32	Rhodustalfs	76
Paralithic materials	32	Rhodustults	278
Particle-size classes for Histosols and Histels	306	Rupture-resistance classes for mineral soils	305
Particle-size classes for mineral soils	295	S	
Permafrost	32	Salaquerts	284
Permanent cracks (classes) in mineral soils	306	Salic horizon	21
Perox	234	Salicyrids	121
Petraquepts	170	Salids	128
Petroargids	111	Salitorrerts	286
Petrocalcic horizon	20	Salusterts	291
Petrocalcids	113	Sapric soil materials. <i>See</i> Organic soil material.	
Petrocambids	117	Sapristels	150
Petrocryids	120	Sapristis	162
Petroferric contact	25	Series control section	308
Petrogypsic horizon	20	Series differentiae within a family	308
Petrogypsids	127	Slickensides	26
Placaquands	86	Soil	9
Placaquods	251	Soil depth classes for Histosols and Histels	308
Placic horizon	21	Soil depth classes for mineral soils	305
Placocryods	253	Soil moisture regimes	32
Placohumods	254	Aquic	33
Placorthods	257	Aridic and torric	33
Placudands	97	Udic	34
Plagganthrepts	165	Ustic	34
Plaggen epipedon	15	Xeric	34
Plinthaqualfs	50	Soil temperature classes for Histosols and Histels	308
Plinthaquox	234		
Plinthaquults	263		
Plinthite	26		

Soil temperature classes for mineral soils	304	Turbels	154
Soil temperature regimes	34	U	
Cryic	34	Udalfs	54
Frigid	35	Udands	90
Hyperthermic	35	Udarents	133
Isofrigid	35	Udepts	172
Isohyperthermic	35	Uderts	286
Isomesic	35	Udic moisture regime. <i>See</i> Soil moisture regimes.	
Isothermic	35	Udifluvents	136
Mesic	35	Udifolists	161
Thermic	35	Udipsamments	146
Sombric horizon	21	Udivitrands	99
Sombrihumults	266	Udolls	201
Sombriperox	238	Udorthents	141
Sombriudox	243	Udox	239
Sombriustox	247	Udufts	266
Sphagnofibrists	160	Ultisols	259
Spodic horizon	21	Umbraquults	263
Spodic materials	26	Umbric epipedon	15
Spodosols	249	Umbristurbels	156
Strongly contrasting particle-size classes	299	Umbrorthels	153
Subsurface tier	29	Ustalfts	65
Suffix symbols in horizon designators	312	Ustands	97
Conventions for using letter suffixes	314	Ustarents	133
Vertical subdivision	315	Ustepts	178
Sulfaquents	133	Usterts	288
Sulfaquepts	170	Ustic moisture regime. <i>See</i> Soil moisture regimes.	
Sulfidic materials	35	Ustifluvents	137
Sulfihemists	162	Ustifolists	161
Sulfisapristis	163	Ustipsamments	147
Sulfohemists	162	Ustivitrands	99
Sulfosapristis	163	Ustolls	207
Sulfudepts	178	Ustorthents	141
Sulfuric horizon	35	Ustox	243
Surface tier	29	Ustults	274
T		V	
Thermic temperature regime. <i>See</i> Soil temperature regimes.		Vermaqualfs	50
Torrands	89	Vermaquepts	171
Torrerts	285	Vermudolls	207
Torriarents	133	Vermustolls	222
Torric moisture regime. <i>See</i> Soil moisture regimes.		Vertisols	281
Torrifluvents	134	Vitrands	99
Torrifolists	161	Vitraquands	86
Torriorthents	140	Vitricryands	89
Torrripsamments	146	Vitritorrands	90
Torrox	238	Vitrixerands	101
Transitional and combination horizons	312		

W		Xerarents	133
W layers. <i>See</i> Horizons and layers.		Xerepts	184
Weatherable minerals	27	Xererts	291
X		Xeric moisture regime. <i>See</i> Soil moisture regimes.	
Xeralfs	76	Xerofluvents	138
Xerands	100	Xerolls	222
		Xeropsamments	147
		Xerorthents	143
		Xerults	278

S O I	The Soils That We Classify
D I F	Differentiae for Mineral Soils and Organic Soils
D I A	Horizons and Characteristics Diagnostic for the Higher Categories
I D E	Identification of the Taxonomic Class of a Soil
A L F	Alfisols
A N D	Andisols
A R I	Aridisols
E N T	Entisols
G E L	Gelisols
H I S	Histosols
I N C	Inceptisols
M O L	Mollisols
O X I	Oxisols
S P O	Spodosols
U L T	Ultisols
V E R	Vertisols
F A M	Family and Series Differentiae and Names
H O R	Designations for Horizons and Layers