# Keys to Soil Taxonomy

by Soil Survey Staff

United States Department of Agriculture
Soil Conservation Service

Sixth Edition, 1994

## Keys to Soil Taxonomy, Sixth Edition

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# Foreword

This publication, Keys to Soil Taxonomy, serves two purposes. It provides the taxonomic keys necessary for the classification of soils according to Soil Taxonomy in a form that can be used easily in the field, and it also acquaints users of Soil Taxonomy with recent changes in the classification system. This volume includes all revisions of the keys that have so far 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 abridged version, first published in 1983, is based. We plan to continue issuing updated editions of Keys to Soil Taxonomy approximately every two years. After most of the current International Soil Classification Committees (ICOMs) have completed their mandates, Soil Taxonomy in its entirety is to be revised and republished.

This publication incorporates all amendments approved to date and published in National Soil Taxonomy Handbook (NSTH) Issues 1-17. 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), and the International Committee on Aridisols (NSTH Issue #17). Editorial changes have been made throughout the Keys to Soil Taxonomy to make grammatical corrections 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 Keys to Soil Taxonomy are identified as "Soil Survey Staff." This term is meant to include all the soil classifiers in the National Cooperative Soil Survey program and in the international community who have made significant contributions to the improvement of Soil Taxonomy.

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1994

# Table of Contents

# Chapter 1

# The Soil That We Classify, and Buried Soils

## The Soil That We Classify

*Soil* is the collective term used in this text for the natural bodies, made up of mineral and organic materials, that cover much of the earth's surface, contain living matter and can support vegetation out of doors, and have in places been changed by human activity. The upper limit of soil is air or shallow water. Its horizontal boundaries are where it grades to deep water or to barren areas of rock or ice. The lower boundary that separates soil from the not-soil underneath is most difficult to define. Soil consists of the horizons near the earth's surface which, in contrast to the underlying rock material, have been altered by the interactions, over time, between climate, relief, parent materials, and living organisms. In the few places where it contains thin cemented horizons that are impermeable to roots, soil is considered to be as deep as the deepest cemented horizon. More commonly, soil grades at its lower boundary to hard rock or to earthy materials virtually devoid of animals, roots, or other marks of biologic activity. Thus the lower limit of soil is normally the lower limit of biologic activity, which generally coincides with the common rooting depth of native perennial plants. If, however, either biological activity or current pedogenic processes extend to depths greater than 200 cm, the lower limit of the soil that we classify is arbitrarily set at 200 cm. For certain soil management purposes, layers deeper than the lower boundary of the soil that we classify must also be described if they affect the content and movement of water and air in the soil of the root zone.

## Buried Soils

A soil is considered to be a buried soil if it is covered with a surface mantle of new soil material that is either 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 less than 30 cm thick is not considered in the taxonomy, but is considered in establishing a phase if it affects the use of the soil. In areas where a surface mantle is present, the soil that we classify therefore has its upper boundary either at the soil surface or less than 50 cm below the surface, depending on the thickness of its horizons.
A surface mantle of new material, as defined here, is largely unaltered. It is usually finely stratified and overlies a horizon sequence that can be clearly identified as the solum of a buried soil in at least part of each pedon. The recognition of a surface mantle should not be based only on studies of associated soils.

# Chapter 2

# Horizons and Properties Diagnostic for the Higher Categories: Mineral Soils[1]

## Mineral Soil Material

Mineral soil material either:

1. Is never saturated with water for more than a few days and contains less than 20 percent (by weight) organic carbon; or

2. Is saturated with water for long periods (or 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.

Soil material that contains more than the above amounts of organic carbon is considered to be organic soil material.

## Diagnostic Surface Horizons; The Epipedon

Any horizon may be at the surface of a truncated soil. The following section, however, is concerned with seven diagnostic horizons that have formed at the soil surface. A horizon that has developed at the soil surface is called an epipedon (Gr. *epi*, over, upon; and *pedon*, soil). It is a horizon in which rock structure has been destroyed and which has either been darkened by organic matter or eluviated. Such a horizon may become covered by thin alluvial or eolian deposits without losing its identity as an epipedon. The depth to which an epipedon must be buried to be considered part of a buried soil is defined above (Chapter 1).

[1] Mineral soils include all soil orders in this taxonomy except Histosols.

A recent alluvial or eolian deposit that retains fine stratification, 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 the illuvial B horizon if the darkening by organic matter extends from the soil surface into or through the B horizon. To avoid changes in the classification of a soil as a result of plowing, the properties of the epipedon, except for structure, should be determined after mixing the surface soil to a depth of 18 cm, or the whole soil if its depth to bedrock is less than 18 cm.

**Anthropic epipedon** (Gr. *anthropikos*, human)
The anthropic epipedon conforms to all the requirements for the mollic epipedon (defined below) except either (1) the limits on acid-soluble $P_2O_5$, with or without the base saturation, or (2) the duration of available moisture. Additional data on anthropic epipedons from several parts of the world may permit future improvements in this definition.

**Histic epipedon** (Gr. *histos*, tissue)
The histic epipedon is normally at the soil surface, although it may be buried. It consists of organic soil material (peat or muck) if the soil has not been plowed. If the soil has been plowed, the epipedon normally has a high content of organic matter that results from mixing organic soil material with some mineral material. The histic epipedon either has aquic conditions for some time in most years or has been artificially drained.

The histic epipedon can thus be defined as a layer (one or more horizons) that has aquic conditions for some time in most years (or is artificially drained), and either:

1. Consists of organic soil material which:

   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 $g/cm^3$; or

   b. Is 20 to 40 cm thick and has an organic-carbon content (by weight) of:

      (1) 18 percent or more if the mineral fraction contains 60 percent or more clay; or

      (2) 12 percent or more if the mineral fraction contains no clay; or

      (3) 12 + (clay percentage multiplied by 0.1) percent or more if the mineral fraction contains less than 60 percent clay; or

2. Is an Ap horizon which, 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 + (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 as defined below. Item 2 provides for histic epipedons that are Ap horizons consisting of mineral soil material.

**Melanic epipedon** (Gr. *melas, melan-*, black)
The melanic epipedon is a thick black horizon at or near the soil surface which contains high concentrations of organic carbon, usually associated with short-range-order minerals or aluminum-humus complexes. The intense black color is attributed to the accumulation of organic matter from which "Type A" humic acids are extracted. This organic matter is thought to result from large amounts of root residues supplied by a gramineous vegetation, and can be distinguished from organic matter formed under forest vegetation by the melanic index (Honna et al., 1988).[2]

The suite of secondary minerals is usually dominated by allophane, and the soil material has a low bulk density and a high anion adsorption capacity.

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 top 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. Six percent or more organic carbon as a weighted average, and 4 percent or more organic carbon in all layers.

**Mollic epipedon** (L. *mollis*, soft)
The mollic epipedon consists of mineral soil material and is at the soil surface, unless it underlies either a recent deposit that is less than 50 cm thick and has fine stratification if not plowed, or a thin layer of organic soil material. If the surface layer of organic material is so thick that the soil is recognized as a Histosol (defined below), the mollic epipedon is considered to be buried.

The mollic epipedon has the following properties:

1. Soil structure is strong enough so that one half or more of the horizon is not both hard, very hard, or harder and massive when dry. Very coarse prisms, with a diameter of 30 cm or more, are included in the meaning of *massive* if there is no secondary structure within the prisms.

2. Unless the fine-earth fraction has 15 percent or more calcium carbonate equivalent, crushed and smoothed samples have a Munsell color value of 3 or less when moist and of 5 or less when dry, and a chroma of 3 or less[3], moist; normally the color value is at least 1 Munsell unit lower or the chroma at least 2 units lower (both moist and dry) than that of the 1C horizon if present. If only a 2C horizon or an R layer is present, the comparison should be made with the horizon that overlies the 2C. Some parent materials such as loess, cinders, alluvium, or carbonaceous shale can also have dark color and low chroma. Soils formed in such materials may accumulate appreciable amounts of organic matter but have no visible darkening in the epipedon. In this situation, the requirement that the mollic epipedon should have a lower color value or chroma than the 1C horizon, or than the next underlying horizon if there is no 1C, is waived if (a) the surface horizon(s) meets all other requirements for a mollic epipedon and, in addition, has at least 0.6 percent more organic carbon than the 1C or the 2C horizon, or if (b) the epipedon extends to rock (i.e., a lithic or paralithic contact, defined below).

   The mollic epipedon has dark color and low chroma in 50 percent or more of its matrix. If its structure is fine granular or fine blocky, the sample when broken may show only the color of the coatings of peds. The color of the matrix in such situations can be determined only by

[2] Honna, T., S. Yamamoto, and K. Matsui. 1988. A simple procedure to determine Melanic Index. See ICOMAND Ciscular Letter No. 10, pp. 76-77.

[3] The color when moist is that of a specimen moist enough so that an additional drop of water produces no change in its color. The color when dry is that of a specimen dry enough so that continued drying produces no further change.

crushing or briefly rubbing the sample. Prolonged rubbing should be avoided because it may cause darkening of a sample if soft iron-manganese concretions are present; crushing should be just sufficient to mix the coatings with the matrix. The color value when dry should be determined after the crushed sample has been smoothed to eliminate shadows.

If the fine-earth fraction has 15 to 40 percent calcium carbonate equivalent, the limit for the color value, dry, is waived. If it has 40 percent or more calcium carbonate equivalent, the limit for the color value, dry, is waived and the color value, moist, is 5 or less. These changes are necessary because finely divided lime acts as a white pigment.

3. Base saturation is 50 percent or more by the $NH_4OAc$ method.

4. The organic-carbon content is either 0.6 percent or more throughout the thickness of the mollic epipedon, or 2.5 percent or more in layers that have a color value, moist, of 4 or 5 and a fine-earth fraction with a calcium carbonate equivalent of 40 percent or more.

Since the mollic epipedon consists of mineral soil material, the upper limit of its organic-carbon content is the same as that defined above for mineral soil material.

5. After mixing the upper 18 cm of the mineral soil, or the whole mineral soil if its depth to a lithic or paralithic contact, petrocalcic horizon, or duripan (all defined below) is less than 18 cm, the thickness of the epipedon is as follows:

   a. 10 cm or more if the epipedon is directly above a lithic or paralithic contact, a petrocalcic horizon, or a duripan; or

   b. 25 cm or more if either

      (1) The texture of the epipedon is loamy fine sand or coarser throughout; or

      (2) There are no underlying diagnostic horizons (defined below) and the organic-carbon content of the underlying materials decreases irregularly with increasing depth (as in recent alluvial deposits); or

   c. 25 cm or more if the epipedon is finer than loamy fine sand and 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. If the epipedon is loamy or clayey, 18 cm or more, and one third or more of the total thickness between the top of the epipedon and the shallowest of any features listed in (c) that are less than 75 cm below the mineral soil surface; or

   e. 18 cm or more if none of the above conditions apply.

6. The epipedon has less than 250 parts per million (ppm) of $P_2O_5$ soluble in 1 percent citric acid, or it does not have a regular decrease in the amounts of $P_2O_5$ with increasing depth below the epipedon, or there are phosphate nodules within the epipedon. This restriction is made to eliminate plow layers of very old arable soils and kitchen middens which, under use, have acquired the properties of a mollic epipedon, while includin the epipedon of a soil developed in highly phosphatic parent matrial.

7. If the soil is not irrigated, some part of the epipedon is moist 3 months or more (cumulative) per year in 8 or more out of 10 years during times when the soil temperature at a depth of 50 cm i 5°C or higher.

8. The *n* value (defined below) is less than 0.7. Although man soils that have a mollic epipedon are very poorly drained, a mollic epipedon does not have the same very high water content as sediments that have been continuously under water since deposition.

**Ochric epipedon** (Gr. *ochros*, pale)
The ochric epipedon fails to meet the definitions for any of the other 6 epipedons because it is too thin or too dry, has too high a color value or chroma, contains too little organic matter, or has too high an *n* value or melanic index, or is both hard and massive when dry. Most ochric epipedons have either a Munsell color value of 4 or more when moist and 6 or more when dry, or a chroma of 4 or more[4], or include an A or Ap horizon that has both low color values and low chroma but is

4 The color when moist is that of a specimen moist enough so that an additional drop of water produces no change in color. The color when dry is that of a specimen dry enough so that continued drying produces no further change in color.

too thin to be recognized as a mollic or an umbric epipedon (and has less than 15 percent calcium carbonate equivalent in the fine-earth fraction). 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, a kandic, a natric, or a 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 in a soil that has not been plowed. Actually, the same horizon in an unplowed soil may be both a part of the epipedon and a part of the cambic horizon; the ochric epipedon and the subsurface diagnostic horizons are not mutually exclusive. The ochric epipedon does not have rock structure and does not include finely stratified fresh sediments.

**Plaggen epipedon** (Ger. *Plaggen*, sod)
The plaggen epipedon is a man-made surface layer 50 cm or more thick that has been produced by long-continued manuring. The color of a plaggen epipedon and its organic-carbon content depend on the materials used for bedding.

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.

**Umbric epipedon** (L. *umbra*, shade, hence dark)
Requirements for an umbric epipedon with regard to color, organic-carbon and phosphorus content, consistence, structure, *n* value, and thickness are the same as those for the mollic epipedon. The umbric epipedon includes those thick, dark-colored surface horizons that have a base saturation of less than 50 percent (by $NH_4OAc$). It should be noted that the restriction against an epipedon that is hard, very hard, or harder and massive when dry is applied only to those epipedons that become dry. If the epipedon is always moist, there is no restriction on its consistence or structure when dry. It should also be noted that some plaggen epipedons meet all these requirements but also show evidence of a gradual addition of materials during cultivation, whereas 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 discussed 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, while others are generally regarded as parts of the A horizon.

**Agric horizon**
The agric (L. *ager*, field) horizon is an illuvial horizon which has formed under cultivation and contains significant amounts of illuvial silt, clay, and humus. After a soil has been cultivated for a long time, changes in the horizon directly below the plow layer become apparent and cannot be ignored in classifying the soil. The large pores in the plow layer and the absence of vegetation immediately after plowing permit a turbulent flow of muddy water to the base of the plow layer. Here the water can enter wormholes or fine cracks between peds, and the suspended materials are deposited as the water is withdrawn into capillary pores. The worm channels, root channels, and surfaces of peds in the horizon underlying the plow layer become coated with a dark-colored mixture of organic matter, silt, and clay. The accumulations on the sides of wormholes become thick and can eventually fill them. If worms are scarce, the accumulations may take the form of lamellae that range in thickness from a few millimeters to about 1 cm. The lamellae and the coatings on the sides of wormholes always have a lower color value and chroma than the soil matrix.

The agric horizon can have somewhat different forms in different climates if there are differences in soil fauna. In a humid temperate climate where soils have a udic moisture regime and a mesic soil temperature regime (defined below), earthworms can become abundant. If there are earthworm holes which, including their coatings, constitute 5 percent or more (by volume) of the horizon and if the coatings are 2 mm or more thick and have a color value, moist, of 4 or less and a chroma of 2 or less, the horizon is an agric horizon. After long cultivation, the content of organic matter in the agric horizon is not likely to be high, but the carbon-nitrogen ratio is low (usually less than 8). The pH value of the agric horizon is close to neutral (6 to 6.5).

In a Mediterranean climate where soils have a xeric soil moisture regime (defined below), earthworms are less common and the illuvial materials accumulate as lamellae directly below the Ap horizon. If these lamellae are 5 mm or more thick, have a color value, moist, of 4 or less and a chroma of 2 or less, and constitute 5 percent or more (by volume) of a horizon 10 cm or more thick, this horizon is an agric horizon.

**Albic horizon**
The albic (L. *albus*, white) horizon is an eluvial horizon 1.0 cm or more thick which contains 85 percent or more (by volume) albic materials (defined below). It usually occurs below an A horizon but may be at the mineral soil surface. Under the albic horizon there is usually 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 a 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 which, if 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.

In some soils the horizon underlying the albic horizon is too sandy or too weakly developed to have the levels of accumulation required for an argillic, a kandic, a natric, or a spodic horizon. Some soils have, directly below the albic horizon, either a lithic or paralithic contact, or another relatively impervious layer that produces a perched water table with stagnant or moving water.

**Argillic horizon**
An argillic (L. *argilla*, clay) horizon is an illuvial horizon which contains significant accumulations of illuviated layer-lattice silicate clays. It must have formed below an eluvial horizon but may be found at the surface of a partially truncated soil. The following characteristics are used for its identification:

1. If there is a lithologic discontinuity between the overlying eluvial horizon and the argillic horizon or if it is overlain only by a plow layer, clay films are required only in some part of the argillic horizon, either in some fine pores or, if peds are present, on some vertical and horizontal surfaces of peds. Either some part of the horizon is shown in thin section to have 1 percent or more oriented clay bodies, or the ratio of fine clay to total clay in the argillic horizon is higher than in the overlying or the underlying horizon.

2. If an eluvial horizon remains and there is no lithologic discontinuity between it and the underlying argillic horizon, the argillic horizon contains, within 30 cm of its upper boundary, higher percentages of total clay and fine clay than the eluvial horizon, as follows:

   a. If any part of the overlying eluvial horizon has less than 15 percent total clay in its fine-earth fraction, the total clay content in the argillic horizon is 3 percent or more (absolute) higher than in the eluvial horizon (e.g., 13 percent versus 10 percent). The ratio of fine clay to total clay in the argillic horizon is normally one third or more higher than in the overlying eluvial or in the underlying horizon.

   b. If the overlying eluvial horizon has 15 to 40 percent total clay in its fine-earth fraction, the total clay content in the argillic horizon is 20 percent or more (relative) higher than in the eluvial horizon (e.g., 24 percent versus 20 percent). The ratio of fine clay to total clay in the argillic horizon is normally one third or more higher than in the eluvial horizon.

   c. If the eluvial horizon has 40 to 60 percent total clay in the fine-earth fraction, the total clay content in the argillic horizon is 8 percent or more (absolute) higher than in the eluvial horizon (e.g., 50 percent versus 42 percent).

   d. If the eluvial horizon has 60 percent or more total clay in the fine-earth fraction, the fine-clay content in the argillic horizon should be 8 percent or more (absolute) higher than that of the eluvial horizon.

3. The thickness of the argillic horizon is one tenth or more the total thickness of all overlying horizons (in a soil that is not truncated and has no lithologic discontinuity between the eluvial horizon and the underlying argillic horizon), and one of the following:

   a. 7.5 cm or more if the horizon is loamy or clayey; or

   b. 15 cm or more if the horizon is sand or loamy sand; or

   c. If the horizon is composed entirely of lamellae, 15 cm or more combined thickness of lamellae that are 1 cm or more thick.

4. In structureless soils, the argillic horizon has oriented clay lining some pores and bridging the sand grains.

5. If peds are present, the argillic horizon has one of the following:

   a. Either clay films on some vertical and horizontal surfaces of peds and in the fine pores, or oriented clay in 1 percent or more of the cross section; or

   b. A broken or irregular upper boundary and some clay films in the lowest part of the horizon; or

c. If the eluvial horizon has 40 percent or more clay, and if the argillic horizon is clayey and the clay is kaolinitic, some clay films on peds and in pores within the lower part of the argillic horizon if it has blocky or prismatic structure; or

d. No clay films if the argillic horizon is clayey with 2:1 lattice clays, and if either the overlying horizon has uncoated grains of sand or silt and the argillic horizon shows evidence of pressure caused by swelling (e.g., occasional slickensides or wavy horizon boundaries), or if the ratio of fine clay to total clay in the argillic horizon is one third or more higher than in the overlying or underlying horizon, or if the fine-clay content in the argillic horizon is 8 percent or more (absolute) higher than in the eluvial horizon.

**Calcic horizon**

The calcic (L. *calx*, calc-, lime) horizon is an illuvial horizon in which secondary calcium carbonate, or other carbonates have accumulated to a significant extent. It may occur in conjunction with various other horizons such as a mollic epipedon, an argillic or a natric horizon.
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 of a petrocalcic horizon; and

3. Has one or more of the following:

   a. Fifteen percent or more $CaCO_3$ equivalent, (see below) and its $CaCO_3$ equivalent is 5 percent or more (absolute) higher than that of an underlying horizon; or

   b. Fifteen percent or more $CaCO_3$ equivalent, and 5 percent or more (by volume) identifiable secondary carbonates; or

   c. Five percent or more calcium carbonate equivalent and has:

      (1) Less than 18 percent clay in the fine-earth fraction; and

      (2) A particle size that is sandy, sandy-skeletal, coarse-loamy, or loamy-skeletal; and

      (3) A weight of identifiable secondary carbonates, that is 5 percent or more (absolute) higher than that of an underlying horizon.

**Cambic horizon**

The cambic (L. *cambiare*, change) horizon is an altered horizon that does not have the dark color, organic-matter content, and structure of a histic, a mollic, or an umbric epipedon, and has all of the following:

1. A texture of very fine sand, loamy very fine sand, or finer; and

2. Soil structure, or absence of rock structure, in one half or more of its volume; and

3. Evidence of alteration in the form of either:

   a. Aquic conditions for some time in most years (or artificial drainage), and both of the following:

      (1) Within 50 cm of the mineral soil surface, either on faces of peds, or in the matrix if peds are absent, 50 percent or more chroma as follows:

         (a) Two or less, and redox concentrations; or

         (b) Zero, and a color value, moist, of 3 or less; or

         (c) One or less, and a color value, moist, of 4 or more; and

      (2) One or more of the following properties:

         (a) A regular decrease in the amount of organic carbon with increasing depth, and an organic-carbon content of less than 0.2 percent either at a depth of 125 cm below the mineral soil surface, or directly above a sandy-skeletal substratum at a depth of less than 125 cm; or

         (b) Cracks that open and close in most years and are 1 cm or more wide at a depth of 50 cm below the mineral soil surface; or

         (c) Permafrost at some depth; or

         (d) A histic epipedon consisting of mineral soil materials, or a mollic or an umbric epipedon; or

   b. Either no aquic conditions (or artificial drainage), or colors different from those defined in 3.a, or both, and one or more of the following:

      (1) A higher chroma, redder hue, or higher clay content than in the underlying horizon; or

(2) Evidence of removal of carbonates; particularly, less carbonate than in the underlying k horizon (if all coarse fragments in the k horizon are completely coated with lime, some in the cambic horizon are partly free of coatings; if coarse fragments in the k horizon are coated only on the underside, those in the cambic horizon are free of coatings); or

(3) If carbonates are absent in the parent material and in the dust that falls on the soil, the requirement of evidence of alteration is satisfied by the presence of soil structure and absence of rock structure; and

4. Properties that do not meet the requirements for an argillic, a kandic, an oxic, or a spodic horizon; and

5. No cementation or induration and no brittle consistence when moist; and

6. A lower boundary at a depth of 25 cm or more from the mineral soil surface, unless the soil temperature regime is cryic or pergelic.

**Duripan**

The duripan (L. *durus*, hard; meaning hardpan) is a subsurface horizon that is cemented by illuvial silica to the degree that less than 50 percent of the volume of air-dry fragments slake in water or during prolonged soaking in acid (HCl). Duripans vary in the degree of cementation by silica and, in addition, they commonly contain accessory cements, chiefly iron oxides and calcium carbonate.

Summary of properties

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

A duripan must meet all of the following requirements:

1. Is cemented or indurated in more than 50 percent of the volume of some horizon; and

2. Has evidence of accumulation of opal or other forms of silica as laminar capping, coatings, lenses, partly filled interstices, bridges between sand-size grains, or coatings on rock fragments; and

3. Less than 50 percent of the volume slakes in 1N HCl even during prolonged soaking, but more than 50 percent slakes in concentrated KOH, NaOH, or in alternating acid and alkali; and

4. Has lateral continuity such that roots cannot penetrate except along vertical fractures, which have a horizontal spacing of 10 cm or more.

**Fragipan**

A fragipan (L. *fragilis*, brittle; meaning brittle pan) is a loamy or, uncommonly, a sandy subsurface horizon which may underlie an albic, argillic, cambic, or spodic horizon. It has a very low organic-matter content, a higher bulk density than the overlying horizons, and hard or very hard consistence when dry (is seemingly cemented). When moist, a fragipan has moderate or weak brittleness (i.e., tendency for a ped or clod to rupture suddenly rather than undergo slow deformation when pressure is applied). A dry fragment slakes or fractures when placed in water. A fragipan typically has redoximorphic features, is slowly or very slowly permeable to water, and has few or many bleached, roughly vertical planes which are faces of coarse or very coarse polyhedrons or prisms.

There is no known laboratory procedure for identifying a sample from a fragipan, and because no single unique property of fragipans exists, a combination of clues must be used for field identification of such a pan, as follows:

1. A fragipan lies below, although not necessarily directly below, an eluvial horizon, unless the soil has been truncated. In a truncated soil the fragipan can be traced up slope to where an eluvial horizon has been preserved.

2. If there is an argillic or a cambic horizon above the fragipan, an E' horizon commonly intervenes between the fragipan and the overlying horizon. This E' horizon is marked by uncoated grains of sand and silt and seems associated with water which either stands above the pan or moves laterally along its surface.

3. If the fragipan is not saturated for long periods of time, some or all pedons normally have bleached vertical streaks 10 cm or more apart which form a roughly polygonal pattern on a horizontal plane and which are bounded by strong brown or reddish brown streaks where iron and manganese have accumulated. This polygonal color pattern may be absent if the pan is saturated for long periods or if its texture is sandy.

4. If the moisture content of the fragipan is near the wilting point, the matrix between its streaks is very firm; if it is near field capacity, the matrix is brittle. This brittle matrix constitutes 60 percent or more (by volume) of one or more subhorizons of the fragipan.

5. The brittleness in parts of the fragipan is well enough expressed so that there are virtually no fine feeder roots

in this brittle matrix, which has mean horizontal dimensions of 10 cm or more. The surrounding bleached vertical streaks may contain few to many fine feeder roots and some tap roots of trees.

6. The fine-earth fraction of a fragipan has a texture finer than fine sand and generally contains less than 35 percent clay (in most soils considerably less); it is generally loamy (silt loam, loam, or sandy loam).

7. A fist-sized, air-dried fragment of a fragipan slakes or fractures when placed in water.

**Glossic horizon**
The glossic (Gr. *glossa*, tongue) 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 of an argillic, a kandic, or a natric horizon (defined below).

The glossic horizon develops as a result of the degradation of an argillic, a kandic, or a natric horizon, from which clay and free iron oxides are removed. This process of eluviation gradually progresses from the exteriors of peds to their interiors. In early stages of the development, the peds of the remnant argillic, kandic, or natric horizon still form structural units that extend throughout the glossic horizon, constituting close to 85 percent of its volume. In later stages, some of these structural units no longer extend throughout the horizon, and in the most advanced stages of the degradation process remnant peds constitute little more than 15 percent (by volume) of the glossic horizon and are completely surrounded by albic materials. The boundary between the illuvial and eluvial parts of the glossic horizon may be either abrupt or clear, and either irregular or broken.

A glossic horizon usually occurs between an overlying albic horizon and an underlying argillic, kandic, or natric horizon or fragipan. It can lie between an argillic, cambic, or kandic horizon and a fragipan. In the early stages of the degradation process described above, a glossic horizon can be within an argillic, kandic, or natric horizon, or within a fragipan if the fragipan shows evidence of the degradation of an argillic horizon. An albic horizon may be below, or between subhorizons of, the glossic horizon.
Argillic horizons consisting of lamellae and intervening albic materials are not within the concept of the glossic horizon.

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

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 of a petrogypsic horizon; and

3. Is 5 percent or more gypsum and is 1 percent or more byvolume secondary visible gypsum; and

4. Has a product of thickness in centimeters multiplied by 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 of a petrogypsic horizon. The gypsum percentage can be calculated by multiplying the milliequivalents of gypsum per 100 g soil by the milliequivalent weight of $CaSO_4 2H_2O$, which is 0.086.

**Kandic horizon**[5] (*kand-* modified from kandite)
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 lithic, paralithic, or petroferric contact (defined below) within 50 cm of the mineral soil surface.

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 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 in the surface horizon if that horizon has 20 to 40 percent total clay in the fine-earth fraction; or

[5] 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), claimed by Frank R. Moormann.

(3) 8 percent or more (absolute) higher than 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 throughout the upper 100 cm is sandy; or

(2) Less than 125 cm from the mineral soil surface, if the clay content in the fine-earth fraction of the surface horizon is less than 20 percent and the particle-size class (of part or all of the upper 100 cm) is finer than sandy; or

(3) Less than 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.

3. Has a thickness of either:

a. 30 cm or more; or

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

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

5. Has a CEC of 16 cmol(+) or less per kg clay[6] (by 1N $NH_4OAc$ pH 7) and an 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 lithic, paralithic, or petroferric contact if shallower.

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 organic carbon contents which decrease irregularly with increasing depth.

[6] The percentage of clay is either measured by the pipete method, or estimated to be 2.5 times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

**Natric horizon**

The natric (NL. *natrium*, sodium) horizon is a special kind of argillic horizon. It has, in addition to the properties of the argillic horizon:

1. Either

a. Columns, or less commonly, prisms in some (usually the upper) part, which may break to blocks; or

b. Rarely, blocky structure, and tongues of an eluvial horizon 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 subhorizons 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 subhorizons 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.

**Oxic horizon**

The oxic (*oxic* modified from oxide) horizon is a mineral subsurface horizon of sandy loam or a finer particle size with low cation exchange capacity and low weatherable-mineral content. Its upper boundary is either 18 cm below the mineral soil surface or at the lower boundary of an Ap horizon, whichever is deeper, or at a greater depth where mineralogical and charge characteristics meet the requirements for the oxic horizon. Any increase in clay content at the upper boundary must be diffuse. The lower boundary of the oxic horizon is also defined by its mineralogical and charge requirements and may, in addition, be defined by the presence of saprolite with rock structure.

The oxic horizon does not have andic soil properties (defined below), and has all the following characteristics:

1. A thickness of 30 cm or more; and

2. A particle size 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, or sesquioxide coatings on lithorelics containing weatherable minerals; and

5. A diffuse upper particle-size boundary, i.e., within a vertical distance of 15 cm, a clay increase with depth of:

   a. Less than 4 percent (absolute) in its fine-earth fraction if that of the surface horizon contains less than 20 percent clay; or

   b. Less than 20 percent (relative) in its fine-earth fraction if that of the surface horizon contains 20 to 40 percent clay; or

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

6. A CEC of 16 cmol(+) or less per kg clay[7] (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al).

**Petrocalcic horizon**

The petrocalcic (Gr. *petra*, rock) 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.

The petrocalcic horizon is indurated or cemented throughout each pedon by calcium carbonate or, less commonly, by calcium and magnesium carbonate, with or without accessory silica, to such a degree that dry fragments do not slake in water and roots cannot enter except in cracks that have a horizontal spacing of 10 cm or more. If soaked in acid, cementation of the petrocalcic horizon is destroyed in half or more of its lateral extent in each pedon. The horizon is commonly massive or platy, very hard or harder and very firm or firmer when moist. Its saturated hydraulic conductivity is commonly moderately low to very low unless the horizon is fractured.

A laminar cap may be present but is not required. If one is present, carbonates normally constitute half or more by weight of the laminar horizon. Gravel, sand, and silt grains have been separated by the crystallization of carbonates in at least parts of the laminar subhorizon.

A petrocalcic horizon must meet the following requirements:

1. It is cemented or indurated by carbonates with or without silica or other cementing agents; and

2. Has a lateral continuity such that roots cannot penetrate except along vertical fractures, which have a horizontal spacing of 10 cm or more; and

3. Has a thickness of:

   a. 10 cm or more; or

   b. 1 cm or more if it consists of a laminar capping 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.

A petrogypsic horizon must meet the following requirements:

1. It is cemented or indurated by gypsum with or without other cementing agents; and

2. Has a lateral continuity such that roots cannot penetrate except along vertical fractures, which have a horizontal spacing of 10 cm or more; and

3. Has a thickness of 10 cm or more; and

4. Is 5 percent or more gypsum and the product of the thickness in centimeters multiplied by the gypsum content percentage is 150 or more.

**Placic horizon**

The placic (Gr. *plax*, *plak-*, flat stone) horizon is a thin, black to dark reddish pan that is cemented either by iron, or iron and manganese, or an iron-organic-matter complex. It is generally between 2 and 10 mm thick, but may be as thin as 1 mm or, in spots, up to 40 mm thick. It is often associated with stratification in parent materials. The placic horizon is in the solum, commonly within 50 cm of the mineral soil surface, and roughly parallel with it. It has a pronounced wavy or even convolute form. Normally it occurs as a single pan rather than as multiple sheets (one underlying another), but it may be bifurcated. It is a barrier to water and roots.

If cemented by iron, the pan is strong brown to dark reddish brown; if cemented by iron and manganese or by iron-organic-matter complexes, it is black or reddish black. A single pan may contain two or more layers that are cemented by different agents; commonly iron-organic-matter complexes are found in the upper part of the pan.

[7] 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.

Unless its thickness is minimal, identification of a placic horizon is seldom difficult because the hard, brittle pan differs so much from the material in which it occurs and is so close to the mineral soil surface. Analyses of placic horizons show that they contain between 1 and more than 10 percent organic carbon. The presence of organic carbon and the shape and position of the placic horizon distinguish it from the ironstone sheets that may form where water hangs, or moves laterally, at a lithologic discontinuity.

**Salic horizon**

A salic (L. *sal*, salt) horizon is a horizon of accumulation of salts which are more soluble than gypsum in cold water.

A salic horizon is 15 cm or more thick and has for 90 consecutive days or more per year, in 6 or more years out of 10:

1. An electrical conductivity (EC) equal to or greater than 30 dS/m in a 1:1 soil : water extract; and

2. The product of the EC in dS/m and thickness in cm equal 900 or more.

**Sombric horizon**

The sombric (Sp. *sombra*, shade, hence dark) horizon is a subsurface horizon of mineral soils which 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 it 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, a cambic, or an 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 rather than uniformly dispersed through the matrix.

**Spodic horizon**

The spodic (Gr. *spodos*, wood ash) horizon is an illuvial layer that is 2.5 cm or more thick, is not part of an Ap horizon, and contains 85 percent or more spodic materials (defined below).

Spodic materials contain illuvial active amorphous materials composed of organic matter and aluminum, with or without iron. The term "active" is used here to describe materials that have a high pH-dependent charge, a large surface area, and high water retention. In uncultivated soils the spodic horizon normally lies below an albic horizon; less commonly, it is either under an ochric epipedon that does not meet the color requirements of an albic horizon, or in or under an umbric epipedon. In some soils the spodic horizon is at the surface of the mineral soil directly below a thin O horizon. In cultivated soils it generally occurs directly below the Ap horizon.

**Sulfuric horizon**

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 below), or

3. 0.05 percent or more water-soluble sulfate.

A sulfuric horizon forms as a result of drainage, most commonly artificial, and oxidation of sulfide-rich mineral or organic soil materials. Such a horizon is highly toxic to most plants. It may also form in places where sulfidic materials have been exposed as a result of surface mining, road construction, dredging, or other earth-moving operations.

## Other Diagnostic Soil Characteristics

**Abrupt textural change**
An abrupt textural change is a specific kind of change that may occur between an ochric epipedon or 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 of 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 of the fine-earth fraction of the ochric epipedon or 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 two times or more the amount contained in the overlying horizon.

Normally there is no transitional horizon between an ochric epipedon or albic horizon and an argillic horizon, or it 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** (L. *albus*, white)
Albic 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. The definition implies that clay and/or free iron oxides have been removed from the materials, or 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.
Albic materials have one of the following colors:

1. A chroma of 2 or less, and either:

   a. A color value, moist, of 3 or more, 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. A chroma of 3 or less, and

   a. A color value, moist, of 6 or more; or

   b. A color value, dry, of 7 or more; or

   c. A chroma that is controlled by the color of uncoated grains of silt or sand, a hue of 5YR or redder, and color values listed in 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 which have not had clay and/or free iron removed and do not overlie an illuvial horizon or other soil horizon except a buried soil. Light-colored krotovina or filled root channels should only be considered albic materials if they have no fine stratifications or lamellae, if any sealing along krotovina walls has been destroyed, and if these intrusions have, after deposition, been leached of free iron oxides and/or clay.

**Andic soil properties** (Japn. *ando*, dark soil)
Andic soil properties result mainly from the presence, in soils, of significant amounts of allophane, imogolite, ferrihydrite or aluminum-humus complexes.

The concept of Andisols includes weakly weathered soils with much volcanic glass as well as more strongly weathered soils rich in short-range-order minerals. Hence the content of volcanic glass is one of the characteristics used in defining andic soil properties.

Volcanic glass is defined as optically isotropic translucent glass or pumice of any color, including glassy aggregates and glass coatings on other mineral grains. Composite grains must have at least 50 percent by volume of volcanic glass to be counted as volcanic glass.

Most horizons that have andic soil properties consist of mineral soil materials but some consist of organic soil materials but they must have less than 25 percent organic carbon.

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 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 $g/cm^3$ or less, and

   c. A phosphate retention[6] of 85 percent or more; or

[6] Blakemore, L.C., P.L.Searle, and B.K. Daly. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. pp. 44-45.

2. In the fine-earth fraction, a phosphate retention of 25 percent or more, 30 percent or more particles of 0.02 to 2.0 mm, and one of the following:

   a. Aluminum plus 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 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 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 1/2 iron percentages in the fine-earth fraction, falls within the shaded area of Figure 1.

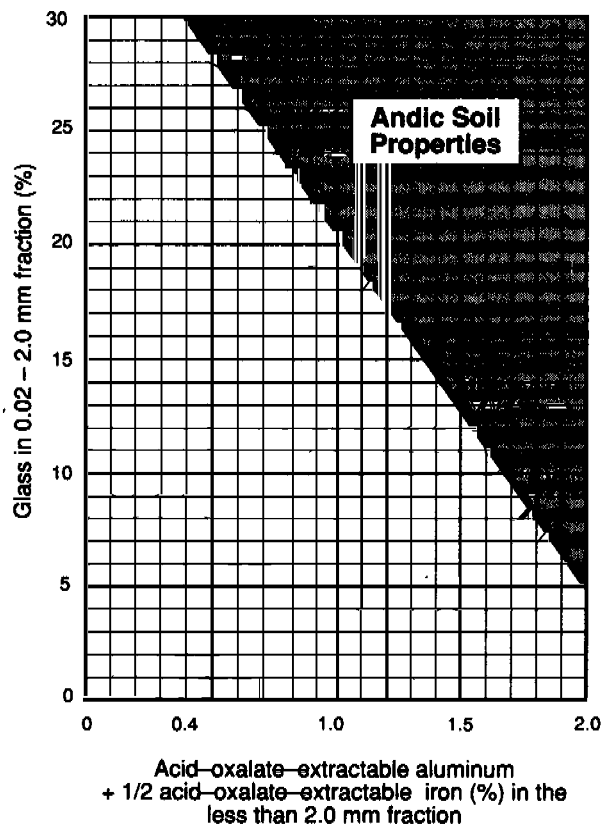


Figure 1 – *Soils that plot in the shaded area have Andic soil properties if the less than 2.0 mm fraction has phosphate retention of more than 25 percent and the 0.02 to 2.0 mm fraction is at least 30 percent of the less than 2.0 mm fraction.,*

**Aquic conditions**[9] (L. *aqua*, water)
Soils with aquic conditions are those which currently experience continuous or periodic saturation and reduction. The presence of these conditions is indicated by redoximorphic features (defined below) and can be verified, except in artificially drained soils,[10] by measuring saturation and reduction.

Elements of aquic conditions:

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. However, problems may arise 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, however, still occur if water runs into pyrometer slits near the bottom of the pyrometer 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 only be obtained with tensiometers. For operational purposes, the use of piezometers is recommended as a standard method.

   The duration of saturation required for creating aquic conditions is variable, 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.

[9] The term *aquic conditions* was introduced, and other changes were made throughout Soil Taxonomy, in 1992 as a result of recommendations submitted to SCS by the International Committee on Aquic Moisture Regime (ICOMAQ), which ws established in 1982 and chaired initially by Frank Moormann, then by Johan Bouma (since 1985).

[10] Artificial drainage is defined here as removal of free water from soils (by surface mounding, ditches, or subsurface tiles) to the extent that watertable 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.

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 200 cm depth, 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 variant of episaturation is 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.

2. The degree of <u>reduction</u> 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. Accurate measurements of the degree of reduction existing in a soil are difficult to obtain. In the context of Soil Taxonomy, however, only a degree of reduction that results in reduced Fe 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 α,α'-dipyridyl[11] in neutral, 1-normal <u>ammonium-acetate</u> solution. The appearance of a strong red color on the freshly broken surface indicates the presence of reduced iron ions. Use of α,α'-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. <u>Redoximorphic features</u> associated with wetness result from the reduction and oxidation of iron and manganese compounds in the soil after saturation with water and desaturation, respectively. 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 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 is oxidized and precipitated, it forms 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, ie., cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal <u>organization</u>. 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;

(2) Masses are noncemented concentrations of substances within the matrix; and

(3) Pore linings, i.e., zones of accumulation along pores which 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 (2 or less) where either Fe-Mn oxides alone or both Fe-Mn oxides and clay have been stripped out, including:

(1) Iron depletions, i.e., zones which 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 neoalbans); and

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

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[11] A positive reaction to the α,α'-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; this may only mean that the level of 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.

* (Childs, C.W. 1981. Field test for ferrous iron and ferric-organic complexes (on exchange sites or in water-soluble forms) in soils. Australian Journal of Soil Research 19: 175-180.

c. Reduced matrix.—This is a soil matrix which has a 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 positive 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 the taxa in one particular category. Therefore color patterns that are unique to specific taxa are referenced in the keys.

Anthraquic conditions represent a special kind of aquic conditions which occur in soils that are cultivated and irrigated. Soils with anthraquic conditions must meet the requirements for aquic conditions and in addition have both of the following:

a. A tilled surface layer and a directly underlying slowly permeable layer which have, for three months or more per year in most years, both

(1) Saturation and reduction; and

(2) A chroma of 2 or less in the matrix; and

b. A subsurface horizon with one or more of the following:

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

(2) Redox concentrations of iron; or

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

**Coefficient of linear extensibility (COLE)**

The coefficient of linear extensibility (COLE) is the ratio of the difference between moist length and dry length of a clod, to its dry length. It is $(Lm - Ld)/Ld$, where $Lm$ is the length at 33 kPa tension and $Ld$ 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.

**Durinodes** (L. *durus*, hard; *nodus*, knot)
Durinodes are weakly cemented to indurated nodules. The cement is $SiO_2$, presumably opal and microcrystalline forms of silica. It breaks down in hot concentrated KOH after treatment with HCl to remove carbonates, but does 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 and in some slaking. Durinodes are firm or very firm; they are brittle when wet, both before and after treatment with acid; and they are disconnected and have a diameter of 1 cm or more. Most durinodes are roughly concentric when viewed in cross section, and concentric stringers of opal may be visible under a hand lens.

**Identifiable Secondary Carbonates**

Identifiable secondary carbonates is a term 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 may either disrupt the soil structure or fabric to form masses, nodules, concretions, or spheroidal aggregates (white eyes) that are soft and powdery when dry; or it may be present as coatings in pores, on structural faces, or on the undersides of rock fragments. If present as coatings, it covers a significant part of the surfaces. Commonly, it coats all of them to a thickness of 1 mm or more; but if little calcium carbonate is present in the soil, the surfaces may be only partially coated. The coatings must be thick enough to be visible when moist. In some horizons with much calcium carbonate the entire horizon is colored by secondary carbonates.

The filaments (pseudomycelia) 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* means albic materials that penetrate 5 cm or more into an underlying argillic 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 which they penetrate, but they form continuous skeletans (ped coatings of clean silt or sand defined by Brewer, 1964) 1 mm or more thick on the vertical ped faces, 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.

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 which they penetrate.

**Linear extensibility (LE)**

The linear extensibility (LE) of a soil layer is the product of the thickness, in centimeters, multiplied by the COLE of the layer in question. The LE of a soil is the sum of these products for all soil horizons.

**Lithic contact** (Gr. *lithos*, stone)

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. If it consists of a single mineral, it must have a hardness by Mohs scale of 3 or more; otherwise, chunks of gravel size that can be broken out must not disperse during 15 hours of shaking in water or in a sodium hexametaphosphate solution. 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 of Oxisols and within 50 cm of the mineral soil surface of all other mineral soils.

***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 formula:

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

*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 are available in the United States for calculations of the *n* value, 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; if the soil flows easily between the fingers, the *n* value is 1 or more.

**Paralithic contact**

A paralithic (lithiclike) contact is a boundary between soil and a continuous, coherent underlying material. It differs from a lithic contact in that the underlying material, if a single mineral, has a hardness by Mohs scale of less than 3. If the underlying material does not consist of a single mineral, chunks of gravel size that can be broken out disperse more or less completely during 15 hours of shaking in water or in a sodium hexametaphosphate solution and, when moist, the material can be dug with difficulty with a spade. Normally the material underlying a paralithic contact is a partly consolidated sedimentary rock such as sandstone, siltstone, marl, or shale, and its bulk density or consolidation is such that roots cannot enter. There may be cracks in the rock, but their horizontal spacing is 10 cm or more.

**Permafrost**

Permafrost is a layer in which the temperature is perennially at or below 0°C, whether its consistence is very hard or loose. Dry permafrost has loose consistence.

**Petroferric contact** (Gr. *petra*, rock, and L. *ferrum*, iron)

A petroferric 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 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 from an indurated spodic horizon (ortstein, see below), both of which contain organic matter.

Several features can aid in making the distinction between a lithic 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** (Gr. *plinthos*, brick)
Plinthite is an iron-rich, humus-poor mixture of clay with quartz and other dilutents. It commonly occurs as dark red redox concentrations which 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 is usually 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 redox concentrations, however, 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 in the soil is usually 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 can then be dispersed in large part by shaking in water with a dispersing agent.

In a moist soil, plinthite is soft enough so that it can 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 by shaking in water with a dispersing agent.

**Sequum and bisequum**

The sequence of an eluvial horizon and the underlying B horizon, if one is present, is called a sequum. For example, an albic horizon and a spodic horizon directly below it, or a mollic epipedon and an underlying cambic horizon, or an argillic horizon and a *k* horizon directly below it, constitute a sequum. If two sequa are present in vertical sequence in a single soil, that sequence is called a bisequum.

**Slickensides**

Slickensides are polished and grooved surfaces that are produced by one soil mass sliding 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 are very common in swelling clays that undergo marked changes in moisture content.

**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, by 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. But if a soil is saturated with water that is too salty to be available to most plants, we call such a soil 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 the months of June, July, and August, and *winter* means December, January, and February.

<u>Soil moisture control section</u>

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 lithic, paralithic, or petroferric contact or to a petrocalcic horizon or a duripan, the upper boundary of the rock or 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 lithic contact itself, the paralithic contact, or the upper boundary of the cemented horizon. The control section of such a soil is considered moist if the upper boundary of the rock or 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 coarse fragments that do not absorb and release water, the limits of the moisture control section are deeper. In addition to the particle-size class, the limits of the soil moisture control section are also affected by differences in soil structure or pore-size distribution, or by other factors that influence movement and retention of water in the soil.

Classes of soil moisture regimes

The soil moisture regimes are defined in terms of the ground-water level, 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., it may be in crops, grass, or native vegetation, but it is not being irrigated, nor fallowed to increase the amount of stored moisture. These cultural practices affect the soil moisture conditions as long as they are continued.

**Aquic moisture regime.**—The aquic (L. *aqua*, water) moisture regime signifies a reducing regime in a soil that is virtually free of dissolved oxygen because it is saturated by ground water or by water of the capillary fringe. Some soils at times are saturated with water 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 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 (5°C) for some time while the soil is saturated.

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. A tidal marsh and a closed, landlocked depression fed by perennial streams are examples. The moisture regime in these soils is called *peraquic*.

Although the terms *aquic moisture regime* and *peraquic* are not used as either a criterion or a formative element for taxa, they are used in taxon descriptions as an aid in understanding genesis.

**Aridic and torric** (L. *aridus*, dry, and L. *torridus*,[12] 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 6 or more out of 10 years,

1. Dry in all parts for more than half 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 or a torric moisture regime normally occur in arid climates. A few are in semiarid climates and either have physical properties that keep them dry, such as a crusty surface that virtually precludes infiltration of water, or they are very shallow over bedrock. There is little or no leaching in these moisture regimes, and soluble salts accumulate in the soil if there is a source of them.

The limits set for soil temperature exclude from these moisture regimes the very cold and dry polar regions and high elevations. The data available on the soils of those regions are so fragmentary that no provision is made for their moisture regimes in this taxonomy.

**Udic moisture regime.**—The udic (L. *udus*, humid) moisture regime implies that, in 6 or more out of 10 years, the soil moisture control section is not dry in any part for as long as 90 cumulative days per year. 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 6 or more out of 10 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 which have well-distributed rainfall, or which have enough rain in summer so that the amount of stored moisture plus rainfall is approximately equal to, or exceeds, the amount of evapotranspiration. Water moves down through the soil at some time in most years.

[12] *Torridus* is not a very satisfactory root, but a better one could not be found. Soils that have a torric moisture regime are not and dry in summer, although they may not be hot throughout the year.

In climates where precipitation exceeds evapotranspiration in all months of most years, the moisture tension rarely goes up to 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; 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 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 cryic or pergelic soil temperature regimes (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 5°C at a depth of 50 cm below the soil surface, the soil moisture control section in the ustic moisture regime, in 6 or more out of 10 years, is dry in some or all parts for 90 or more cumulative days per year. But the moisture control section is moist 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 5°C or more at a depth of 50 cm from the soil surface, the soil moisture control section in the ustic regime is dry in some or all parts for 90 or more cumulative days per year in most years. But it is not dry in all parts for more than half the cumulative days when the soil temperature at a depth of 50 cm is higher than 5°C. If the moisture control section, in 6 or more out of 10 years, 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 moisture regime (Gr. *xeros*, dry) is the typical moisture regime of Mediterranean climates, where winters are moist and cool and summers are warm and dry. The moisture, coming during the winter when potential evapotranspiration is at a minimum, is particularly effective for leaching. In a xeric moisture regime the soil moisture control section, in 6 or more out of 10 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 6 or more out of 10 years, the moisture control section is moist in some part for more than half the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is higher than 5°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 mean summer and mean winter soil temperatures differ by 5°C or more either at a depth of 50 cm from the soil surface, or at a lithic or paralithic contact if shallower.

**Soil temperature regimes**

Classes of soil temperature regimes

The following soil temperature regimes are used in defining classes at various categoric levels in the taxonomy.

**Pergelic** (L. *per*, throughout in time and space, and L. *gelare*, to freeze; meaning permanent frost).—Soils with a pergelic temperature regime have a mean annual temperature lower than 0°C. These are soils that have permafrost if they are moist, or dry frost if there is no excess water. It seems likely that the moist and the dry pergelic regimes should be defined separately, but at present we have only fragmentary data on the dry soils of very high latitudes. Ice wedges and lenses are normal in such soils in the United States.

**Cryic** (Gr. *kryos*, coldness; meaning very cold soils).—Soils in this temperature regime have a mean annual temperature higher than 0°C but lower than 8°C.

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 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 soil is either:

a. Frozen in some layer within the control section in most years 2 months after the summer solstice; i.e., the soil is very cold in winter but warms up slightly in summer; or

b. Not frozen in most years below a depth of 5 cm from the soil surface; i.e., the soil is cold throughout the year but, because of marine influence, does not freeze in most years.

Cryic soils that have an aquic moisture regime commonly are churned by frost. All isofrigid (see below) soils without permafrost are considered to have a cryic temperature regime.

**Frigid.**—The concept of the frigid soil temperature regime and other soil temperature regimes listed below are used chiefly in defining classes of soils in the low categories. A soil with a frigid 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 and mean winter soil temperatures (June-July-August and December-January-February) is more than 5°C either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

**Mesic** (Gr. *mesos*, intermediate).—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 5°C either at a depth of 50 cm from the soil surface or at a 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 5°C either at a depth of 50 cm from the soil surface or at a 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 5°C either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

If the name of a soil temperature regime has the prefix *iso* (Gr. *isos*, equal), the mean summer and mean winter soil temperatures for June, July, and August and for December, January, and February differ by less than 5°C at a depth of 50 cm or at a 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.

**Spodic materials** (Gr. *spodos*, wood ash)

Spodic materials have formed in an illuvial horizon that normally underlies a histic, an ochric, or an umbric epipedon or an albic horizon. In most undisturbed areas spodic materials underlie an albic horizon. They may occur within an umbric epipedon or 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 must be at least two times as high as the ODOE value for 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 to an illuvial horizon. The morphological, chemical, and physical properties of spodic materials are as follows.

<u>Definition of spodic materials</u>

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

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 more of the following:

a. An overlying albic horizon which extends horizontally through 50 percent or more of each pedon, and have, directly under the albic horizon, colors, moist (crushed and smoothed sample), as follows:

(1) A hue of 5YR or redder; or

(2) A hue of 7.5YR, color value of 5 or less, and chroma of 4 or less; or

(3) A 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. One of the colors listed above or a hue of 7.5YR, color value, moist, of 5 or less, and chroma of 5 or 6 (crushed and smoothed sample), and one or more of the following morphologic or chemical properties:

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

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

(3) Aluminum plus 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, or an 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, or an ochric epipedon or albic horizon.

**Sulfidic materials**

Sulfidic materials contain oxidizable sulfur compounds, and are mineral or organic soil materials with a pH value of more than 3.5 which, 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 which 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 mouths of rivers that carry noncalcareous sediments, but they may occur in fresh-water 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 formation of iron and aluminum sulfates. The iron sulfate, jarosite, may segregate to form the yellow mottles 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.

**Weatherable minerals**

Several references are made to weatherable minerals in the text of this and subsequent chapters. 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. Minerals that are included in the meaning of weatherable minerals are as follows:

1. Clay minerals: All 2:1 lattice clays except one which 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-size minerals (0.02 to 0.2 mm in diameter): Feldspars, feldspathoids, ferromagnesian minerals, glass, micas, zeolites, and apatite.

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

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# Chapter 3

# Horizons and Properties Diagnostic for the Higher Categories: Organic Soils[1]

## Organic Soil Material

Organic soil material either:

1. Is saturated with water for long periods (or artificially drained) and, excluding live roots, has an organic-carbon content (by weight) of:

    a. 18 percent or more if the mineral fraction contains 60 percent or more clay; or

    b. 12 percent or more if the mineral fraction contains no clay; or

    c. 12 + (clay percentage multiplied by 0.1) percent or more if the mineral fraction contains less than 60 percent clay; or

2. Is never saturated with water for more than a few days and contains 20 percent or more (by weight) organic carbon.

Item 1 in this definition covers materials that have been called peat and muck. Item 2 is intended to include what has been called litter or an O horizon.

## 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 they are derived. The three kinds (defined below) 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, as follows.

[1] Organic soils are referred to as Histosols in this taxonomy.

**Fibers**

*Fibers*, in the terminology of this taxonomy, are pieces of plant tissue in organic soil materials (excluding live roots) which:

1. Are large enough to be retained on a 100-mesh sieve (openings 0.15 mm in diameter) when the materials are screened after dispersion in sodium hexametaphosphate; and

2. Show evidence of the cellular structure of the plants from which they are derived; and

3. Are either 2 cm or less in their smallest dimension, or are decomposed enough so they can be crushed and shredded with the fingers.

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

**Fibric soil materials** (L. *fibra*, fiber)

Fibric soil materials are organic soil materials which either:

1. Contain three fourths[2] 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 (Munsell designations) 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** (Gr. *hemi*, half; implying intermediate decomposition)

Hemic soil materials 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. They are partly altered both physically and biochemically.

[2] Fractions are used rather than percentages to avoid implying a higher degree of accuracy than is justified.

**Sapric soil materials** (Gr. *sapros*, rotten)

These 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. Their fiber content, after rubbing, is less than one sixth (by volume), excluding coarse fragments; and

2. Their sodium-pyrophosphate-extract color 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). If few or no fibers can be detected and the color of the pyrophosphate extract is to the left or above this line, the possibility that the material is limnic must be considered.

**Humilluvic material**

Humilluvic material, i.e., illuvial humus, accumulates in the lower parts of some organic soils if they are acid and have been drained and cultivated. The humilluvic material has a younger $C^{14}$ age 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 humilluvic material must constitute one half or more (by volume) of a layer 2 cm or more thick.

**Limnic materials** (Gr. *limne*, lake)

The presence or absence of limnic deposits is taken into account in the higher categories of organic soils (Histosols, see below), while the nature of such deposits is considered in the lower categories. Limnic materials include both organic and inorganic materials that were either (1) deposited in water by precipitation or through the action of aquatic organisms, such as algae or diatoms, or (2) derived from underwater and floating aquatic plants and subsequently modified by aquatic animals. They include coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

<u>Coprogenous earth</u>

A coprogenous-earth (sedimentary peat) layer is a limnic layer which:

1. Contains many fecal pellets with diameters between a few hundredths and a few tenths of a millimeter; and

2. Has a color value, moist, of 4 or less; and

3. Either forms a slightly viscous water suspension and is slightly plastic but not sticky, or shrinks upon drying to form clods that are difficult to rewet and often tend to crack along horizontal planes; and

4. Normally contains almost no visible fragments of plants; and

5. Either yields a saturated sodium-pyrophosphate extract on white chromatographic or filter paper that has a higher color value and lower chroma than 10 YR 7/3 (Munsell designations), or has a cation-exchange capacity of less than 240 cmol(+) per kg organic matter (measured by loss on ignition), or both.

<u>Diatomaceous earth</u>

A diatomaceous-earth layer is a limnic layer which:

1. If not previously dried, has a matrix color value of 3, 4, or 5, which changes irreversibly on drying as the result of the irreversible shrinkage of organic-matter coatings on diatoms (identifiable by microscopic, 440X, examination of dry samples); and

2. Either yields a saturated sodium-pyrophosphate extract on white chromatographic or filter paper that has a higher color value and lower chroma than 10 YR 7/3 (Munsell designations), or has a cation-exchange capacity of less than 240 cmol(+) per kg organic matter (by loss on ignition), or both.

<u>Marl</u>

A marl layer is a limnic layer which:

1. Has a color value, moist, of 5 or more; *and*

2. Reacts with dilute HCl to evolve $CO_2$.

Marl usually does not change its color 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)**

For practical reasons an arbitrary control section has been established for the classification of organic soils (Histosols). Depending on the kinds of soil materials that are present 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 lithic or paralithic contact, thick layer of water, or permafrost within the respective limit. The thicker control section is used if the surface soil 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 $g/cm^3$. 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 lithic or paralithic contact, if shallower than 130 or 160 cm, constitutes the lower boundary of the control section; or the lower boundary of the control section is 25 cm below the upper limit of permafrost 2 months after the summer solstice. An unconsolidated mineral substratum shallower than those limits does not change the lower boundary of the control section.

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

**Surface tier**

The surface tier of a Histosol 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 $g/cm^3$; otherwise, the surface tier extends from the soil surface to a depth of 30 cm.

On some organic soils, a surface mineral layer less than 40 cm thick is present as a result of flooding, volcanic eruptions, additions of mineral materials to increase soil strength or reduce frost hazard, 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, however, the control section ends at a shallower depth (at a lithic or paralithic contact or a water layer, or in permafrost), 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 lithic or paralithic contact or a water layer, or in permafrost).

# Chapter 4

# Family and Series Differentiae

## Family Differentiae for Mineral Soils

To distinguish families of mineral soils within a subgroup, the following differentiae are used. They are listed and defined in the same sequence in which the descriptive adjectives relating to each differentia appear in the family names.

Particle-size classes
Mineralogy classes
Calcareous and reaction classes
Soil temperature classes
Soil depth classes
Soil consistence classes
Classes of coatings
Classes of cracks

### Particle-size classes

The term *particle size* is used to characterize the grain-size composition of a whole soil, while the term *texture* is used in describing its fine-earth fraction, which consists of particles with a diameter of less than 2.0 mm.

The particle-size classes of this taxonomy represent a compromise between conventional divisions in pedologic and in engineering classifications. Engineering classifications have set the limit between sand and silt at a diameter of 74 microns, while pedologic classifications have put 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 very-fine-sand separate (diameter between 0.05 mm and 0.1 mm) has been subdivided by the 74-micron limit. In defining the particle-size classes for this taxonomy, a similar division has been made, but in a different way. A fine sand or loamy fine sand normally contains an appreciable amount of very fine sand, but the very-fine-sand fraction is mostly coarser than 74 microns. A silty sediment such as loess may also contain an appreciable amount of very fine sand, most of which, however, is finer than 74 microns. So in designing the 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. But it is treated as silt 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 the different kinds of soils. So this taxonomy is providing a choice of either 7 or 11 particle-size classes, of which the second set replaces the *loamy* class of the first set with 4 and the *clayey* class with 2 more narrowly defined classes (see below). This permits relatively fine distinctions between families of soils for which particle size is important, while providing broader groupings for soils in which particle sizes are difficult to measure precisely, or for 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 or more in specific horizons, while in other families the more narrowly defined terms *fine* and *very fine* indicate that these horizons have clay contents either of 35 to 60 percent, or of 60 percent or more, in their fine-earth fraction. The term *fine earth* refers to particles smaller than 2.0 mm in diameter. The term *rock fragments* means particles 2.0 mm or more in diameter and includes all particles with horizontal dimensions smaller than the size of a pedon.

<u>Definition of classes</u>

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, then the percentage of clay is estimated with the following formula:

Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon)

If the product is more than 100, the clay content is estimated at 100 percent.

**Fragmental.**—90 percent or more (by volume) rock fragments and voids; less than 10 percent (by volume) particles less than 2.0 mm in diameter.

**Sandy-skeletal.**—35 percent or more (by volume) rock fragments; 10 percent or more (by volume) particles less than 2.0 mm in diameter (fine-earth fraction) with a texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand.

**Loamy-skeletal.**—35 percent or more (by volume) rock fragments; 10 percent or more (by volume) particles less than 2.0 mm in diameter (fine-earth fraction) with a texture of loamy very fine sand, very fine sand, or finer, including less than 35 percent (by weight) clay.

**Clayey-skeletal.**—35 percent or more (by volume) rock fragments; 10 percent or more (by volume) particles less than 2.0 mm in diameter (fine-earth fraction), including 35 percent or more (by weight) clay.

**Sandy.**—In the fine-earth fraction, a texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand; in the whole soil, less than 35 percent (by volume) rock fragments.

**Loamy.**—In the fine-earth fraction, a texture of loamy very fine sand, very fine sand, or finer, including less than 35 percent (by weight) clay; in the whole soil, less than 35 percent (by volume) rock fragments.

*Coarse-loamy.* 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); in the fine-earth fraction, less than 18 percent (by weight) clay.

*Fine-loamy.* 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); in the fine-earth fraction, 18 to 35 percent (by weight) clay (Vertisols are excluded).

*Coarse-silty.* 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); in the fine-earth fraction, less than 18 percent (by weight) clay.

*Fine-silty.* 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); in the fine-earth fraction, 18 to 35 percent (by weight) clay (Vertisols are excluded).

**Clayey.**— In the fine-earth fraction, 35 percent or more (by weight) clay; in the whole soil, less than 35 percent (by volume) rock fragments.

*Fine.* 35 to 60 percent (by weight) clay (30 to 60 percent in Vertisols) in the fine-earth fraction.

*Very fine.* 60 percent or more (by weight) clay in the fine-earth fraction.

<u>Modifiers that replace names of particle-size classes</u>1

There are two situations in which particle-size class names are not used. In one, the name is redundant. Psamments and Psammaquents are sandy by definition, so no particle-size modifier is used in the family names of those soils.

In the second situation particle-size analysis is difficult to apply, which is the case with soil materials that are derived from volcanic ejecta and/or have a high content of sequioxides and organic matter. Normal particle-size classes do not characterize these components adequately, especially as they often cannot be readily dispersed and the results of dispersion are variable. Consequently, normal particle-size class names are not used for those parts of soils that have andic soil properties or a high amount of volcanic glass, as is the case with Andisols and many andic and vitrandic subgroups of other soil orders. In addition, most Cryods and Cryaquods and a few other Spodosols that are not identified in andic subgroups have andic soil properties in some horizons within the particle-size control section, and particle-size class names are not used for these horizons.[2]

The following is a list of modifiers used as substitutes for particle-size class names, together with the criteria for each. These criteria combine particle-size and mineralogical properties and take the place of both.

[1] Definitions of the geologic terms used in the substitute particle-size classes are generally the same as in: Bates, R.L., and J. A. Jackson (Eds). 1980. Glossary of Geology. 2nd ed. American Geological Institute, Falls Church, VA. 751 pp. However, different definitions are used here for the following terms:

<u>Cinders</u>: Uncemented, juvenile, vitric, vesicular pyroclastic materials, more than 2.0 mm in at least one dimension, with an apparent specific gravity (including vesicles) of more than 1.0 and less than 2.0 g/cm$^3$.

<u>Lapilli</u>: Nonvesicular or slightly vesicular pyroclastics, 2.0 to 76 mm in at least one dimension, with an apparent specific gravity of 2.0 or more g/cm$^3$.

<u>Pumice-like</u>: Vesicular pyroclastic materiasl other than pumice that have an apparent specific gravity (including vesicles) of less than 1.0 g/cm$^3$.

2. Particle-size class names are applied, although with reservations, to spodic horizons that do not have andic soil properties but contain significant amounts of organize matter. Somewhat different classes probably should be used for most families of Spodosols, because some series that otherwise seem reasonably homogeneous are split at the family level by the particle-size classes. But alternatives have not yet been sufficiently tested.

1. Substitutes for the fragmental particle-size class:

These classes have a fine-earth component of less than 10 percent of the total volume.

Pumiceous - In the whole soil, more than 60 percent (by weight) volcanic ash, cinders, lapilli, pumice and pumice-like[3] fragments with diameters of more than 1 mm; in the fraction coarser than 2.0 mm, two thirds or more (by volume) pumice or pumice-like fragments.

Cindery - In the whole soil, more than 60 percent (by weight) volcanic ash, cinders, lapilli, pumice and pumice-like fragments with diameters of more than 1 mm; in the fraction coarser than 2.0 mm, less than two thirds (by volume) pumice and pumice-like fragments.

2. Substitutes for the non-fragmental particle-size classes:

These classes have a fine-earth component of 10 percent or more of the total volume.

Ashy - Less than 35 percent (by volume) rock fragments; a fine-earth fraction which contains 30 percent or more (by weight) particles between 0.02 and 2.0 mm in diameter and which has either:

a. Andic soil properties, and 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. No andic soil properties, and a total of 30 percent or more of the 0.02-to-2.0-mm fraction (by grain count) consisting of volcanic glass.

Ashy-pumiceous - 35 percent or more (by volume) rock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments; an ashy fine-earth fraction.

Ashy-skeletal - 35 percent or more (by volume) rock fragments, of which less than two-thirds (by volume) are pumice and pumice-like fragments; an ashy fine-earth fraction.

Medial - A fine-earth fraction which has andic soil properties, and which 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; less than 35 percent (by volume) rock fragments.

Medial-pumiceous - 35 percent or more (by volume) rock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments; a medial fine-earth fraction.

Medial-skeletal - 35 percent or more (by volume) rock fragments, of which less than two thirds (by volume) are pumice or pumice-like fragments; a medial fine-earth fraction.

Hydrous - A fine-earth fraction which has andic soil properties, and which has a water content at 1500 kPa tension of 100 percent or more on undried samples; less than 35 percent (by volume) rock fragments.

Hydrous-pumiceous - 35 percent or more (by volume) rock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments; a hydrous fine-earth fraction.

Hydrous-skeletal - 35 percent or more (by volume) rock fragments, of which less than two thirds (by volume) are pumice or pumice-like fragments; a hydrous fine-earth fraction.

Control section for particle-size classes or their substitutes

The particle-size and substitute class names listed above are applied to certain horizons, or to the soil materials within specific depth limits, which have been designated as the *particle-size control section*. The lower boundary of the control section may be at a specified depth (in centimeters) from the mineral soil surface, or at the upper boundary of a root-limiting layer, i.e., a duripan, a fragipan, a petrocalcic, petrogypsic, or placic horizon, or continuous ortstein; or at a lithic, paralithic, or petroferric contact. The following list of particle-size control sections for particular kinds of soils is arranged as a key.[4] The control sections are as follows:

1. For soils that have, within 36 cm of the mineral soil surface,

a. A root-limiting layer: Between the mineral soil surface and the root-limiting layer;

b. A soil temperature of 0°C or lower, 2 months after the summer solstice: Between the mineral soil surface and a depth of 36 cm.

[3] See footnote 1.

[4] This key, like the others in Soil Taxonomy, is designed in such a way that the reader makes the correct classification by going through the key systemati cally, starting at the beginning and eliminating one by one any classes which include criteria that do not fit the soil in question. The soil belongs into the first class listed for which it meets the criteria.

2. 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 shallowest of the following: (a) a depth of 100 cm, or (b) a root-limiting layer or contact, or (c) a depth of 25 cm below the level to which the soil is frozen 2 months after the summer solstice.

3. For those great groups of Alfisols, Spodosols, and Ultisols that have a fragipan or spodic horizon in or above an argillic or a kandic horizon; for Oxisols; and for other soils that do not have an argillic, kandic, or natric horizon: Between the lower boundary of an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and the shallowest of the following: (a) a depth of 100 cm, or (b) a root-limiting layer or contact, or (c) a depth of 25 cm below the level to which the soil is frozen 2 months after the summer solstice.

4. For those Alfisols, Ultisols, and great groups of Aridisols and Mollisols which have an argillic, a kandic, or a 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, or which are in a grossarenic subgroup, one of the following:

   a. If there are no horizons or layers of strongly contrasting particle sizes (defined below), and there is no root-limiting layer or contact at a depth of less than 50 cm from the top of the argillic, kandic, or natric horizon: Either the whole argillic, kandic, or natric horizon if less than 50 cm thick, or its upper 50 cm; or

   b. If there are horizons or layers of strongly contrasting particle sizes within or below the argillic, kandic, or natric horizon and within 100 cm of the mineral soil surface: Between the upper boundary of the argillic, kandic, or natric horizon and either a depth of 100 cm from the mineral soil surface or a root-limiting layer or contact, whichever is shallower; or

   c. If there is a root-limiting layer or contact directly below the argillic, kandic, or natric horizon: Between the upper boundary of the argillic, kandic, or natric horizon and either the root-limiting layer or contact, or a depth of 50 cm from the top of the argillic, kandic, or natric horizon, whichever is shallower.

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

6. For other soils which have an argillic or a natric horizon that has its lower boundary at a depth of less than 25 cm from the mineral soil surface: Between the upper boundary of the argillic or natric horizon and either a depth of 100 cm or a root-limiting layer or contact, whichever is shallower.

Strongly contrasting particle-size classes

In general, the weighted average particle size of the whole control section determines what particle-size or substitute class name is used for a soil family. If a particle-size class name applies for one part and a substitute class name for the remaining part of the control section, the name for the thicker part is used for that soil family.

If, however, the particle-size control section consists of two parts with strongly contrasting particle-size or substitute classes (listed below) and if the transition zone between them is less than 12.5 cm thick, both class names are used. For example, if the weighted average particle size of the control section's upper part is loamy fine sand and that of the lower part is clay, with a transition zone of less than 12.5 cm, the family particle-size class of that soil is *sandy over clayey*. If the particle-size control section includes more than one pair of the strongly contrasting classes listed below, then the pair of adjacent classes that contrast most strongly is used in classifying the soil family; 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.

The following particle-size or substitute classes are considered strongly contrasting if the transition zone between the two parts of the particle-size control section is less than 12.5 cm thick:

1. Ashy over clayey.
2. Ashy over loamy-skeletal.
3. Ashy over loamy.
4. Ashy over medial-skeletal.
5. 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.
6. Ashy over pumiceous or cindery if there is an absolute difference of 20 percent or more between volumes of rock fragments in the two parts of the control section.
7. Ashy over sandy or sandy-skeletal.
8. 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.
9. Cindery over loamy.
10. Cindery over medial-skeletal.

11. Cindery over medial.
12. layey 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.
13. Clayey over fragmental.
14. 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.
15. 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.
16. Clayey over sandy or sandy-skeletal.
17. Clayey-skeletal over sandy or sandy-skeletal.
18. Coarse-loamy over clayey.
19. Coarse-loamy over fragmental.
20. Coarse-loamy over sandy or sandy-skeletal if the coarse-loamy material contains less than 50 percent fine or coarser sand.
21. Coarse-silty over clayey.
22. Coarse-silty over sandy or sandy-skeletal.
23. 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.
24. Fine-loamy over fragmental.
25. Fine-loamy over sandy or sandy-skeletal.
26. 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.
27. Fine-silty over fragmental.
28. Fine-silty over sandy or sandy-skeletal.
29. Hydrous over clayey-skeletal.
30. Hydrous over clayey.
31. Hydrous over fragmental.
32. Hydrous over loamy-skeletal.
33. Hydrous over loamy.
34. Hydrous over sandy or sandy-skeletal.
35. Loamy over sandy or sandy-skeletal if the loamy material contains less than 50 percent fine or coarser sand.
36. Loamy over pumiceous or cindery.
37. 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.
38. 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.
39. Loamy-skeletal over sandy or sandy-skeletal if the loamy material has less than 50 percent fine or coarser sand.
40. 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.
41. Medial over clayey-skeletal.
42. Medial over clayey.
43. Medial over fragmental.
44. Medial over hydrous.
45. Medial over loamy-skeletal.
46. Medial over loamy.
47. Medial over pumiceous or cindery.
48. Medial over sandy or sandy-skeletal.
49. 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.
50. Pumiceous or ashy-pumiceous over loamy.
51. Pumiceous or ashy-pumiceous over medial-skeletal.
52. Pumiceous or ashy-pumiceous over medial.
53. Pumiceous or ashy-pumiceous over sandy or sandy-skeletal.
54. Sandy over clayey.
55. Sandy over loamy if the loamy material contains less than 50 percent fine or coarser sand.
56. Sandy-skeletal over loamy if the loamy material contains less than 50 percent fine or coarser sand.

The purpose in setting up classes of strongly contrasting particle sizes has been to identify changes in pore-size distribution which are not identified in higher soil categories and which seriously affect the movement and retention of water. The above list has been compiled for use in grouping the soil series of the United States into families, and is not intended as a complete list. For example, "fine sand over coarse sand" is a pair of strongly contrasting particle-size classes common among Udipsamments in western Europe, but not included here because it is much less common in the United States.

Choice of 7 or 11 particle-size classes

Only seven particle-size class names are used for families of shallow soils and those in lithic, arenic, and grossarenic subgroups.

With families of Ultisols not included in the preceding item, subclasses of the loamy particle-size class, but not those of the clayey class, are used.

Contrasting particle-size families are recognized for soils in which substitute class names are applicable to part of the control section. If such substitute terms are applied only to the upper part, one of the seven particle-size class names is used to characterize the lower part. For example, we use the term *cindery over loamy* (not cindery over fine-loamy).

Only two subclasses of particle-size classes are applied to soil families in the Vertisol order, i.e., *fine* if there is less than 60 percent clay, and *very fine* if there is 60 percent or more clay in the weighted average of the control section's fine-earth fraction.

**Mineralogy classes**

The control section

Mineralogy classes are based on the approximate mineralogical composition of selected grain-size fractions of the same segment of a soil (i.e., the same control section) that is used to determine particle-size classes.

Contrasting mineralogy modifiers

Contrasting mineralogy modifiers are only recognized in those soil families to which substitutes for particle-size names have been applied. In naming the contrasting mineralogy classes for the families of such soils, the set of seven particle-size classes is used to describe the lower part of the particle-size control section. For example, a pair of contrasting layers in the control section is characterized as *medial over loamy, mixed* (not medial over coarse-loamy, mixed).

If there are layers of contrasting particle sizes in the control section, the mineralogy class of the upper part determines the family mineralogy modifier. For example, if there is fine-loamy material of mixed mineralogy over siliceous sandy material, the soil family is described as *fine-loamy over sandy, mixed* (not fine-loamy, mixed, over sandy, siliceous).

Key to mineralogy classes

Table 1 provides a key for determining the proper mineralogy classes of families in all mineral soils except Oxisols; the mineralogy classes of Oxisol families are listed in Table 2. These tables contain keys, not complete definitions.

Important variations in Andisols, in many intergrades to Andisols, and in many cryic great groups and cryic subgroups of Spodosols are identified by using the substitute modifiers listed above which replace names of particle-size classes, and which include aspects of texture, consistence, and mineralogy.

Mineralogy classes are not named in families of Calciaquolls because their amount of carbonates is more significant than other aspects of their mineralogy, and they are not mentioned in families of Quartzipsamments because these soils are siliceous by definition.

Obviously, it is normally impossible to be certain what percentages of the different kinds of clay minerals are present in a soil. Quantitative methods of identification are still subject to change, and although much progress has been made in the past few decades, an element of judgment still enters into the estimation. However, one does not have to depend exclusively on X-ray, surface, and DTA determinations. Other physical and chemical properties, e.g., changes in volume, cation-exchange capacity, and consistence, can suggest the mineralogy of many clayey soils.

The clay mineralogy descriptions for clayey soils are based on the weighted average percentages of the control section's fine-earth fraction.

**Calcareous and reaction classes**

In the following, presence or absence of carbonates in mineral soils and reaction classes are treated together because they are so intimately related; e.g., a calcareous horizon cannot be strongly acid. Two classes identifying the presence or absence of carbonates, *calcareous* and *noncalcareous*, are defined for selected taxa. Their control section is one of the following: (1) between 25 and 50 cm from the mineral soil surface, or (2) between a depth of 25 cm from the mineral soil surface and a lithic or paralithic contact at a depth between 25 and 50 cm, or (3) a layer directly above a lithic or paralithic contact that is less than 25 cm below the mineral soil surface. Definitions of the two classes are as follows:

**Calcareous.**—The fine-earth fraction effervesces in all parts with cold dilute HCl.

**Noncalcareous.**—The fine-earth fraction does not effervesce in all parts with cold dilute HCl. The term *noncalcareous* is not used as part of the family name.

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 control section for reaction classes is the same as for particle-size classes. Three classes, *acid, nonacid*, and *allic*, are defined for use in selected taxa, as follows:

**Acid.**—The pH is less than 5.0 in 0.01 M $CaCl_2$ (2:1) throughout the control section (about 5.5 in $H_2O$, 1:1).

**Nonacid.**—The pH is 5.0 or more in 0.01 M $CaCl_2$ (2:1) in some or all layers of the control section. The term *nonacid* is not used in the family name of calcareous soils.

**Allic.**—A layer 30 cm or more thick within the control section contains more than 2 cmol(+) of KCl-extractable Al per kg soil in the less-than-2.0-mm fraction.

The terms *acid* and *nonacid* are used only in names of certain families of Entisols and Aquepts; they are not used in sandy, sandy-skeletal, cindery, pumiceous, and fragmental families of these taxa, or in Sulfaquepts and Fragiaquepts, or in families with a carbonatic or gypsic mineralogy. The term *allic* is used only in names of Oxisol families.

Calcareous classes, if appropriate, are applied to the same taxa as reaction classes and are also used in family names of Aquolls, except Calciaquolls and Aquolls with an argillic horizon. Calcareous and reaction class names are not used in soil families that have a carbonatic or gypsic mineralogy. Because *calcareous* implies *nonacid*, the term *nonacid* is omitted as redundant if a soil family is termed *calcareous*. If a soil is both nonacid and noncalcareous, only the class name *nonacid* is used (*noncalcareous* is never used in a family name). The term *calcareous*, when used as a family modifier, is considered a subclass of mineralogy and is added to the mineralogy class name in parentheses, e.g.: fine-loamy, mixed (calcareous), mesic Typic Haplaquolls.

**Soil temperature classes**

Soil temperature classes, as named and defined here, are used as family differentiae in all orders. The names are used as family modifiers unless the criteria for a higher taxon carry the same limitation. Thus *frigid* is implied in all boric suborders and cryic great groups, and would be redundant if used in the names of families within these classes of soils.

The Celsius (centigrade) scale is the standard. It is assumed that the temperature is that of a soil that is not being irrigated.

For soil families that have a difference of 5°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) soil temperatures, either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower, the soil temperature classes, defined in terms of the mean annual soil temperature, are as follows:

**Frigid.**— Lower than 8°C.

**Mesic.**— 8° to 15°C.

**Thermic.**— 15° to 22°C.

**Hyperthermic.**— 22°C or higher.

For soil families that have a difference of less than 5°C between mean summer and mean winter soil temperatures, either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower, the soil temperature classes, defined in terms of the mean annual soil temperature, are as follows:

**Isofrigid.**— Lower than 8°C.

**Isomesic.**— 8° to 15°C.

**Isothermic.**— 15° to 22°C.

**Isohyperthermic.**— 22°C or higher.

**Other characteristics**

Several other soil characteristics besides those mentioned above are considered in particular taxa for grouping series into families. These characteristics include depth of soil, consistence, coatings on sands, and permanent cracks.

Depth of soil

Distinctions according to soil depth are made in some great groups and in arenic, grossarenic, and lithic subgroups. But at the family level some other soils should also be grouped according to depth, e.g., soils which have a shallow paralithic contact with weakly consolidated rock, such as clay shale, that is too compact for penetration by roots. One soil-depth class name, *shallow*, is used to characterize certain soil families that have one of the following depths (from the mineral soil surface):

**Shallow.**—Either:

1. Less than 50 cm to the upper boundary of a duripan or of a petrocalcic or petrogypsic horizon, or to a lithic, paralithic, or petroferric contact. Used for families in all great groups of Alfisols, Andisols, Aridisols, Entisols, Inceptisols, Mollisols, Spodosols, and Ultisols, except in the family names of lithic subgroups of these orders, where it would be redundant. Or:

2. Less than 100 cm to a lithic, paralithic, or petroferric contact. Used for families of Oxisols.

Consistence

In this taxonomy, some cemented horizons, e.g., a duripan, serve as differentiae in categories above the family, while others, such as a cemented spodic horizon (ortstein), do not. But no single family should include soils both with and without a continuous, shallow, cemented horizon. In Spodosols, in particular, a cemented spodic horizon has to be used as a family differentia. The following two soil consistence classes are defined for Spodosol families:

**Ortstein.**—All or part of the spodic horizon, when moist, is at least weakly cemented into a massive horizon that is present in more than half of each pedon.

**Noncemented.**—The spodic horizon, when moist, is not cemented into a massive horizon in one half or more of each pedon.

Cementation of a small volume within the spodic horizon into concretions does not constitute cementation to form a massive horizon. While the name of a family of noncemented Spodosols normally does not have a modifier to indicate lack of cementation, the name of a family of cemented Spodosols contains the modifier *ortstein*.

A cemented calcic or gypsic horizon is not identified in the family name. Many calcic and some gypsic horizons are weakly cemented and some are indurated. The recognition of petrocalcic and petrogypsic horizons is expected to meet most, if not all, the needs for recognition of cementation in those horizons. Therefore, taxa with a petrocalcic or petrogypsic horizon do not have a family modifier indicating cementation.

Classes of coatings

Despite the emphasis given to particle-size classes in the 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. A total of 5 percent silt plus clay makes a reasonable division of the sands at the family level. Two classes of Quartzipsamments are defined in terms of their silt-plus-clay content, as follows:

**Coated.**—The fine-earth fraction contains more than 5 percent (by weight) silt plus clay.

**Uncoated.**—The fine-earth fraction contains 5 percent or less (by weight) silt plus clay.

Classes of permanent cracks

Hydraquents consolidate or shrink after drainage and become Fluvaquents. In the process they form polyhedrons roughly 12 to 50 cm in diameter, depending on their *n* value and particle size. 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 soil, but the cracks are permanent and can persist for several hundreds of years even though the soils are cultivated. These cracks permit rapid movement of water through the soil, either vertically or laterally. But such soils may have the same particle size, mineralogy, and other family properties as soils which are not cracked or which have cracks that open and close with the seasons. Soils with permanent cracks are very rare in the United States. They are identified by the following term:

**Cracked.**—This modifier is used only for families of Fluvaquents. It means that there are continuous, permanent lateral and vertical cracks 2 mm or more wide, spaced at average lateral intervals of less than 50 cm. If the family name of a Fluvaquent does not contain the modifier *cracked*, permanent cracks are assumed to be absent.

**Family Differentiae for Histosols**

Most of the differentiae which are used to distinguish families of Histosols (organic soils) have already been defined, either because they are used as differentiae in mineral soils as well as Histosols, or because their definitions are used for the classification of some Histosols in categories higher than the family. In the following, differentiae not previously mentioned are defined and the classes in which they are used are enumerated.

The order in which family modifiers, if appropriate for a particular family, are placed in the technical family names of Histosols, is as follows:

Particle size
Mineralogy, including nature of limnic deposits
Reaction
Soil temperature regime
Soil depth

**Particle-size classes**

Particle-size modifiers are used only in family names of terric subgroups of Histosols. The following terms are used:

Fragmental
Loamy-skeletal or clayey-skeletal
Sandy or sandy-skeletal
Loamy
Clayey

The meanings of these terms are the same as those defined for particle-size classes of mineral soils. The proper term is selected to describe the weighted average particle size of either the upper 30 cm of the mineral layer or of that part of the mineral layer that is within the control section, whichever is thicker.

**Mineralogy classes**

Three different kinds of mineralogy classes are recognized for families in certain great groups and subgroups of Histosols:

**Ferrihumic.**—Used for families of Histosols, i.e., Fibrists, Hemists, and Saprists, except Sphagnofibrists and sphagnic subgroups of other great groups. 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 the following characteristics:

1. Saturation with water for more than 6 months per year (or artificial drainage);

2. Two percent or more (by weight) iron concretions with lateral dimensions ranging from less than 5 mm to more than 100 mm, 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 reddish brown, dark reddish brown, or similar color which changes little on drying.

If *ferrihumic* is used as a modifier in the technical name of a Histosol family, no other mineralogy modifier is used for that family because the presence of iron is considered to be by far its most important mineralogical characteristic.

**Modifiers applied only to terric subgroups.**—In families within terric subgroups of Histosols, the same mineralogy modifiers that are used for mineral soils are applied to those mineral parts of the soil for which a particle-size modifier has been used, unless the mineralogy is ferrihumic.

**Modifiers applied to limnic subgroups.**—If limnic materials with a thickness of 5 cm or more are present in the control section of Histosol families, and if they do not have ferrihumic mineralogy, the following family modifiers are used:

*Coprogenous.* The limnic materials consist of coprogenous earth.

*Diatomaceous.* The limnic materials consist of diatomaceous earth.

*Marly.* The limnic materials consist of marl.

**Reaction classes**

The following two modifiers indicating reaction are used in families of all subgroups of Histosols:

**Euic.**—The pH value of undried samples is 4.5 or more (in 0.01 M $CaCl_2$) in one or more layers of organic soil materials within the control section.

**Dysic.**—The pH value of undried samples is less than 4.5 (in 0.01 M $CaCl_2$) in all layers of organic soil materials within the control section.

**Soil temperature classes**

The soil temperature classes of Histosol families have the same names and definitions as those used for families of mineral soils. The modifier *frigid*, however, would be redundant in the family names of boric and cryic great groups and is therefore omitted. No temperature modifier is used for families of pergelic subgroups.

**Soil depth classes**

Soil depth classes refer to the depth to a lithic, paralithic, or petroferric contact, or to cindery, fragmental, or pumiceous material. The following two soil depth modifiers are used for families in all subgroups of Histosols, except that the shallow class is not used in the suborder of Folists:

**Shallow.**—Between 18 and 50 cm from the soil surface.

**Micro.**—At a depth less than 18 cm from the soil surface. The following two soil depth modifiers are used for families in all lithic subgroups of Histosols, except in the suborder of Folists:

**Series Differentiae Within a Family**

Control sections for the soil series are very similar to those for the family, but they differ 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 contain few roots, and in contrast to the control sections for the series, those for the family do not take into account the thickness of such horizons, or a lithic or paralithic contact between 50 and 100 cm from the mineral soil surface. 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. Separations of soils at the series level can be based on differences in particle size, texture, mineralogy, amount of organic matter, structure, etc. that have not been recognized as family differentiae.

Primary attention at the series level is given to the nature of the soil within the control section, especially to genetic horizons, provided that they are well expressed and not thin. If the genetic horizons are thin or not well expressed, attention is centered on a corresponding part of the regolith. Differences in soil or regolith which are outside the control section and have not been recognized as differentiae in categories higher than the series, but which are relevant to potential uses of certain soils, are considered as a basis for phase distinctions.

**Control section for the differentiation of series**

Whether or not well-expressed genetic horizons are present, the part of a soil to be considered in differentiating series within a family of mineral soils is as follows:

**Mineral soils with permafrost.**—The series control section for soils that have permafrost within 150 cm of the soil surface extends from the soil surface to the shallowest of the following:

1. A lithic or petroferric contact; or

2. A depth of 100 cm if 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 paralithic contact; or

5. A depth of 150 cm.

**All other mineral soils.**—The series control section for all other mineral soils extends 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 paralithic contact or 150 cm below the soil surface, whichever is shallower, if there is a 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.

**Organic soils (Histosols).**—The series control section for Histosols normally consists of the surface, subsurface, and bottom tiers, with the same exceptions with respect to the lower boundary of the control section as defined above for the higher categories of Histosols.

# Table 1.—Key to Mineralogy Classes[1]

(except for Oxisols - see Table 2)

## A. Mineralogy Classes of Soil Families in Any Particle-size Class

**Carbonatic**: More than 40 percent (by weight) carbonates (expressed as $CaCO_3$) plus gypsum, with carbonates constituting more than 65 percent of the total weight of carbonates plus gypsum, either in the fine-earth fraction or in the less-than-20-mm fraction, whichever has a higher percentage of carbonates plus gypsum.

**Ferritic**: 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.

**Gibbsitic**: More than 40 percent (by weight) hydrated aluminum oxides, reported as gibbsite and bohemite, in the fine-earth fraction.

**Oxidic**: In the 0.02-to-2.0-mm fraction, less than 90 percent quartz and less than 40 percent of any other single kind of mineral listed below; in the fine-earth fraction, a ratio of extractable-iron-oxide plus gibbsite percentages to the clay percentage[2] that is 0.20 or more:

$$\frac{\text{extractable } Fe_2O_3 \text{ (pct.)} + \text{gibbsite (pct.)}}{\text{clay (pct.)}} \geq 0.2$$

**Serpentinitic**: More than 40 percent (by weight) serpentine minerals (antigorite, chrysotile, fibrolite, and talc) in the fine-earth fraction.

[1] This key, like the others in Soil 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 which include criteria that do not fit the soil in question. The soil belongs into the first class listed for which it meets the criteria. In the case of Table 1, the user should first go through all the items in section A and if the soil in question does not meet the criteria for any class listed there, proceed either to section B or to Section C, depending on the particle-size class of the soil.

[2] 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 in half or more of the particle-size control section, then the percentage of clay is estimated with the following formula:

Clay % = 2.5 (% water retained at 1500 kPa tension - % organic carbon)
If the product is more than 100, the clay content is estimated at 100 percent.

**Gypsic**: 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 less-than-20-mm fraction, whichever has a higher percentage of carbonates plus gypsum.

**Glauconitic**: More than 40 percent (by weight) glauconite in the fine-earth fraction.

## B. Other mineralogy classes of soil families, in the fragmental, sandy, sandy-skeletal, loamy, or loamy-skeletal particle-size classes

**Micaceous**: More than 40 percent (by weight)[3] mica in the 0.02-to-20-mm fraction.

**Siliceous**: More than 90 percent (by weight)[4] 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.

**Mixed**: All others that have less than 40 percent (by weight) of any single kind of mineral other than quartz or feldspars, in the 0.02-to-2.0-mm fraction.

## C. Other Mineralogy Classes of Soil Families, inthe Clayey or Clayey-Skeletal Particle-Size Class

**Halloysitic**: More than one half (by weight) halloysite[5], and smaller amounts of allophane or kaolinite, or both, in the less-than-0.002-mm fraction.

**Kaolinitic**: More than one half (by weight) kaolinite, tabular halloysite, dickite, and nacrite, smaller amounts of other 1:1 or non-expanding 2:1 layer minerals or gibbsite, and less than 10 percent (by weight) montmorillonite, in the less-than-0.002-mm fraction.

**Montmorillonitic**: More than one half (by weight) montmorillonite and nontronite, or a mixture that contains more montmorillonite than any other single kind of clay mineral, in the less-than-0.002-mm fraction.

**Illitic**: More than one half (by weight) illite (hydrous mica), and commonly more than 4 percent $K_2O$, in the less-than-0.002-mm fraction.

**Vermiculitic**: More than one half (by weight) vermiculite, or more vermiculite than any other single kind of clay mineral, in the less-than-0.002-mm fraction.

**Chloritic**: More than one half (by weight) chlorite, or more chlorite than any other single kind of clay mineral, in the less-than-0.002-mm fraction.

**Mixed**: Other soils[6].

## Table 2.—Key to Mineralogy classes of Oxisols

Does 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?
2. More than 40 percent gibbsite in the fine-earth fraction?
3. 18 to 40 percent iron oxide (12.6 to 28 percent Fe) (by dithionite citrate) in the fine-earth fraction?
4. 18 to 40 percent gibbsite in the fine-earth fraction?
5. More than 50 percent (by weight) kaolinite in the less than 0.002 mm fraction?
6. More than 50 percent (by weight) halloysite in the less than 0.002 mm fraction?

[3] Percentages by weight are estimated from grain counts. Usually, counting one or two of the dominant grain-size fractions of a conventional mechanical analysis is sufficient for placement of the soil.

[4] See preceding footnote.

[5] The halloysite considered here includes only the tubular forms. What is known as tabular halloysite is grouped with kaolinite.

[6] *Sepiolitic*, defined as containing more than one half (by weight) sepiolite, attapulite, and palygorskite, should abe listed separately if identified.

If none of the above—*Mixed*

*1* with or without *2, 4, 5, 6*—*Ferritic*

*2* with or without *3, 5, 6*—*Gibbsitic*

*3* with or without *5, 6*—*Ferruginous*

*4* with or without *5, 6*—*Allitic*

*3 and 4* with or without *5, 6*—*Sesquic*

*5*—*Kaolinitic*

*6*—*Halloysitic*

# Chapter 5

# Identification of the Taxonomic Class of a Soil

All the keys in Soil Taxonomy are designed in such a way that their user can determine the correct classification of a soil by going through the key systematically, starting at the beginning and eliminating one by one any classes which include criteria that do not fit the soil in question. The soil belongs into the first class listed for which it meets all the criteria.

In classifying a specific soil to the subgroup level, the user of Soil Taxonomy begins by checking through the *Key to soil orders* to determine the name of the first order which, according to the criteria listed, includes the soil in question. The next step is to go systematically through the *Key to suborders* of that particular order to identify the right suborder for the soil, i.e., the first in the list for which it meets all the criteria. The same procedure is used to find the soil's great group class 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 for the classified soil the name of the first taxon for which it meets all the criteria.

## Key to Soil Orders

In this key and the other keys that follow, the diagnostic horizons and the properties mentioned do not include those below any lithic, paralithic, or petroferric contact, nor the properties of buried soils except their organic carbon if of Holocene age, andic soil properties, and base saturation. Other properties of buried soils are considered in the categories of subgroup, family, and series but not in those of order, suborder, and great group. The meaning of the term "buried soil" is given in Chapter 1.

A. Soils which:

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 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 interstices[1], *and* directly below these materials either a lithic or paralithic contact; *or*

b. When added with 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 lithic or paralithic contact *and* mineral soils which, if present, have a total thickness of 10 cm or less; *or*

d. Are saturated with water for 6 months or more per year in most years (or artificially drained), and 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/cm$^3$; *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/cm$^3$ or more.

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B. Other soils which do not have a plaggen epipedon or an argillic or a 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 or pergelic soil temperature regime; *or*

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

3. A spodic horizon with *all* 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*

[1] Materials that meet the definition of cindery, fragmental, or pumiceous except have more than 10 percent (by volume) voids that are filled with organix soil materials are considered as organic soil materials.

KEY

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

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

(5) A cryic or pergelic 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 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 lithic, paralithic, or petroferric contact, whichever is shallowest; *or*

(2) At any depth,

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

(b) If the soil has a cryic or pergelic 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 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 lithic or paralithic contact, duripan, or petrocalcic horizon.

**Spodosols,** p.249

C. 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 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 lithic or paralithic contact, duripan, or petrocalcic horizon.

**Andisols,** p.81

D. Other soils which 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 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

E. Other soils which 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 close enough to intersect *or* wedge-shaped aggregates which 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 soil surface and a depth of 18 cm (after mixing) 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 lithic or paralithic contact, duripan, or petrocalcic horizon if shallower; *and*

3. Cracks[2] that open and close periodically.

**Vertisols,** p.279

[1] A crack is a separation between gross polyedrons. If the surface horizon is strongly self-mulcing, i.e., a mass of loose granules, or if the soil is cultivated while cracks are open, the cracks may be largely filled with 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.

F. 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: an argillic, calcic, cambic, gypsic, natric, petrocalcic, petrogypsic, or a salic horizon, or a duripan; *or*

2. Have:

a. A salic horizon; *and*

b. Saturation with water in one or more layers within 100 cm of the soil surface for 1 month or more per year in 6 out of 10 years; *and*

c. No sulfuric horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Aridisols**, p.103

G. Other soils that have *either*:

1. An argillic or a 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 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 lithic, paralithic, or petroferric 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 lithic, paralithic, or petroferric 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 lithic, paralithic, or petroferric contact.

**Ultisols**, p.259

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

1. *Either*

a. A mollic epipedon; *or*

b. *Both* a surface horizon which meets all the requirements for a mollic epipedon except thickness after 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, a kandic, or a 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 lithic or paralithic contact, whichever depth is shallowest.

**Mollisols**, p.187

I. Other soils which have *either*:

1. An argillic, a kandic, or a natric horizon; *or*

2. A fragipan that has clay films 1 mm or more thick in some part.

**Alfisols**, p.45

J. Other soils which have *either*:

1. *One or more* of the following:

a. A cambic horizon; *or*

KEY

b. Aquic conditions within 50 cm of the mineral soil surface for some time in most years (or artificial drainage), and permafrost; *or*

c. Within 100 cm of the mineral soil surface, the upper boundary of one or more of the following: a calcic, petrocalcic, gypsic, petrogypsic, or placic horizon or a duripan; *or*

d. Either a fragipan or an oxic horizon that has its upper boundary within 200 cm of the mineral soil surface; *or*

e. A sulfuric horizon that has its upper boundary within 150 cm of the mineral soil surface; *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 histic, a mollic, a plaggen, or an 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.161

K. Other soils.

**Entisols,** p.131

# Chapter 6

# Alfisols

Key to suborders

IA. Alfisols that have, in one or more horizons within 50 cm of the mineral soil surface, aquic conditions for some time in most 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, or kandic horizon:

   a. Fifty percent or more redox depletions with a 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 a chroma or 2 or less in the matrix; *or*

   c. Fifty percent or more redox depletions with a 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.45

IB. Other Alfisols that have *either*:

1. A frigid temperature regime, but not a xeric moisture regime; *or*

2. A cryic temperature regime.

**Boralfs**, p.53

IC. Other Alfisols that have an ustic moisture regime.

**Ustalfs**, p.67

ID. Other Alfisols that have a xeric moisture regime.

**Xeralfs**, p.75

IE. Other Alfisols.

**Udalfs**, p.57

## Aqualfs

Key to great groups

IAA. Aqualfs that have one or more horizons 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.52

IAB. Other Aqualfs that have a duripan.

**Duraqualfs**, p.47

IAC. Other Aqualfs that have a natric horizon.

**Natraqualfs**, p.52

IAD. Other Aqualfs that have a fragipan.

**Fragiaqualfs**, p.50

IAE. Other Aqualfs that have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

**Kandiaqualfs**, p.51

IAF. Other Aqualfs that have a glossic horizon.

**Glossaqualfs**, p.51

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

**Albaqualfs**, p.45

IAH. Other Aqualfs that have an umbric epipedon.

**Umbraqualfs**, p.53

IAI. Other Aqualfs that have episaturation.

**Epiaqualfs**p,48

IAJ. Other Aqualfs.

**Endoaqualfs**,47

## Albaqualfs

Key to subgroups

IAGA. Albaqualfs that have a sandy particle size 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 Albaqualfs**

IAGB. Other Albaqualfs which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. A 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**

IAGC. Other Albaqualfs which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. An Ap horizon or materials between the mineral soil surface and 18 cm that after mixing meet *one or more* the following colors;

   a. A color value, moist, of 4 or more; *or*

   b. A color value, dry, of 6 or more; *or*

   c. A chroma of 4 or more.

**Chromic Vertic Albaqualfs**

IAGD. Other Albaqualfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Albaqualfs**

IAGE. Other Albaqualfs that have *both*:

1. A 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. 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 which have these color values after mixing.

**Udollic Albaqualfs**

IAGF. Other Albaqualfs that have a 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**

IAGG. Other Albaqualfs which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Albaqualfs**

IAGH. Other Albaqualfs 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 which have these color values after mixing.

**Mollic Albaqualfs**

IAGI. Other Albaqualfs which have, within 100 cm of the mineral soil surface, the upper boundary of a brittle horizon 15 cm or more thick that contains either some opal coatings or 20 percent or more (by volume) durinodes.

**Durinodic Albaqualfs**

IAGJ. Other Albaqualfs.

**Typic Albaqualfs**

## Duraqualfs

Key to subgroups

IABA. All Duraqualfs (provisionally).

**Typic Duraqualfs**

## Endoaqualfs

Key to subgroups

IAJA. Endoaqualfs which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Endoaqualfs**

IAJB. Other Endoaqualfs that have a sandy particle size 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 Endoaqualfs**

IAJC. Other Endoaqualfs that have a sandy particle size 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 Endoaqualfs**

IAJD. Other Endoaqualfs which have *both*:

1. A mollic epipedon, or an Ap horizon that meets all 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* of the following colors:

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

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

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

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

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

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

**Udollic Endoaqualfs**

IAJE. 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, *one* of the following colors:

1. A hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

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

A
L
F

b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

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

   a. Both a color value, moist, and chroma of 3 or more; *or*

   b. A chroma of 2 or more if there are no redox concentrations.

**Aeric Endoaqualfs**

IAJF. Other Endoaqualfs which have a mollic epipedon, or an Ap horizon that meets all 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**

IAJG. Other Endoaqualfs which have an Ap horizon that meets all 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**

IAJH. Other Endoaqualfs.

**Typic Endoaqualfs**

## Epiaqualfs

Key to subgroups

IAIA. Epiaqualfs which 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 most 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 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, *one* of the following colors:

   a. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

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

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

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

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

      (2) A chroma of 2 or more if there are no redox concentrations; *and*

3. An Ap horizon or materials between the mineral soil surface and 18 cm that after mixing meet *one or more* the following colors;

   a. A color value, moist, of 4 or more; *or*

   b. A color value, dry, of 6 or more; *or*

   c. A chroma of 4 or more.

**Aeric Chromic Vertic Epiaqualfs**

IAIB. Other Epiaqualfs which 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 most 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 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, *one* of the following colors:

   a. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

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

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

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

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

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

**Aeric Vertic Epiaqualfs**

IAIC. Other Epiaqualfs which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. An Ap horizon or materials between the mineral soil surface and 18 cm that after mixing meet *one or more* the following colors:

a. A color value, moist, of 4 or more; *or*

b. A color value, dry, of 6 or more; *or*

c. A chroma of 4 or more.

**Chromic Vertic Epiaqualfs**

IAID. Other Epiaqualfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Epiaqualfs**

IAIE. Other Epiaqualfs which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Epiaqualfs**

IAIF. Other Epiaqualfs that have a sandy particle size 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 Epiaqualfs**

IAIG. Other Epiaqualfs that have a sandy particle size 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 Epiaqualfs**

IAIH. Other Epiaqualfs which have:

1. An Ap horizon that meets all 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* of the following colors:

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

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

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

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

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

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

**Aeric Umbric Epiaqualfs**

IAII. Other Epiaqualfs which have *both*:

1. A mollic epipedon, or an Ap horizon that meets all 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* of the following colors:

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

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

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

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

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

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

**Udollic Epiaqualfs**

IAIJ. 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, colors as follows: *either*

1. A hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

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

b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

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

a. Both a color value, moist, and chroma of 3 or more; *or*

b. A chroma of 2 or more if there are no redox concentrations.

**Aeric Epiaqualfs**

IAIK. Other Epiaqualfs which have a mollic epipedon, or an Ap horizon that meets all 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**

IAIL. Other Epiaqualfs which have an Ap horizon that meets all 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**

IAIM. Other Epiaqualfs.

**Typic Epiaqualfs**

## Fragiaqualfs

Key to subgroups

IADA. 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 the hue is 10YR or redder, or of 4 or more if the hue is 2.5Y or yellower.

**Aeric Fragiaqualfs**

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

**Plinthic Fragiaqualfs**

IADC. Other Fragiaquals 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 which have these color values after mixing.

**Umbric Fragiaqualfs**

IADD. Other Fragiaqualfs.

**Typic Fragiaqualfs**

## Glossaqualfs

Key to subgroups

IAFA. Glossaqualfs that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm to 100 cm.

**Arenic Glossaqualfs**

IAFB. Other Glossaqualfs that have a sandy particle size 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 Glossaqualfs**

IAFC. 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, *one* of the following colors:

1. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

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

   b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

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

   a. Both a color value, moist, and chroma of 3 or more; *or*

   b. A chroma of 2 or more if there are no redox concentrations.

**Aeric Glossaqualfs**

IAFD. Other Glossaqualfs 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 which have these color values after mixing.

**Mollic Glossaqualfs**

IAFE. Other Glossaqualfs.

**Typic Glossaqualfs**

## Kandiaqualfs

Key to subgroups

IAEA. Kandiaqualfs that have a sandy particle size 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 Kandiaqualfs**

IAEB. Other Kandiaqualfs that have a sandy particle size 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 Kandiaqualfs**

IAEC. 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**

IAED. 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 which 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, *one* of the following colors:

   a. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

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

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

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

ALF

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

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

**Aeric Umbric Kandiaqualfs**

IAEE. 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, *one* of the following colors:

1. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

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

   b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

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

   a. Both a color value, moist, and chroma of 3 or more; *or*

   b. A chroma of 2 or more if there are no redox concentrations.

**Aeric Kandiaqualfs**

IAEF. Other Kandiaqualfs 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 which have these color values after mixing.

**Umbric Kandiaqualfs**

IAEG. Other Kandiaqualfs.

**Typic Kandiaqualfs**

## Natraqualfs

Key to subgroups

IACA. Natraqualfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Natraqualfs**

IACB. Other Natraqualfs that have *both*:

1. A glossic horizon, or interfingering of albic materials into the natric horizon; *and*

2. In all horizons within 40 cm of the mineral soil surface, an exchangeable sodium percentage of less than 15 percent, and less magnesium and sodium than calcium and extractable acidity.

**Albic Glossic Natraqualfs**

IACC. Other Natraqualfs that have an exchangeable sodium percentage of less than 15 percent, and less magnesium and sodium than calcium and 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**

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

**Glossic Natraqualfs**

IACE. Other Natraqualfs 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 which have these color values after mixing.

**Mollic Natraqualfs**

IACF. Other Natraqualfs.

**Typic Natraqualfs**

## Plinthaqualfs

IAAA. All Plinthaqualfs (provisionally).

**Typic Plinthaqualfs**

## Umbraqualfs

Key to subgroups

IAHA. Umbraqualfs 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/ $cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Umbraqualfs**

IAHB. Other Umbraqualfs that have a sandy particle size 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 Umbraqualfs**

IAHC. Other Umbraqualfs that have a sandy particle size 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 Umbraqualfs**

IAHD. Other Umbraqualfs that have, in one or more horizons above the argillic horizon, 5 percent or more (by volume) discrete nodules 2.5 to 30 cm in diameter that are cemented by iron.

**Ferrudalfic Umbraqualfs**

IAHE. Other Umbraqualfs.

**Typic Umbraqualfs**

## Boralfs

Key to great groups

IBA. Boralfs which have *all* of the following:

1. An argillic horizon that has its upper boundary 60 cm or more below the mineral surface; *and*

2. A texture finer than loamy fine sand in one or more horizons above the argillic horizon; *and*

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

**Paleboralfs**, p.57

IBB. Other Boralfs that have a fragipan.

**Fragiboralfs**, p.55

IBC. Other Boralfs that have a natric horizon.

**Natriboralfs**, p.56

IBD. Other Boralfs that have a cryic soil temperature regime.

**Cryoboralfs**, p.53

IBE. Other Boralfs that have *both*:

1. A base saturation (by sum of cations) of 60 percent or more in all subhorizons of the argillic horizon; *and*

2. A moisture control section that is dry in one or more horizons for some time in most years.

**Eutroboralfs**, p.54

IBF. Other Boralfs.

**Glossoboralfs**, p.56

## Cryoboralfs

Key to subgroups

IBDA. Cryoboralfs 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 (crushed and smoothed sample) either in an Ap horizon, or between the soil surface and a depth of 15 cm, after mixing.

**Lithic Mollic Cryoboralfs**

IBDB. Other Cryoboralfs that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Cryoboralfs**

IBDC. Other Cryoboralfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Cryoboralfs**

IBDD. Other Cryoboralfs 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Cryoboralfs**

IBDE. Other Cryoboralfs 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Cryoboralfs**

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

**Aquic Cryoboralfs**

IBDG. Other Cryoboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Cryoboralfs**

IBDH. Other Cryoboralfs which have an argillic horizon that *either* has a texture of loamy fine sand or coarser, *or* is discontinuous vertically *in its* upper 15 cm (in lamellae).

**Psammentic Cryoboralfs**

IBDI. Other Cryoboralfs that have a color value, moist, of 3 or less (crushed and smoothed sample) either in an Ap horizon, or between the soil surface and a depth of 15 cm, after mixing.

**Mollic Cryoboralfs**

IBDJ. Other Cryoboralfs that have a glossic horizon.

**Glossic Cryoboralfs**

IBDK. Other Cryoboralfs.

**Typic Cryoboralfs**

## Eutroboralfs

Key to subgroups

IBEA. Eutroboralfs that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Eutroboralfs**

IBEB. Other Eutroboralfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Eutroboralfs**

IBEC. Other Eutroboralfs 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Eutroboralfs**

IBED. Other Eutroboralfs 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Eutroboralfs**

IBEE. Other Eutroboralfs that have *both*:

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

2. A sandy particle size 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 Eutroboralfs**

IBEF. Other Eutroboralfs which have *both*:

1. A glossic horizon; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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 Eutroboralfs**

IBEG. Other Eutroboralfs that have redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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 Eutroboralfs**

IBEH. Other Eutroboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Eutroboralfs**

IBEI. Other Eutroboralfs which have an argillic horizon that *either* has a texture of loamy fine sand or coarser, *or* is discontinuous vertically in its upper 15 cm (in lamellae).

**Psammentic Eutroboralfs**

IBEJ. Other Eutroboralfs that have a sandy particle size 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 Eutroboralfs**

IBEK. Other Eutroboralfs 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 which have these color values after mixing.

**Mollic Eutroboralfs**

IBEL. Other Eutroboralfs that have a glossic horizon.

**Glossic Eutroboralfs**

IBEM. Other Eutroboralfs.

**Typic Eutroboralfs**

## Fragiboralfs

Key to subgroups

IBBA. Fragiboralfs 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Fragiboralfs**

IBBB. Other Fragiboralfs 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Fragiboralfs**

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

**Aquic Fragiboralfs**

IBBD. Other Fragiboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Fragiboralfs**

IBBE. Other Fragiboralfs.

**Typic Fragiboralfs**

## Glossoboralfs

Key to subgroups

IBFA. Glossoboralfs that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Glossoboralfs**

IBFB. Other Glossoboralfs 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Glossoboralfs**

IBFC. Other Glossoboralfs 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Glossoboralfs**

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

**Aquic Glossoboralfs**

IBFE. Other Glossoboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Glossoboralfs**

IBFF. Other Glossoboralfs which have an argillic horizon that *either* has a texture of loamy fine sand or coarser, *or* is discontinuous vertically in its upper 15 cm (in lamellae).

**Psammentic Glossoboralfs**

IBFG. Other Glossoboralfs that do not have a glossic horizon.

**Eutric Glossoboralfs**

IBFH. Other Glossoboralfs.

**Typic Glossoboralfs**

## Natriboralfs

Key to subgroups

IBCA. All Natriboralfs (provisionally).

**Typic Natriboralfs**

## Paleboralfs

Key to subgroups

IBAA. Paleboralfs 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Paleboralfs**

IBAB. Other Paleboralfs 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Paleboralfs**

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

**Aquic Paleboralfs**

IBAD. Other Paleboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Paleboralfs**

IBAE. Other Paleboralfs which have an argillic horizon that has, in its fine-earth fraction, a clay increase with depth of 20 percent or more (absolute) within its upper 7.5 cm.

**Abruptic Paleboralfs**

IBAF. Other Paleboralfs 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 which have these color values after mixing.

**Mollic Paleboralfs**

IBAG. Other Paleboralfs.

**Typic Paleboralfs**

## Udalfs

Key to great groups

IEA. Udalfs that have an agric horizon.

**Agrudalfs**, p.58

IEB. Other Udalfs that have a natric horizon.

**Natrudalfs**, p.65

IEC. Other Udalfs which have:

1. A discontinuous albic horizon, or none, above the argillic horizon; *and*

2. An argillic horizon that is discontinuous horizontally; *and*

3. In the argillic horizon, discrete nodules 2.5 cm to 30 cm in diameter with exteriors that (a) are enriched and weakly cemented to indurated with iron, and (b) have either a redder hue or a higher chroma than the interiors.

**Ferrudalfs**, p.58

IED. Other Udalfs that have a glossic horizon and a fragipan.

**Fraglossudalfs**, p.59

IEE. Other Udalfs that have a glossic horizon.

**Glossudalfs**, p.60

IEF. Other Udalfs that have a fragipan.

**Fragiudalfs**, p.58

IEG. Other Udalfs which:

1. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus

A
L
F

1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *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; *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.

**Kandiudalfs**, p.64

IEH. Other Udalfs that have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

**Kanhapludalfs**, p.65

IEI. Other Udalfs which:

1. Do not have a 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 depth of 20 percent or more (relative) from the maximum clay content; *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; *and*

3. Have *one or more* of the following in the argillic horizon:

   a. In the matrix of its lowest subhorizon, a hue redder than 10YR and 50 percent or more chroma of 5 or more; *or*

   b. In 50 percent or more of its matrix, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, of 4 or less; *or*

   c. In one or more subhorizons, many coarse redox concentrations with a hue redder than 7.5YR or a chroma of 6 or more, or both.

**Paleudalfs**, p.65

IEJ. Other Udalfs which have throughout the argillic horizon a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, no more than 1 unit higher than the value, moist.

**Rhodudalfs**, p.67

IEK. Other Udalfs.

**Hapludalfs**, p.61

## Agrudalfs

Key to subgroups

IEAA. All Agrudalfs (provisionally).

**Typic Agrudalfs**

## Ferrudalfs

Key to subgroups

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

**Aquic Ferrudalfs**

IECB. Other Ferrudalfs.

**Typic Ferrudalfs**

## Fragiudalfs

Key to subgroups

IEFA. Fragiudalfs which:

1. Do not, above the fragipan, have an argillic horizon with clay films on both vertical and horizontal faces of any peds; *and*

2. Have, directly above the fragipan, a layer 5 cm or more thick which *either*:

   a. Has, on faces of primary peds, clay depletions of clean silt and sand that constitute 1 percent or more (by volume) of the layer; *or*

b. Is an eluvial horizon (E) and has 3 or more percent (absolute) less clay in the fine-earth fraction than both the overlying and underlying horizons; *and*

3. 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 which have these color values after mixing; *and*

4. Have a base saturation (by $NH_4OAc$) of less than 50 percent in one or more layers of the epipedon.

**Umbreptic Fragiudalfs**

IEFB. Other Fragiudalfs 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 which have these color values after mixing.

**Mollic Fragiudalfs**

IEFC. Other Fragiudalfs that have *both*:

1. Directly above the fragipan, a layer 5 cm or more thick which *either*:

   a. Has, on faces of primary peds, clay depletions of clean silt and sand that constitute 1 percent or more (by volume) of the layer; *or*

   b. Is an eluvial horizon (E) and has 3 or more percent (absolute) less clay in the fine-earth fraction than both the overlying and underlying horizons; *and*

2. In one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Glossaquic Fragiudalfs**

IEFD. Other Fragiudalfs which:

1. Do not, above the fragipan, have an argillic horizon with clay films on both vertical and horizontal faces of any peds; *and*

2. Have, in one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aqueptic Fragiudalfs**

IEFE. Other Fragiudalfs that have *both*:

1. In one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Within a vertical distance of 7.5 cm at the top of the argillic horizon, a clay increase of more than 15 percent (absolute) in the fine-earth fraction.

**Albaquic Fragiudalfs**

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

**Aquic Fragiudalfs**

IEFG. Other Fragiudalfs that are saturated with water, in one or more layers above the fragipan, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Fragiudalfs**

IEFH. Other Fragiudalfs that have, directly above the fragipan, a layer 5 cm or more thick which *either*:

1. Has, on faces of primary peds, clay depletions of clean silt and sand that constitute 1 percent or more (by volume) of the layer; *or*

2. Is an eluvial horizon (E) and has 3 or more percent (absolute) less clay in the fine-earth fraction than both the overlying and underlying horizons.

**Glossic Fragiudalfs**

IEFI. Other Fragiudalfs that do not, above the fragipan, have an argillic horizon with clay films on both vertical and horizontal faces of any peds.

**Ochreptic Fragiudalfs**

IEFJ. Other Fragiudalfs.

**Typic Fragiudalfs**

## Fraglossudalfs

Key to subgroups

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

**Aquic Fraglossudalfs**

A L F

IEDB. Other Fraglossudalfs that are saturated with water, in one or more layers above the fragipan, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Fraglossudalfs**

IEDC. Other Fraglossudalfs.

**Typic Fraglossudalfs**

## Glossudalfs

Key to subgroups

IEEA. Glossudalfs which have a brittle matrix in 25 percent or more of a horizon 10 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface.

**Fragic Glossudalfs**

IEEB. Other Glossudalfs which have *both*:

1. In one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Glossudalfs**

IEEC. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Glossudalfs**

IEED. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Glossudalfs**

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

**Aquic Glossudalfs**

IEEF. Other Glossudalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Glossudalfs**

IEEG. Other Glossudalfs that have a sandy particle size 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 Glossudalfs**

IEEH. Other Glossudalfs that do not have a glossic horizon 50 cm or more thick.

**Haplic Glossudalfs**

IEEI. Other Glossudalfs.

**Typic Glossudalfs**

## Hapludalfs

Key to subgroups

IEKA. Hapludalfs that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. In one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Hapludalfs**

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

**Lithic Hapludalfs**

IEKC. Other Hapludalfs which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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 18 cm that after mixing meet *one or more* the following colors;

   a. A color value, moist, of 4 or more; *or*

   b. A color value, dry, of 6 or more; *or*

   c. A chroma of 4 or more.

**Aquertic Chromic Hapludalfs**

IEKD. Other Hapludalfs which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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**

IEKE. Other Hapludalfs that have *both:*

1. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years; *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 most 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 lithic or paralithic contact, whichever is shallower.

**Oxyaquic Vertic Hapludalfs**

IEKF. Other Hapludalfs which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. An Ap horizon or materials between the mineral soil surface and 18 cm that after mixing meet *one or more* the following colors;

   a. A color value, moist, of 4 or more; *or*

   b. A color value, dry, of 6 or more; *or*

   c. A chroma of 4 or more.

**Chromic Vertic Hapludalfs**

IEKG. Other Hapludalfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Hapludalfs**

IEKH. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Hapludalfs**

IEKI. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Hapludalfs**

IEKJ. Other Hapludalfs which have *both*:

1. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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. An argillic horizon that *either* has a texture of loamy fine sand or coarser *or* is discontinuous vertically within its upper 20 cm.

**Psammaquentic Hapludalfs**

IEKK. Other Hapludalfs which have an argillic horizon that *either* has a texture of loamy fine sand or coarser *or* is discontinuous vertically within its upper 20 cm.

**Psammentic Hapludalfs**

IEKL. Other Hapludalfs that have *both*:

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

2. A sandy particle size 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**

IEKM. Other Hapludalfs that have a sandy particle size 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**

IEKN. Other Hapludalfs that have anthraquic conditions.
**Anthraquic Hapludalfs**

IEKO. Other Hapludalfs which have:

1. An abrupt textural change; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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, or at a depth of 180 cm from the mineral soil surface, or directly above a lithic or paralithic contact, whichever is shallowest.
**Albaquultic Hapludalfs**

IEKP. Other Hapludalfs which have *both*:

1. An abrupt textural change; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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**

IEKQ. Other Hapludalfs which have *both*:

1. Interfingering of albic materials, and albic materials surrounding some peds, in the upper part of the argillic horizon; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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**

IEKR. Other Hapludalfs which have *both*:

1. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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, or at a depth of 180 cm from the mineral soil surface, or directly above a lithic or paralithic contact, whichever is shallowest.
**Aquultic Hapludalfs**

IEKS. Other Hapludalfs which 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 which have these color values after mixing; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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**

IEKT. Other Hapludalfs which have redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most 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**

IEKU. Other Hapludalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Hapludalfs**

IEKV. Other Hapludalfs that have *both*:

1. Five percent or more (by volume) albic materials in one or more subhorizons of the argillic horizon; *and*

2. A mean annual soil temperature of 10°C or higher.

**Glossic Hapludalfs**

IEKW. Other Hapludalfs that have *both*:

1. In the upper part of the argillic horizon, interfingering of albic materials and albic materials surrounding some peds; *and*

2. A mean annual soil temperature lower than 10°C.

**Glossoboric Hapludalfs**

IEKX. 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, or at a depth of 180 cm below the mineral soil surface, or directly above a lithic or paralithic contact, whichever is shallowest.

**Ultic Hapludalfs**

IEKY. Other Hapludalfs 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 which have these color values after mixing.

**Mollic Hapludalfs**

IEKZ. Other Hapludalfs.

**Typic Hapludalfs**

## Kandiudalfs

Key to subgroups

IEGA. Kandiudalfs that have *both*:

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

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Plinthaquic Kandiudalfs**

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

**Aquic Kandiudalfs**

IEGC. Other Kandiudalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Kandiudalfs**

IEGD. Other Kandiudalfs that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Arenic Plinthic Kandiudalfs**

IEGE. Other Kandiudalfs that have *both*:

1. A sandy particle size 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. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Grossarenic Plinthic Kandiudalfs**

IEGF. Other Kandiudalfs that have a sandy particle size 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 Kandiudalfs**

IEGG. Other Kandiudalfs that have a sandy particle size 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 Kandiudalfs**

IEGH. 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**

IEGI. Other Kandiudalfs that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Kandiudalfs**

IEGJ. Other Kandiudalfs 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 which have these color values after mixing.

**Mollic Kandiudalfs**

IEGK. Other Kandiudalfs.

**Typic Kandiudalfs**

## Kanhapludalfs

Key to subgroups

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

**Lithic Kanhapludalfs**

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

**Aquic Kanhapludalfs**

IEHC. Other Kanhapludalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Kanhapludalfs**

IEHD. Other Kanhapludalfs that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Kanhapludalfs**

IEHE. Other Kanhapludalfs.

**Typic Kanhapludalfs**

## Natrudalfs

Key to subgroups

IEBA. Natrudalfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Natrudalfs**

IEBB. Other Natrudalfs that have either a glossic horizon, or interfingering of albic materials into the natric horizon.

**Glossic Natrudalfs**

IEBC. Other Natrudalfs that have an Ap horizon with a color value, moist, of 2 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have that color value after mixing.

**Mollic Natrudalfs**

IEBD. Other Natrudalfs.

**Typic Natrudalfs**

## Paleudalfs

Key to subgroups

IEIA. Paleudalfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Paleudalfs**

IEIB. Other Paleudalfs that have anthraquic conditions.
**Anthraquic Paleudalfs**

IEIC. Other Paleudalfs that have *both*:

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

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
**Plinthaquic Paleudalfs**

IEID. Other Paleudalfs which have *both*:

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

2. In the upper part of the argillic horizon, one or more subhorizons that have 5 percent or more (by volume) clay depletions with a chroma of 2 or less.
**Glossaquic Paleudalfs**

IEIE. Other Paleudalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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**

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

IEIG. Other Paleudalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Paleudalfs**

IEIH. Other Paleudalfs that have *both*:

1. A sandy particle size 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. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
**Arenic Plinthic Paleudalfs**

IEII. Other Paleudalfs that have *both*:

1. A sandy particle size 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. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
**Grossarenic Plinthic Paleudalfs**

IEIJ. Other Paleudalfs which have an argillic horizon that has a texture of loamy fine sand or coarser, *or* is discontinuous horizontally, *or* is discontinuous vertically within its upper 20 cm.
**Psammentic Paleudalfs**

IEIK. Other Paleudalfs that have a sandy particle size 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**

IEIL. Other Paleudalfs that have a sandy particle size 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**

IEIM. 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**

IEIN. Other Paleudalfs that have *either*:

1. In the upper part of the argillic horizon, one or more subhorizons that have 5 percent or more (by volume) skeletans with a chroma of 2 or less; *or*

2. Five percent or more (by volume) albic materials in some subhorizon of the argillic horizon.
**Glossic Paleudalfs**

IEIO. Other Paleudalfs that have, throughout the argillic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.
**Rhodic Paleudalfs**

IEIP. Other Paleudalfs 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 which have these color values after mixing.

**Mollic Paleudalfs**

IEIQ. Other Paleudalfs.

**Typic Paleudalfs**

## Rhodudalfs

Key to subgroups

IEJA. All Rhodudalfs (provisionally).

**Typic Rhodudalfs**

## Ustalfs

Key to great groups

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

**Durustalfs**, p.68

ICB. 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.74

ICC. Other Ustalfs that have a natric horizon.

**Natrustalfs**, p.71

ICD. Other Ustalfs which:

1. Have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *and*

2. Do not have a lithic, paralithic, or petroferric 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; *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.70

ICE. Other Ustalfs that have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

**Kanhaplustalfs**, p.71

ICF. Other Ustalfs which 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 lithic or paralithic contact within 150 cm of the mineral soil surface, *and* an argillic horizon which has *both*:

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

      (1) No clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

      (2) Five 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. *One or more* of the following:

      (1) In the matrix of its lowest subhorizon, a hue of 7.5YR or redder and a chroma of 5 or more; *or*

      (2) In 50 percent or more of its matrix, a hue of 7.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, of 4 or less; *or*

      (3) In the matrix of its lowest subhorizon, common or many coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

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



ALF

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

b. At its upper boundary, a clay increase 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, in the fine-earth fraction.

**Paleustalfs**, p.72

ICG. Other Ustalfs which have throughout the argillic horizon a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, no more than 1 unit higher than the value, moist.

**Rhodustalfs**, p.74

ICH. Other Ustalfs.

**Haplustalfs**, p.68

## Durustalfs

ICAA. All Durustalfs (provisionally).

**Typic Durustalfs**

## Haplustalfs

Key to subgroups

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

**Lithic Haplustalfs**

ICHB. Other Haplustalfs which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

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

**Aquertic Haplustalfs**

IHCC. 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 most 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 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, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Vertic Haplustalfs**

ICHD. Other Haplustalfs which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 most 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 lithic or paralithic contact, whichever is shallower.

**Udertic Haplustalfs**

ICHE. Other Haplustalfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Haplustalfs**

ICHF. Other Haplustalfs that have *both*:

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

2. A sandy particle size 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**

ICHG. Other Haplustalfs that have *both*:

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

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

**Aquultic Haplustalfs**

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

**Aquic Haplustalfs**

ICHI. Other Haplustalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Haplustalfs**

ICHJ. Other Haplustalfs which have an argillic horizon that has a texture of loamy fine sand or coarser, *or* is discontinuous horizontally, *or* is discontinuous vertically within its upper 20 cm.

**Psammentic Haplustalfs**

ICHK. Other Haplustalfs which have *both*:

1. A sandy particle size 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. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.

**Arenic Aridic Haplustalfs**

ICHL. Other Haplustalfs that have a sandy particle size 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**

ICHM. Other Haplustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Haplustalfs**

ICHN. Other Haplustalfs that have a CEC of less than 24 cmol(+)/kg clay (by 1N $NH_4OAc$ 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**

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

**Ultic Haplustalfs**

ICHP. Other Haplustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 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*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 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**

ICHQ. Other Haplustalfs.

**Typic Haplustalfs**

## Kandiustalfs

Key to subgroups

ICDA. Kandiustalfs that have a sandy particle size 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 Kandiustalfs**

ICDB. Other Kandiustalfs that have *both*:

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

2. A sandy particle size 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 Kandiustalfs**

ICDC. 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**

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

**Aquic Kandiustalfs**

ICDE. Other Kandiustalfs which have *both*:

1. A sandy particle size 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. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.

**Arenic Aridic Kandiustalfs**

ICDF. Other Kandiustalfs that have a sandy particle size 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 Kandiustalfs**

ICDG. Other Kandiustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Kandiustalfs**

ICDH. Other Kandiustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 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 Kandiustalfs**

ICDI. Other Kandiustalfs which have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Kandiustalfs**

ICDJ. Other Kandiustalfs.

**Typic Kandiustalfs**

## Kanhaplustalfs

Key to subgroups

ICEA. Kanhaplustalfs that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Kanhaplustalfs**

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

**Aquic Kanhaplustalfs**

ICEC. Other Kanhaplustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Kanhaplustalfs**

ICED. Other Kanhaplustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 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**

ICEE. Other Kanhaplustalfs which have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Kanhaplustalfs**

ICEF. Other Kanhaplustalfs.

**Typic Kanhaplustalfs**

## Natrustalfs

Key to subgroups

ICCA. Natrustalfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Natrustalfs**

ICCB. Other Natrustalfs that have a sandy particle size 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 Natrustalfs**

ICCC. Other Natrustalfs that have *both*:

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

2. A sandy particle size 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 Natrustalfs**

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

ICCE. Other Natrustalfs that have a sandy particle size 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 Natrustalfs**

ICCF. Other Natrustalfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.
**Petrocalcic Natrustalfs**

ICCG. Other Natrustalfs which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.
**Salidic Natrustalfs**

ICCH. Other Natrustalfs 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 which have these color values after mixing.
**Mollic Natrustalfs**

ICCI. Other Natrustalfs.
**Typic Natrustalfs**

## Paleustalfs

Key to subgroups

ICFA. Paleustalfs which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

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

ICFB. Other Paleustalfs 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 most 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 lithic or paralithic contact, whichever is shallower. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years; *and*

2. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Vertic Paleustalfs**

ICFC. Other Paleustalfs which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 most 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 lithic or paralithic contact, whichever is shallower.

**Udertic Paleustalfs**

ICFD. Other Paleustalfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Paleustalfs**

ICFE. Other Paleustalfs which have an argillic horizon that has a texture of loamy fine sand or coarser, *or* is discontinuous horizontally, *or* is discontinuous vertically within its upper 20 cm.

**Psammentic Paleustalfs**

ICFF. Other Paleustalfs that have a sandy particle size 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**

ICFG. Other Paleustalfs that have *both*:

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

2. A sandy particle size 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**

ICFH. 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**

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

**Aquic Paleustalfs**

ICFJ. Other Paleustalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Paleustalfs**

ICFK. Other Paleustalfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Petrocalcic Paleustalfs**

ICFL. Other Paleustalfs which have *both*:

1. A sandy particle size 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. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

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b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.

**Arenic Aridic Paleustalfs**

ICFM. Other Paleustalfs that have a sandy particle size 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**

ICFN. Other Paleustalfs which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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. 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.

**Calcidic Paleustalfs**

ICFO. Other Paleustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Paleustalfs**

ICFP. Other Paleustalfs that have a CEC of less than 24 cmol(+) per kg clay (by 1N $NH_4OAc$ 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**

ICFQ. Other Paleustalfs which have, throughout the argillic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Paleustalfs**

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

**Ultic Paleustalfs**

ICFS. Other Paleustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 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*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 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**

ICFT. Other Paleustalfs.

**Typic Paleustalfs**

## Plinthustalfs

Key to subgroups

ICBA. All Plinthustalfs (provisionally).

**Typic Plinthustalfs**

## Rhodustalfs

Key to subgroups

ICGA. Rhodustalfs that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Rhodustalfs**

ICGB. Other Rhodustalfs that have a CEC of less than 24 cmol(+) per kg clay (by 1N $NH_4OAc$ 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**

ICGC. Other Rhodustalfs which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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**

ICGD. Other Rhodustalfs.

**Typic Rhodustalfs**

## Xeralfs

Key to great groups

IDA. Xeralfs which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

**Durixeralfs**, p.75

IDB. Other Xeralfs that have a natric horizon.

**Natrixeralfs**, p.78

IDC. Other Xeralfs that have a fragipan.

**Fragixeralfs**, p.76

IDD. 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.80

IDE. Other Xeralfs which have throughout the argillic horizon a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, no more than 1 unit higher than the value, moist.

**Rhodoxeralfs**, p.80

IDF. Other Xeralfs which 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 lithic or paralithic contact within 150 cm of the mineral soil surface, and an argillic horizon which has *both*:

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

      (1) No clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

      (2) Five 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 matrix of its lowest subhorizon, *one or both* of the following:

      (1) A hue of 7.5YR or redder and a chroma of 5 or more; *or*

      (2) Common or many coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

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

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

   b. 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.

**Palexeralfs**, p.78

IDG. Other Xeralfs.

**Haploxeralfs**, p.77

## Durixeralfs

Key to subgroups

IDAA. Durixeralfs that have a natric horizon.

**Natric Durixeralfs**

IDAB. Other Durixeralfs which 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 most 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**

IDAC. Other Durixeralfs that have, in one or more subhorizons within the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Durixeralfs**

IDAD. Other Durixeralfs which have *both*:

1. An argillic horizon that has *both*:

   a. A clayey particle size 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 not indurated in any subhorizon.

**Abruptic Haplic Durixeralfs**

IDAE. Other Durixeralfs which have an argillic horizon that has *both*:

1. A clayey particle size 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**

IDAF. Other Durixeralfs which have a duripan that is not indurated in any subhorizon.

**Haplic Durixeralfs**

IDAG. Other Durixeralfs.

**Typic Durixeralfs**

## Fragixeralfs

Key to subgroups

IDCA. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Fragixeralfs**

IDCB. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Fragixeralfs**

IDCC. 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 which have these color values after mixing.

**Mollic Fragixeralfs**

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

**Aquic Fragixeralfs**

IDCE. Other Fragixeralfs that do not, above the fragipan, have an argillic horizon with clay films on both vertical and horizontal faces of any peds.

**Ochreptic Fragixeralfs**

IDCF. Other Fragixeralfs.

**Typic Fragixeralfs**

## Haploxeralfs

Key to subgroups

IDGA. 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**

IDGB. Other Haploxeralfs which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon that is discontinuous horizontally in each pedon.

**Lithic Ruptic-Xerochreptic Haploxeralfs**

IDGC. Other Haploxeralfs that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haploxeralfs**

IDGD. Other Haploxeralfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Haploxeralfs**

IDGE. Other Haploxeralfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Haploxeralfs**

IDGF. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Haploxeralfs**

IDGG. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Haploxeralfs**

A L F

IDGH. Other Haploxeralfs which have *both*:

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

2. An argillic 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 lithic or paralithic contact, whichever is shallower.

**Aquultic Haploxeralfs**

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

**Aquic Haploxeralfs**

IDGJ. 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 horizon.

**Natric Haploxeralfs**

IDGK. Other Haploxeralfs which have an argillic horizon that is *either* discontinuous vertically within its upper 20 cm, *or* has a sandy particle size.

**Psammentic Haploxeralfs**

IDGL. 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**

IDGM. Other Haploxeralfs which have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Calcic Haploxeralfs**

IDGN. Other Haploxeralfs which have an argillic 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 lithic or paralithic contact, whichever is shallower.

**Ultic Haploxeralfs**

IDGO. 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**

IDGP. Other Haploxeralfs.

**Typic Haploxeralfs**

## Natrixeralfs

Key to subgroups

IDBA. Natrixeralfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Natrixeralfs**

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

**Aquic Natrixeralfs**

IDBC. Other Natrixeralfs.

**Typic Natrixeralfs**

## Palexeralfs

Key to subgroups

IDFA. Palexeralfs which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Palexeralfs**

IDFB. Other Palexeralfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Palexeralfs**

IDFC. 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Palexeralfs**

IDFD. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Palexeralfs**

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

**Aquic Palexeralfs**

IDFF. Other Palexeralfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Petrocalcic Palexeralfs**

IDFG. Other Palexeralfs that have a sandy particle size 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 Palexeralfs**

IDFH. 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**

IDFI. Other Palexeralfs that have a calcic horizon within 150 cm of the mineral soil surface.

**Calcic Palexeralfs**

IDFJ. 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**

IDFK. Other Palexeralfs which have an argillic horizon that has a base saturation (by sum of cations) of less than 75 percent throughout.

**Ultic Palexeralfs**

IDFL. Other Palexeralfs with an argillic horizon that has *neither*:

1. A clayey particle size throughout subhorizon in its upper part; *nor*

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

**Haplic Palexeralfs**

IDFM. 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**

IDFN. Other Palexeralfs.

**Typic Palexeralfs**

## Plinthoxeralfs

Key to subgroups

IDDA. All Plinthoxeralfs (provisionally).

**Typic Plinthoxeralfs**

## Rhodoxeralfs

Key to subgroups

IDEA. Rhodoxeralfs that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Rhodoxeralfs**

IDEB. Other Rhodoxeralfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Petrocalcic Rhodoxeralfs**

IDEC. Other Rhodoxeralfs which have a calcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Calcic Rhodoxeralfs**

IDED. Other Rhodoxeralfs which have an argillic horizon that is either less than 15 cm thick or is discontinuous horizontally in each pedon.

**Ochreptic Rhodoxeralfs**

IDEE. Other Rhodoxeralfs.

**Typic Rhodoxeralfs**

# Chapter 7

# Andisols[1]

Key to suborders

CA. Andisols that have *either*:
1. A histic epipedon; *or*

2. In a layer above a lithic or paralithic contact or in a layer 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 most years (or artificial drainage) *and one or more* of the following:

    a. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquands**, p.81

CB. Other Andisols that have a cryic or pergelic soil temperature regime.

**Cryands**, p.85

CC. Other Andisols that have an aridic moisture regime.

**Torrands**, p.88

CD. Other Andisols that have a xeric moisture regime.

**Xerands**, p.101

CE. Other Andisols that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of 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 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 lithic or paralithic contact, duripan, or petrocalcic horizon.

**Vitrands**, p.99

CF. Other Andisols that have an ustic moisture regime.

**Ustands**, p.98

CG. Other Andisols.

**Udands**, p.88

## Aquands

Key to great groups

CAA. Aquands that have a cryic or pergelic soil temperature regime.

**Cryaquands**, p.82

CAB. 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.84

CAC. Other Aquands that have, in 75 percent or more of each pedon, a cemented layer which does not slake in water after air-drying and which 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.

**Duraquands**, p.82

CAD. Other Aquands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of 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 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 lithic or paralithic contact, duripan, or petrocalcic horizon.

**Vitraquands**, p.84

CAE. Other Aquands that have a melanic epipedon.

**Melanaquands**, p.83

[1] This chapter builds on the preliminary Andisol Proposal (1978) by Guy D. Smith (NZ 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.

CAF. Other Aquands that have episaturation.

**Epiaquands, p.83**

CAG. Other Aquands.

**Endoaquands, p.82**

## Cryaquands

Key to subgroups

CAAA. 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**

CAAB. Other Cryaquands that have a mean annual soil temperature of 0°C or lower.

**Pergelic Cryaquands**

CAAC. Other Cryaquands that have a histic epipedon.

**Histic Cryaquands**

CAAD. Other Cryaquands that have, 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 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**

CAAE. Other Cryaquands.

**Typic Cryaquands**

## Duraquands

Key to subgroups

CACA. Duraquands that have a histic epipedon.

**Histic Duraquands**

CACB. Other Duraquands that have extractable bases 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, 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**

CACC. Other Duraquands that have, 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 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**

CACD. Other Duraquands.

**Typic Duraquands**

## Endoaquands

Key to subgroups

CAGA. Endoaquands 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 Endoaquands**

CAGB. Other Endoaquands that have a petroferric contact within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

**Petroferric Endoaquands**

CAGC. Other Endoaquands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, 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.

**Duric Endoaquands**

CAGD. Other Endoaquands that have a histic epipedon.

**Histic Endoaquands**

CAGE. Other Endoaquands that have more than 2.0 cmol(+)/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, 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**

CAGF. Other Endoaquands that have, undried, 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**

CAGG. Other Endoaquands that have, 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 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**

CAGH. Other Endoaquands.

**Typic Endoaquands**

## Epiaquands

Key to subgroups

CAFA. Epiaquands that have a petroferric contact within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

**Petroferric Epiaquands**

CAFB. Other Epiaquands that have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, 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.

**Duric Epiaquands**

CAFC. Other Epiaquands that have a histic epipedon.

**Histic Epiaquands**

CAFD. Other Epiaquands that have more than 2.0 cmol(+)/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, 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**

CAFE. Other Epiaquands that have, undried, 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**

CAFF. Other Epiaquands that have, 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 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**

CAFG. Other Epiaquands.

**Typic Epiaquands**

## Melanaquands

Key to subgroups

CAEA. 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**

CAEB. Other Melanaquands that have extractable bases 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, 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**

CAEC. Other Melanaquands that have *both*:

1. Undried, 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 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**

CAED. Other Melanaquands that have, undried, 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**

CAEE. Other Melanaquands that have, 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 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.

**Phaptic Melanaquands**

CAEF. Other Melanaquands.

**Typic Melanaquands**

## Placaquands

Key to subgroups

CABA. 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**

CABB. Other Placaquands which have *both*:

1. A histic epipedon; *and*

2. A horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, 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.

**Duric Histic Placaquands**

CABC. Other Placaquands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, 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.

**Duric Placaquands**

CABD. Other Placaquands that have a histic epipedon.

**Histic Placaquands**

CABE. Other Placaquands that have, 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 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**

CABF. Other Placaquands.

**Typic Placaquands**

## Vitraquands

Key to subgroups

CADA. Vitraquands 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 Vitraquands**

CADB. Other Vitraquands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, 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.

**Duric Vitraquands**

CADC. Other Vitraquands that have a histic epipedon.

**Histic Vitraquands**

CADD. Other Vitraquands that have, 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 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 Vitraquands**

CADE. Other Vitraquands.

**Typic Vitraquands**

## Cryands

Key to great groups

CBA. Cryands that have a mean annual soil temperature of 0°C or lower.

**Gelicryands, p.85**

CBB. Other Cryands that have a melanic epipedon.

**Melanocryands, p.87**

CBC. Other Cryands which have an epipedon with a color value, moist, and chroma of 3 or less that meets the depth, thickness, and organic-carbon requirements for a melanic epipedon.

**Fulvicryands, p.85**

CBD. Other Cryands that have, undried, a 1500-kPa water retention of 100 percent or more, on the weighted average, throughout *either*:

1. One or more layers with a total thickness of 35 cm between the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, and 100 cm from the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, if there is no lithic or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Sixty 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 lithic or paralithic contact, duripan, or petrocalcic horizon.

**Hydrocryands, p.86**

CBE. Other Cryands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of 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 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 lithic or paralithic contact, duripan, or petrocalcic horizon.

**Vitricryands, p.87**

CBF. Other Cryands.

**Haplocryands, p.85**

## Fulvicryands

Key to subgroups

CBCA. 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**

CBCB. Other Fulvicryands that have 1500 kPa water retention of less than 15 percent on air-dried samples or of less than 30 percent on undried samples throughout one or more layers with andic properties that 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**

CBCC. Other Fulvicryands.

**Typic Fulvicryands**

## Gelicryands

Key to subgroups

CBAA. All Gelicryands.

**Typic Gelicryands**

## Haplocryands

Key to subgroups

CBFA. 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**

CBFB. Other Haplocryands that have more than 2.0 cmol(+)/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, 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**

CBFC. Other Haplocryands that have, in some subhorizon 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Haplocryands**

CBFD. Other Haplocryands that have extractable bases 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, 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 Haplocryands**

CBFE. Other Haplocryands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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**

CBFF. Other Haplocryands that have, 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 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**

CBFG. Other Haplocryands that have a xeric moisture regime.

**Xeric Haplocryands**

CBFH. Other Haplocryands.

**Typic Haplocryands**

## Hydrocryands

Key to subgroups

CBDA. 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**

CBDB. 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**

CBDC. Other Hydrocryands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Hydrocryands**

CBDD. Other Hydrocryands that have, 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 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**

CBDE. Other Hydrocryands.

**Typic Hydrocryands**

## Melanocryands

Key to subgroups

CBBA. Melanocryands 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 Melanocryands**

CBBB. Other Melanocryands that have more than 2.0 cmol(+)/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, 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 Melanocryands**

CBBC. Other Melanocryands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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**

CBBD. Other Melanocryands.

**Typic Melanocryands**

## Vitricryands

Key to subgroups

CBEA. Vitricryands 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 Vitricryands**

CBEB. Other Vitricryands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Vitricryands**

CBEC. Other Vitricryands that have, 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 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**

CBED. Other Vitricryands that have a xeric moisture regime and a mollic or an umbric epipedon.

**Humic Xeric Vitricryands**

CBEE. Other Vitricryands that have a xeric moisture regime.

**Xeric Vitricryands**

CBEF. Other Vitricryands which have an argillic or a 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 the entire argillic horizon, if it is less than 50 cm thick.

**Ultic Vitricryands**

CBEG. Other Vitricryands which have an argillic or a 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**

CBEH. Other Vitricryands that have a mollic or an umbric epipedon.

**Humic Vitricryands**

CBEI. Other Vitricryands.

**Typic Vitricryands**

## Torrands

Key to great groups

CCA. All Torrands.

**Vitritorrands, p.88**

## Vitritorrands

Key to subgroups

CCAA. Vitritorrands that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Vitritorrands**

CCAB. Other Vitritorrands which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Petrocalcic Vitritorrands**

CCAC. Other Vitritorrands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm of the mineral soil surface.

**Duric Vitritorrands**

CCAD. Other Vitritorrands that have, in one or more horizons between 50 and 100 cm from the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two 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**

CCAE. Other Vitritorrands which have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

**Calcic Vitritorrands**

CCAF. Other Vitritorrands.

**Typic Vitritorrands**

## Udands

Key to great groups

CGA. 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.96**

CGB. Other Udands that have, in 75 percent or more of each pedon, a cemented layer which does not slake in water after air-drying and which 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.89**

CGC. Other Udands that have a melanic epipedon.

**Melanudands, p.94**

CGD. Other Udands which have an epipedon with a color value, moist, and chroma of 3 or less that meets the depth, thickness, and organic-carbon requirements of a melanic epipedon.

**Fulvudands, p.89**

CGE. Other Udands that have, undried, a 1500-kPa water retention of 100 percent or more, on the weighted average, throughout *either*:

1. One or more layers with a total thickness of 35 cm between the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, and 100 cm from the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, if there is no lithic or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Sixty 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 lithic or paralithic contact, duripan, or petrocalcic horizon.

**Hydrudands, p.93**

CGF. Other Udands.

**Hapludands, p.91**

## Durudands

Key to subgroups

CGBA. Durudands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Durudands**

CGBB. Other Durudands that have extractable bases 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, 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 Durudands**

CGBC. Other Durudands that have *both*:

1. Undried, 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 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 Durudands**

CGBD. Other Durudands that have, 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 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 Durudands**

CGBE. Other Durudands.

**Typic Durudands**

## Fulvudands

Key to subgroups

CGDA. 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. Undried, 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 Lithic Fulvudands**

CGDB. 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**

CGDC. Other Fulvudands that have more than 2.0 cmol(+)/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, 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 Fulvudands**

CGDD. Other Fulvudands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Fulvudands**

CGDE. Other Fulvudands that have *both*:

1. Extractable bases 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, 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. Undried, 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 Fulvudands**

CGDF. Other Fulvudands which have *both*:

1. Extractable bases 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, 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 a 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 Fulvudands**

CGDG. Other Fulvudands that have extractable bases 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, 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 Fulvudands**

CGDH. Other Fulvudands that have *both*:

1. Undried, 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 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 Fulvudands**

CGDI. Other Fulvudands 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 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. More than 6.0 percent organic carbon and 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.

**Eutric Pachic Fulvudands**

CGDJ. Other Fulvudands that have more than 6.0 percent organic carbon and 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 Fulvudands**

CGDK. Other Fulvudands that have *both*:

1. Undried, 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. 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 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 Fulvudands**

CGDL. Other Fulvudands that have, undried, 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**

CGDM. Other Fulvudands that have, 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 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**

CGDN. Other Fulvudands 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 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 Fulvudands**

CGDO. Other Fulvudands.

**Typic Fulvudands**

## Hapludands

Key to subgroups

CGFA. 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**

CGFB. Other Hapludands that have a petroferric contact within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

**Petroferric Hapludands**

CGFC. Other Hapludands that have anthraquic conditions.

**Anthraquic Hapludands**

CGFD. Other Hapludands which have *both*:

1. A horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, 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; *and*

2. In one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

    a. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Duric Hapludands**

CGFE. Other Hapludands that have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, 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.

**Duric Hapludands**

CGFF. Other Hapludands that have more than 2.0 cmol(+)/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, 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**

CGFG. Other Hapludands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Hapludands**

CGFH. Other Hapludands that have *both*:

1. Extractable bases 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, 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. Undried, 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**

CGFI. Other Hapludands that have, 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 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 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**

CGFJ. Other Hapludands that have *both*:

1. Extractable bases 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, 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 a 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**

CGFK. Other Hapludands that have extractable bases 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, 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**

CGFL. Other Hapludands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that have a total thickness of 25 cm or more within 100 cm either of either the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

**Vitric Hapludands**

CGFM. Other Hapludands that have *both*:

1. Undried, 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. 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 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**

CGFN. Other Hapludands that have, undried, 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**

CGFO. 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 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. 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 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**

CGFP. Other Hapludands that have, 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 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**

CGFQ. 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 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**

CGFR. Other Hapludands which 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**

CGFS. Other Hapludands which have an argillic or a 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**

CGFT. Other Hapludands which have an argillic or a 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**

CGFU. Other Hapludands.

**Typic Hapludands**

## Hydrudands

Key to subgroups

CGEA. 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**

CGEB. Other Hydrudands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Hydrudands**

CGEC. Other Hydrudands which have, 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 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 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**

CGED. Other Hydrudands that have extractable bases 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

AND

thickness of 30 cm or more, 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**

CGEE. Other Hydrudands that have, 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 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**

CGEF. 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 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**

CGEG. Other Hydrudands which have an argillic or a 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**

CGEH. Other Hydrudands.

**Typic Hydrudands**

## Melanudands

Key to subgroups

CGCA. Melanudands 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 Melanudands**

CGCB. Other Melanudands that have anthraquic conditions.

**Anthraquic Melanudands**

CGCC. Other Melanudands that have *both*:

1. More than 2.0 cmol(+)/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, 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. In one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

   a. Two 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.

**Alic Aquic Melanudands**

CGCD. Other Melanudands that have *both*:

1. More than 2.0 cmol(+)/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, 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. More than 6.0 percent organic carbon and 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.

**Alic Pachic Melanudands**

CGCE. Other Melanudands that have *both*:

1. More than 2.0 cmol(+)/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, 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. 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 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.

**Alic Thaptic Melanudands**

CGCF. Other Melanudands that have more than 2.0 cmol(+)/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, 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 Melanudands**

CGCG. Other Melanudands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Melanudands**

CGCH. Other Melanudands that have *both*:

1. Extractable bases 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, 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 *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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**

CGCI. Other Melanudands that have *both*:

1. Extractable bases 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, 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. Undried, 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**

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CGCJ. Other Melanudands that have extractable bases 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, 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**

CGCK. Other Melanudands that have *both*:

1. More than 6.0 percent organic carbon and 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 *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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**

CGCL. Other Melanudands 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 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. A 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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.

**Eutric Vitric Melanudands**

CGCM. Other Melanudands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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**

CGCN. Other Melanudands that have *both*:

1. Undried, 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 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**

CGCO. Other Melanudands that have more than 6.0 percent organic carbon and 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**

CGCP. Other Melanudands 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 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. Undried, 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.

**Eutric Hydric Melanudands**

CGCQ. Other Melanudands that have, undried, 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**

CGCR. Other Melanudands that have, 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 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**

CGCS. Other Melanudands which have an argillic or a 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**

CGCT. Other Melanudands.

**Typic Melanudands**

## Placudands

Key to subgroups

CGAA. Placudands 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 Placudands**

CGAB. Other Placudands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Placudands**

CGAC. Other Placudands that have *both*:

1. Extractable bases 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, 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. Undried, 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 Placudands**

CGAD. Other Placudands that have extractable bases 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, 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 Placudands**

CGAE. Other Placudands 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 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. A 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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.

**Eutric Vitric Placudands**

CGAF. Other Placudands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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 Placudands**

CGAG. Other Placudands that have *both*:

1. Undried, 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 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 Placudands**

CGAH. Other Placudands that have more than 6.0 percent organic carbon and 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 Placudands**

CGAI. Other Placudands that have, undried, 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**

CGAJ. Other Placudands that have, 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 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 Placudands**

CGAK. Other Placudands 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 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 Placudands**

CGAL. Other Placudands.

**Typic Placudands**

## Ustands

Key to great groups

CFA. Ustands which have a duripan 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.98

CFB. Other Ustands.

**Haplustands,** p.98

## Durustands

Key to subgroups

CFAA. Durustands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Durustands**

CFAB. Other Durustands that have, 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 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**

CFAC. Other Durustands that have a melanic, mollic, or an umbric epipedon.

**Humic Durustands**

CFAD. Other Durustands.

**Typic Durustands**

## Haplustands

Key to subgroups

CFBA. 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**

CFBB. Other Haplustands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Haplustands**

CFBC. Other Haplustands that have *both*:

1. Extractable bases 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 *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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**

CFBD. Other Haplustands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that 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**

CFBE. Other Haplustands that have more than 6.0 percent organic carbon and 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**

CFBF. Other Haplustands that have, 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 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**

CFBG. Other Haplustands which 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**

CFBH. Other Haplustands that have extractable bases 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**

CFBI. Other Haplustands which 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**

CFBJ. Other Haplustands which have an argillic or a 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 the entire argillic horizon, if it is less than 50 cm thick.

**Ultic Haplustands**

CFBK. Other Haplustands which have an argillic or a 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**

CFBL. Other Haplustands that have a melanic, mollic, or an umbric epipedon.

**Humic Haplustands**

CFBM. Other Haplustands.

**Typic Haplustands**

## Vitrands

Key to great groups

CEA. Vitrands that have an ustic moisture regime.

**Ustivitrands**, p.100

CEB. Other Vitrands.

**Udivitrands**, p.99

## Udivitrands

Key to subgroups

CEBA. 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**

CEBB. Other Udivitrands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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**

CEBC. Other Udivitrands that have, 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 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**

CEBD. Other Udivitrands which have *both*:

1. An argillic or a 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**

CEBE. Other Udivitrands which have an argillic or a 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**

CEBF. Other Udivitrands that have a melanic, a mollic, or an umbric epipedon.

**Humic Udivitrands**

CEBG. Other Udivitrands.

**Typic Udivitrands**

## Ustivitrands

Key to subgroups

CEAA. 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**

CEAB. Other Ustivitrands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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**

CEAC. Other Ustivitrands that have, 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 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**

CEAD. Other Ustivitrands which 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**

CEAE. Other Ustivitrands that have a melanic, mollic, or an umbric epipedon.

**Humic Ustivitrands**

CEAF. Other Ustivitrands.

**Typic Ustivitrands**

## Xerands

Key to great groups

CDA. Xerands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of 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 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 lithic or paralithic contact, duripan, or petrocalcic horizon.

**Vitrixerands,** p.102

CDB. Other Xerands that have a melanic epipedon.

**Melanoxerands,** p.102

CDC. Other Xerands.

**Haploxerands,** p.101

## Haploxerands

Key to subgroups

CDCA. Haploxerands that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haploxerands**

CDCB. Other Haploxerands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Haploxerands**

CDCC. Other Haploxerands that have, between 25 and 100 cm from the mineral soil surface, a layer 10 cm or more thick with more than 3.0 percent organic carbon and 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**

CDCD. Other Haploxerands which have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

**Calcic Haploxerands**

CDCE. Other Haploxerands which have an argillic or a kandic horizon that has *both*:

1. An upper boundary within 125 cm of the mineral soil surface; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

**Ultic Haploxerands**

CDCF. Other Haploxerands which have *both*:

1. A mollic or an umbric epipedon; *and*

2. An argillic or a 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**

CDCG. Other Haploxerands which have an argillic or a kandic horizon that has its upper boundary within 125 cm of the mineral soil surface.

**Alfic Haploxerands**

CDCH. Other Haploxerands that have a mollic or an umbric epipedon.

**Humic Haploxerands**

CDCI. Other Haploxerands.

**Typic Haploxerands**

## Melanoxerands

Key to subgroups

CDBA. Melanoxerands that have more than 6.0 percent organic carbon and 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**

CDBB. Other Melanoxerands.

**Typic Melanoxerands**

## Vitrixerands

Key to subgroups

CDAA. Vitrixerands that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Vitrixerands**

CDAB. Other Vitrixerands that have, in one or more horizons 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 most years (or artificial drainage) *and one or more* of the following:

1. Two 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Vitrixerands**

CDAC. Other Vitrixerands that have, between 25 and 100 cm from the mineral soil surface, a layer 10 cm or more thick with more than 3.0 percent organic carbon and 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.

CD

**Thaptic Vitrixerands**

CDAD. Other Vitrixerands which have *both*:

1. A melanic, a mollic, or an umbric epipedon; and

2. An argillic or a 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**

CDAE. Other Vitrixerands which have an argillic or a 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 the entire argillic horizon, if it is less than 50 cm thick.

**Ultic Vitrixerands**

CDAF. Other Vitrixerands which have an argillic or a kandic horizon that has its upper boundary within 125 cm of the mineral soil surface.

**Alfic Vitrixerands**

CDAG. Other Vitrixerands that have a melanic, a mollic, or an umbric epipedon.

**Humic Vitrixerands**

CDAH. Other Vitrixerands.

**Typic Vitrixerands**

# Chapter 8

# Aridisols[1]

Key to suborders

FA. Aridisols that have a cryic soil temperature regime.
**Cryids**, p.118

FB. Other Aridisols which have a salic horizon that has its upper boundary within 100 cm of the soil surface.
**Salids**, p.128

FC. Other Aridisols which have a duripan that has its upper boundary within 100 cm of the soil surface.
**Durids**, p.121

FD. Other Aridisols which have a gypsic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface and lack a petrocalcic horizon overlying any of these horizons.
**Gypsids**, p.125

FE. Other Aridisols which 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 which 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 which have a duripan or a petrocalcic or petrogypsic horizon that has its upper boundary within 150 cm of the soil surface.
**Petroargids**, p.110

FEB. Other Argids that have a natric horizon.
**Natrargids**, p.108

FEC. Other Argids which do not have a 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 has, in 50 percent or more of the matrix, in some part between 100 and 150 cm either:

   a. Hues of 7.5YR or redder and chroma of 5 or more; or

   b. Hues of 7.5YR or redder and value, moist, that is 3 or less and value, dry, that is 4 or less.

**Paleargids**, p.109

FED. Other Argids which have a gypsic horizon that has its upper boundary within 150 cm of the soil surface.
**Gypsiargids**, p.105

FEE. Other Argids which have a calcic horizon that has its upper boundary within 150 cm of the soil surface.
**Calciargids**, p.103

FEF. Other Argids.
**Haplargids**, p.106

## Calciargids

Key to subgroups

FEEA. Calciargids that have a lithic contact within 50 cm of the soil surface.
**Lithic Calciargids**

FEEB. Other Calciargids which 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 most 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 to a lithic or paralithic contact, if shallower; and

[1] This chapter on Aridisols 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.

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 the soil moisture regime borders a xeric regime.
**Xerertic Calciargids**

FEEC. Other Calciargids which 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 most 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 to a 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 the moisture regime borders an ustic regime.
**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 most 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 to a lithic or paralithic contact, if shallower.
**Vertic Calciargids**

FEEE. Other Calciargids that are either:

1. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years.
**Aquic Calciargids**

FEEF. Other Calciargids which have:

1. A sandy particle size 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 its 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 the moisture regime borders on an ustic regime.
**Arenic Ustic Calciargids**

FEEG. Other Calciargids which have a sandy particle size 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. One or more horizons, within 100 cm of the soil surface, that have 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 the moisture regime borders on a xeric regime.
**Durinodic Xeric Calciargids**

FEEI. Other Calciargids which have one or more horizons, within 100 cm of the soil surface, that have 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 which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.
**Petronodic Calciargids**

FEEK. 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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**

FEEL. Other Calciargids which 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 are cinders, pumice, and pumice-like 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**

FEEM. Other Calciargids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders on a xeric regime.

**Xeric Calciargids**

FEEN. Other Calciargids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders on an ustic regime.

**Ustic Calciargids**

FEEO. Other Calciargids.

**Typic Calciargids**

## Gypsiargids

Key to subgroups

FEDA. Gypsiargids that are either:

1. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years.

**Aquic Gypsiargids**

FEDB. Other Gypsiargids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that either contains 20 percent or more (by volume) durinodes or have brittle and has 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Gypsiargids**

FEDD. Other Gypsiargids which 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 are cinders, pumice, and pumice-like 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 Gypsiargids**

FEDE. Other Gypsiargids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is $5^{\circ}$ C or higher and the moisture regime borders on a xeric regime.

**Xeric Gypsiargids**

FEDF. Other Gypsiargids that are dry in all parts of the moisture control section for less then three-fourths of the time (cumulative) that the soil temperature is $5^{\circ}$ C or higher at a depth of 50 cm and the moisture regime borders on an ustic regime.

**Ustic Gypsiargids**

FEDG. Other Gypsiargids.

**Typic Gypsiargids**

## Haplargids

Key to subgroups

FEFA. Haplargids which 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 which 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 the soil moisture regime borders on a xeric regime.

**Lithic Xeric Haplargids**

FEFC. Other Haplargids which 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 the moisture regime borders on an ustic regime.

**Lithic Ustic Haplargids**

FEFD. Other Haplargids which have a lithic contact within 50 cm of the soil surface.

**Lithic Haplargids**

FEFE. Other Haplargids which 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 most 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 to a 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 the moisture regime borders on a xeric regime.

**Xerertic Haplargids**

FEFF. Other Haplargids which 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 most 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 to a 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 the moisture regime borders on an ustic regime.

**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 most 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 to a lithic or paralithic contact, if shallower.

**Vertic Haplargids**

FEFH. Other Haplargids that are either:

1. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years.

**Aquic Haplargids**

FEFI. Other Haplargids which have:

1. A sandy particle size 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 the moisture regime borders an ustic regime.

**Arenic Ustic Haplargids**

FEFJ. Other Haplargids which have a sandy particle size 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 which have:

1. One or more horizons, within 100 cm of the soil surface, that have 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 the moisture regime borders a xeric regime.

**Durinodic Xeric Haplargids**

FEFL. Other Haplargids that have one or more horizons, within 100 cm of the soil surface, that have 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 which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

**Petronodic Haplargids**

FEFN. 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Haplargids**

FEFO. Other Haplargids that which 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 are cinders, pumice, and pumice-like 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 Haplargids**

FEFP. Other Haplargids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders a xeric regime.

**Xeric 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 is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

**Ustic Haplargids**

FEFR. Other Haplargids.

**Typic Haplargids**

A R I

## Natrargids

Key to subgroups

FEBA. Natrargids which 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 the moisture regime borders a xeric regime.

**Lithic Xeric Natrargids**

FEBB. Natrargids which 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 the moisture regime borders an ustic regime.

**Lithic Ustic Natrargids**

FEBC. Other Natrargids that have a lithic contact within 50 cm of the soil surface.

**Lithic Natrargids**

FEBD. Other Natrargids which 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 years, 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 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 most 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 per year in 6 or more out of 10 years.

**Aquic Natrargids**

FEBF. Other Natrargids that have both of the following:

1. One or more horizons, within 100 cm of the soil surface, that have 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 the moisture regime borders a xeric regime.

**Durinodic Xeric Natrargids**

FEBG. Other Natrargids that have one or more horizons, within 100 cm of the soil surface, that have 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 which have one or more horizons, within 100 cm of the soil surface, that have 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 the moisture regime borders an ustic regime.

**Glossic Ustic Natrargids**

FEBJ. Other Natrargids that have:

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. 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 the moisture regime borders an ustic regime.

**Haplic Ustic Natrargids**

FEBK. Other Natrargids that have:

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. 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 the moisture regime borders a xeric regime.

**Haploxeralfic Natrargids**

FEBL. Other Natrargids that have 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.

**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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 which 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 are cinders, pumice, and pumice-like 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 less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders a xeric regime.

**Xeric Natrargids**

FEBP. Other Natrargids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders an ustic regime.

**Ustic Natrargids**

FEBQ. Other Natrargids which have 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.

**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 most years, 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 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 most 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 per year in 6 or more out of 10 years.

**Aquic Paleargids**

FECC. Other Paleargids that have:

1. A sandy particle size 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

ARI

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 the moisture regime borders an ustic regime.
**Arenic Ustic Paleargids**

FECD. Other Paleargids that have a sandy particle size 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 which 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, that have 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 the moisture regime borders a xeric regime.
**Durinodic Xeric Paleargids**

FECG. Other Paleargids that have one or more horizons, within 100 cm of the soil surface, that have 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 which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.
**Petronodic Paleargids**

FECI. 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Paleargids**

FECJ. 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 are cinders, pumice, and pumice-like 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**

FECK. 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° or higher at a depth of 50 cm and the moisture regime borders a xeric regime.
**Xeric 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 the moisture regime borders an ustic regime.
**Ustic Paleargids**

FDCM. Other Paleargids.
**Typic Paleargids**

## Petroargids

Key to subgroups

FEAA. Petroargids which have both of the following:

1. 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 the moisture regime borders an ustic regime.
**Petrogypsic Ustic Petroargids**

FEAB. Other Petroargids which have a petrogypsic horizon that has its upper boundary within 150 cm of the soil surface.
**Petrogypsic Petroargids**

FEAC. Other Petroargids which 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 the moisture regime borders a xeric regime.
**Duric Xeric Petroargids**

FEAD. Other Petroargids which have a duripan that has its upper boundary within 150 cm of the soil surface.
**Duric Petroargids**

FEAE. Other Petroargids which 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 the soil moisture regime borders a xeric regime.
**Xeric Petroargids**

FEAF. Other Petroargids which 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 the moisture regime borders an ustic regime.
**Ustic Petroargids**

FEAG. Other Petroargids.
**Typic Petroargids**

## Calcids

Key to great groups

FFA. Calcids which 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

FFCA. 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 the moisture regime borders a xeric regime.
**Lithic Xeric Haplocalcids**

FFCB. 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 the moisture regime borders an ustic regime.
**Lithic Ustic Haplocalcids**

FFCC. Other Haplocalcids that have a lithic contact within 50 cm of the soil surface.
**Lithic Haplocalcids**

FFCD. 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 most years, 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 lithic or paralithic contact, whichever is shallower.
**Vertic Haplocalcids**

FFCE. Other Haplocalcids that:

1. Are either:

   a. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years; and

2. Have one or more horizons, within 100 cm of the soil surface, that have 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**

FFCF. Other Haplocalcids that are either:

1. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years.

**Aquic Haplocalcids**

FFCH. 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 the moisture regime borders a xeric regime.

**Duric Xeric Haplocalcids**

FFCI. Other Haplocalcids that have a duripan that has its upper boundary within 150 cm of the surface.

**Duric Haplocalcids**

FFCJ. Other Haplocalcids that have:

1. One or more horizons, within 100 cm of the soil surface, that have 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 the moisture regime borders a xeric regime.

**Durinodic Xeric Haplocalcids**

FFCK. Other Haplocalcids that have one or more horizons, within 100 cm of the soil surface, that have 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**

FFCL. Other Haplocalcids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

**Petronodic Haplocalcids**

FFCM. Other Haplocalcids that have both:

1. A horizon at least 25 cm thick within 100 cm of the soil surface, which has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in six or more years out of ten; 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 the moisture regime borders a xeric regime.

**Sodic Xeric Haplocalcids**

FFCN. Other Haplocalcids that have both:

1. A horizon at least 25 cm thick within 100 cm of the soil surface, which has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in six or more years out of ten; and

2. 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 the soil moisture regime borders an ustic regime.

**Sodic Ustic Haplocalcids**

FFCO. Other Haplocalcids that have, in one or more horizons within 100 cm of the mineral surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

**Sodic Haplocalcids**

FFCP. 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Haplocalcids**

FFCQ. Other Haplocalcids which 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 are cinders, pumice, and pumice-like fragments; *or*

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 are cinders, pumice, and pumice-like 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.

**Vitrandic Haplocalcids**

FFCR. 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 the moisture regime borders a xeric regime.

**Xeric Haplocalcids**

FECS. 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 the moisture regime borders an ustic regime.

**Ustic Haplocalcids**

FECT. Other Haplocalcids.

**Typic Haplocalcids**

## Petrocalcids

Key to subgroups

FFAA. Petrocalcids that are either:

1. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years.

**Aquic Petrocalcids**

FFAB. Other Petrocalcids that have a natric horizon.

**Natric Petrocalcids**

FFAC. Other Petrocalcids which 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 the moisture regime borders a xeric regime.

**Xeralfic Petrocalcids**

FFAD. Other Petrocalcids which 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 the moisture regime borders an ustic regime.

**Ustalfic Petrocalcids**

FFAE. Other Petrocalcids which have an argillic horizon that has its upper boundary within 100 cm of the soil surface.

**Argic Petrocalcids**

FFAF. Other Petrocalcids that have a calcic horizon overlying the petrocalcic horizon.

**Calcic Petrocalcids**

FFAG. Other Petrocalcids 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like fragments; *or*

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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 Petrocalcids**

FFAH. Other Petrocalcids which 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 are cinders, pumice, and pumice-like 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 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 the moisture regime borders a xeric regime.
**Xeric Petrocalcids**

FFAJ. 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 the moisture regime borders an ustic regime.
**Ustic Petrocalcids**

FFAK. Other Petrocalcids
**Typic Petrocalcids**

## Cambids

Key to great groups

FGA. Cambids that are either:

1. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years.
**Aquicambids, p.114**

FGB. Other Cambids which 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 which have a horizon at least 25 cm thick within 100 cm of the soil surface, that have an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in six or more years out of ten.
**Sodic Aquicambids**

FGAB. Other Aquicambids that have:

1. One or more horizons, within 100 cm of the soil surface, that have 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 the moisture regime borders a xeric regime.
**Durinodic Xeric Aquicambids**

FGAC. Other Aquicambids that have one or more horizons, within 100 cm of the soil surface, that have 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 which have one or more horizons, within 100 cm of the soil surface, that have 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 which 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 are cinders, pumice, and pumice-like 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 Aquicambids**

FGAG. Other Aquicambids which have an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a 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 the moisture regime borders 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 the moisture regime borders an ustic regime.

**Ustic Aquicambids**

FGAJ. Other Aquicambids.

**Typic Aquicambids**

## Haplocambids

Key to subgroups

FGDA. 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 the moisture regime borders a xeric regime.

**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 the moisture regime borders an ustic regime.

**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 most 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 to a lithic or paralithic contact, if shallower; and

ARI

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 the moisture regime borders a xeric regime.

**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 most 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 to a 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 the moisture regime borders an ustic regime.

**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 most years, 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 lithic or paralithic contact, whichever is shallower.

**Vertic Haplocambids**

FGDG. Other Haplocambids which have both of the following:

1. One or more horizons, within 100 cm of the soil surface, that have 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 the moisture regime borders a xeric regime.

**Durinodic Xeric Haplocambids**

FGDH. Other Haplocambids that have one or more horizons, within 100 cm of the soil surface, that have 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 which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

**Petronodic Haplocambids**

FGDJ. Other Haplocambids that have both:

1. A horizon at least 25 cm thick within 100 cm of the soil surface, which has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in six or more years out of ten; 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 the moisture regime borders a xeric regime.

**Sodic Xeric Haplocambids**

FGDK. Other Haplocambids that have both:

1. A horizon at least 25 cm thick within 100 cm of the soil surface, which has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in six or more years out of ten; and

2. 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 the soil moisture regime borders an ustic regime.

**Sodic Ustic Haplocambids**

FGDL. Other Haplocambids that have a horizon at least 25 cm thick within 100 cm of the soil surface, which has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in six or more years out of ten.

**Sodic Haplocambids**

FGDM. Other Haplocambids which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Haplocambids**

FGDN. Other Haplocambids which 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 are cinders, pumice, and pumice-like 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 Haplocambids**

FGDO. Other Haplocambids that:

1. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders a xeric regime; *and*

2. Have an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a lithic or paralithic contact if shallower.

**Xerifluventic Haplocambids**

FGDP. Other Haplocambids that:

1. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders an ustic regime; *and*

2. Have an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a lithic or paralithic contact if shallower.

**Ustifluventic Haplocambids**

FGDQ. Other Haplocambids which have an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a lithic or paralithic contact if shallower.

**Fluventic Haplocambids**

FGDR. Other Haplocambids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders a xeric regime.

**Xeric Haplocambids**

FGDS. Other Haplocambids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders an ustic regime.

**Ustic Haplocambids**

FGDT. Other Haplocambids.

**Typic Haplocambids**

## Petrocambids

<u>Key to subgroups</u>

FGBA. Other Petrocambids that have a horizon at least 25 cm thick within 100 cm of the soil surface, which has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in 6 or more years out of 10.

**Sodic Petrocambids**

FGBB. Other Petrocambids which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Petrocambids**

FGBC. Other Petrocambids which 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 are cinders, pumice, and pumice-like 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 Petrocambids**

FGBD. Other Petrocambids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is $5^{\circ}$ C or higher and the moisture regime borders a xeric regime.

**Xeric Petrocambids**

FGBE. Other Petrocambids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is $5^{\circ}$ C or higher and the moisture regime borders an ustic regime.

**Ustic Petrocambids**

FGBF. Other Petrocambids

**Typic Petrocambids**

## Cryids

Key to great groups

FAA. Cryids which have a salic horizon that has its upper boundary within 100 cm of the soil surface.

**Salicryids**, p.121

FAB. Other Cryids which have a duripan, or a petrocalcic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

**Petrocryids**, p.121

FAC. Other Cryids which have a gypsic horizon that has its upper boundary within 100 cm of the soil surface.

**Gypsicryids**, p.120

FAD. Other Cryids that have an argillic or a natric horizon.

**Argicryids**, p.118

FAE. Other Cryids which 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:

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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Argicryids**

FADC. Other Argicryids which have a natric horizon that has its upper boundary within 100 cm of the soil surface.

**Natric Argicryids**

FADD. Other Argicryids which 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 $5^{\circ}$ C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Argicryids**

FADE. Other Argicryids which 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 are cinders, pumice, and pumice-like 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 less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

**Xeric Argicryids**

FADG. Other Argicryids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

**Ustic Argicryids**

FADH. Other Argicryids.

**Typic Argicryids**

## Calcicryids

<u>Key to subgroups</u>

FAEA. Calcicryids that have a lithic contact within 50 cm of the soil surface.

**Lithic Calcicryids**

FAEB. Other Calcicryids which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 which 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 are cinders, pumice, and pumice-like 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° or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

**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 the moisture regime borders an ustic regime.

**Ustic Calcicryids**

FAEF. Other Calcicryids.

**Typic Calcicryids**

## Gypsicryids

Key to subgroups

FACA. Gypsicryids that have a calcic horizon.

**Calcic Gypsicryids**

FACB. Other Gypsicryids which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 which 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 are cinders, pumice, and pumice-like 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 either:

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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Haplocryids**

FABC. 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Haplocambids which 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 are cinders, pumice, and pumice-like 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° or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

**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 the moisture regime borders an ustic regime.

**Ustic Haplocryids**

FAFG. Other Haplocryids.

**Typic Haplocryids**

## Petrocryids

Key to subgroups

FABA. Petrocryids that have:

1. 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° or higher at a depth of 50 cm and the soil moisture regime borders a xeric regime.

**Duric Xeric Petrocryids**

FABB. Other Petrocryids which have a duripan that has its upper boundary within 100 cm of the soil surface.

**Duric Petrocryids**

FABC. Other Petrocryids which have a petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

**Petrogypsic Petrocryids**

FABD. 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 the soil moisture regime borders xeric.

**Xeric 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 the soil moisture regime borders ustic.

**Ustic Petrocryids**

FABF. Other Petrocryids.

**Typic Petrocryids**

## Salicryids

Key to subgroups

FAAA. Salicryids that are saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more per year in 6 or more out of 10 years.

**Aquic Salicryids**

FAAB. Other Salicryids.

**Typic Salicryids**

## 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.123

## Argidurids

Key to subgroups

FCBA. Argidurids which 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 most years, 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 most 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 per year in 6 or more out of 10 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 also has either;

   a. A clay increase of 15 percent or more clay (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 the moisture regime borders a xeric regime.

**Abruptic Xeric Argidurids**

FCBD. Other Argidurids which 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 clay (absolute) within a vertical distance of 2.5 cm within the argillic 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 which 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 the moisture regime borders a xeric regime.

**Haploxeralfic Argidurids**

FCBF. Other Argidurids which have a duripan that is strongly cemented or less cemented in all subhorizons.

**Argidic Argidurids**

FABG. 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Argidurids**

FABH. Other Argidurids which 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 are cinders, pumice, and pumice-like 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. 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 the moisture regime borders a xeric regime.

**Xeric Argidurids**

FCBJ. Other Argidurids which 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 from the soil surface is 5°C or higher and a moisture regime that borders on an ustic regime.

**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 most 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 per year in 6 or more out of 10 years.

**Aquicambidic Haplodurids**

FCCB. Other Haplodurids that are either:

1. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 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 from the soil surface, and a moisture regime that borders on a xeric regime.

**Xerochreptic 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 moisture regime that borders on a xeric regime; *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 are cinders, pumice, and pumice-like 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 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 are cinders, pumice, and pumice-like 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 Haplodurids**

FCCG. 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 from the soil surface, and a moisture regime that borders on a xeric regime.

**Xeric Haplodurids**

FCCH. 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 moisture regime that borders on an ustic regime.

**Ustic Haplodurids**

FCCI. Other Haplodurids.

**Typic Haplodurids**

## Natridurids

Key to subgroups

FCAA. Natridurids which 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 most years, 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 which have both:

1. A duripan that is strongly cemented or less cemented in all subhorizons; and

2. Either:

   a. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years.

**Aquic Natrargidic Natridurids**

FCAC. Other Natridurids that are either:

1. Irrigated and have aquic conditions, for some time in most 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 per year in 6 or more out of 10 years.

**Aquic Natridurids**

FCAD. Other Natridurids that have the following combination of characteristics:

1. Have 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 the moisture regime borders a xeric regime.

**Natraxeralfic 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Natridurids**

FCAG. Other Natridurids which 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 are cinders, pumice, and pumice-like 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 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 the moisture regime borders a xeric regime.

**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.128

FDB. Other Gypsids that have a natric horizon that has its upper boundary within 100 cm of the soil surface.
**Natrigypsids,** p.127

FDC. Other Gypsids that have an argillic horizon that has its upper boundary within 100 cm of the soil surface.
**Argigypsids,** p.125

FDD. Other Gypsids that have a calcic horizon that has its upper boundary within 100 cm of the soil surface.
**Calcigypsids,** p.126

FDE. Other Gypsids.
**Haplogypsids,** p.126

## Argigypsids

Key to subgroups

FDCA. Argigypsids that have a lithic contact within 50 cm of the soil surface.
**Lithic Argigypsids**

FDCB. Other Argigypsids which 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 most years, 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 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 which have one or more horizons, within 100 cm of the soil surface, that have 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 which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Argigypsids**

FDCF. Other Argigypsids which 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 are cinders, pumice, and pumice-like 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 percent or more.
**Vitrandic Argigypsids**

FDCG. Other Argigypsids 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 a moisture regime that borders a xeric regime.
**Xeric Argigypsids**

FDCH. Other Argigypsids 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 a moisture regime that borders an ustic regime.
**Ustic Argigypsids**

FDCI. Other Argigypsids.
**Typic Argigypsids**

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R
I

## Calcigypsids

Key to subgroups

FDDA. Calcigypsids that have a lithic contact within 100 cm of the soil surface.

**Lithic Calcigypsids**

FDDB. Other Calcigypsids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

**Petronodic Calcigypsids**

FDDC. Other Calcigypsids which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Calcigypsids**

FDDD. Other Calcigypsids which 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 are cinders, pumice, and pumice-like 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 Calcigypsids**

FDDE. Other Calcigypsids 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 moisture regime that borders on a xeric regime.

**Xeric Calcigypsids**

FDDF. Other Calcigypsids 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 moisture regime that borders on an ustic regime.

**Ustic Calcigypsids**

FDDG. Other Calcigypsids.

**Typic Calcigypsids**

## Haplogypsids

Key to subgroups

FDEA. Haplogypsids that have a lithic contact within 50 cm of the soil surface.

**Lithic Haplogypsids**

FDEB. Other Haplogypsids which have a gypsic horizon that has its upper boundary within 18 cm of the soil surface.

**Leptic Haplogypsids**

FDEC. Other Haplogypsids which 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 per year in 6 or more out of 10 years.

**Sodic Haplogypsids**

FDED. Other Haplogypsids which have one or more horizons, within 100 cm of the soil surface, that have 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 which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Haplogypsids**

FDEF. Other Haplogypsids which 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 are cinders, pumice, and pumice-like 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 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 moisture regime that borders on a xeric regime.
**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 moisture regime that borders on an ustic regime.
**Ustic Haplogypsids**

FCEI. Other Haplogypsids.
**Typic Haplogypsids**

## Natrigypsids

Key to subgroups

FDBA. Natrigypsids that have a lithic contact within 50 cm of the soil surface.
**Lithic Natrigypsids**

FDBB. Other Natrigypsids that have:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thicknessof 30 cm or more for some time in most years, 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 lithic or paralithic contact, whichever is shallower.
**Vertic Natrigypsids**

FDBC. Other Natrigypsids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.
**Petronodic Natrigypsids**

FDBD. Other Natrigypsids which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Natrigypsids**

FDBE. Other Natrigypsids which 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 are cinders, pumice, and pumice-like 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 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 moisture regime that borders a xeric regime.
**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 moisture regime that borders an ustic regime.

**Ustic Natrigypsids**

FDBH. Other Natrigypsids.

**Typic Natrigypsids**

## Petrogypsids

Key to subgroups

FDAA. Other Petrogypsids which have a petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

**Petrocalcic Petrogypsids**

FDAB. Other Petrogypsids which have a calcic horizon overlying the petrogypsic horizon.

**Calcic Petrogypsids**

FDAC. Other Petrogypsids which 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 the moisture regime borders a xeric regime; *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 are cinders, pumice, and pumice-like 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 Petrogypsids**

FDAD. Other Petrogypsids which 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 are cinders, pumice, and pumice-like 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 Petrogypsids**

FDAE. 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 moisture regime that borders a xeric regime.

**Xeric Petrogypsids**

FDAF. 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 moisture regime that borders an ustic regime.

**Ustic Petrogypsids**

FDAG. Other Petrogypsids.

**Typic Petrogypsids**

## 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 one month or more per year in 6 or more out of 10 years.

**Aquisalids**, p.128

FBB. Other Salids.

**Haplosalids**, p.129

## Aquisalids

Key to subgroups

FBAA. Aquisalids which have a gypsic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

**Gypsic Aquisalids**

FBAB. Other Aquisalids which 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 which have a duripan that has its upper boundary within 100 cm of the soil surface.
**Duric Haplosalids**

FBBB. Other Haplosalids which have a petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.
**Petrogypsic Haplosalids**

FBBC. Other Haplosalids which have a gypsic horizon that has its upper boundary within 100 cm of the soil surface.
**Gypsic Haplosalids**

FBBD. Other Haplosalids which have a calcic horizon that has its upper boundary within 100 cm of the soil surface.
**Calcic Haplosalids**

FBBE. Other Haplosalids.
**Typic Haplosalids**

# Chapter 9

# Entisols

Key to suborders

KA. 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 a depth of 25 cm from the mineral soil surface; *or*

3. In a layer above a lithic or paralithic contact or in a layer between 40 and 50 cm from the mineral soil surface, whichever is shallower, aquic conditions for some time in most 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) A chroma of 0; *or*

      (2) A chroma of 1 or less and a color value, moist, of 4 or more; *or*

      (3) A 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) A chroma of 0; *or*

      (2) A hue of 10YR or redder, a color value, moist, of 4 or more, and a chroma of 1; *or*

      (3) A hue of 10YR or redder, a chroma of 2 or less, and redox concentrations; *or*

      (4) A hue of 2.5Y or yellower, a chroma of 3 or less, and distinct or prominent redox concentrations; *or*

      (5) A hue of 2.5Y or yellower and a chroma of 1; *or*

      (6) A 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.

**Aquents, p.131**

KB. Other Entisols which have, in one or more layers between 25 and 100 cm from the mineral soil surface, 3 percent or more (by volume) fragments of diagnostic horizons that are not arranged in any discernible order.

**Arents, p.135**

KC. Other Entisols that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser, in all layers[1] between either an 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 lithic, paralithic, or petroferric contact, whichever is shallower.

**Psamments, p.146**

KD. Other Entisols which do not have a 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[2] 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 lithic or paralithic contact if shallower; *and*

3. A mean annual soil temperature above 0°C.

**Fluvents, p.136**

KE. Other Entisols.

**Orthents, p. 140**

## Aquents

Key to great groups

KAA. Aquents that have sulfidic materials within 50 cm of the mineral soil surface.

**Sulfaquents, p.135**

KAB. Other Aquents that have *both*:

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[1] Lamellae that are either less than 1 cm thick or too few to meet the requirements for an argillic horizon may have a texture of sandy loam.

[2] The carbon should be of Holocene age, not fossil carbon from transported fragments of bedrock or from buried Pleistocene deposits. The mean residence time of the carbon should be less than 11,000 years B.P.

ENT

1. An *n* value of more than 0.7, *and* 8 percent or more clay in the fine-earth fraction of all horizons between 20 and 50 cm from the mineral soil surface; *and*

2. A mean annual soil temperature above 0°C.

**Hydraquents, p.134**

KAC. Other Aquents that have a cryic soil temperature regime.

**Cryaquents, p.132**

KAD. Other Aquents that have a sandy particle size in all horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 100 cm or a lithic or paralithic contact, whichever is shallower.

**Psammaquents, p.134**

KAE. Other Aquents that have *either* 0.2 percent or more organic carbon[3] 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 lithic or paralithic contact if shallower.

**Fluvaquents, p.133**

KAF. Other Aquents that have episaturation.

**Epiaquents, p.133**

KAG. Other Aquents.

**Endoaquents, p.132**

## Cryaquents

Key to subgroups

KACA. Cryaquents which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Cryaquents**

KACB. Other Cryaquents.

**Typic Cryaquents**

## Endoaquents

Key to subgroups

KAGA. Endoaquents which 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 the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0.

**Sulfic Endoaquents**

KAGB. Other Endoaquents that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Endoaquents**

KAGC. 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. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A hue of 5Y or redder and a chroma of 2 or more if there are no redox concentrations.

**Aeric Endoaquents**

[3] See footnote 2.

KAGD. Other Endoaquents which 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* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by $NH_4OAc$) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

**Humaqueptic Endoaquents**

KAGE. Other Endoaquents which 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* the upper soil to a depth of 15 cm, after mixing, has these colors.

**Mollic Endoaquents**

KAGF. Other Endoaquents.

**Typic Endoaquents**

## Epiaquents

Key to subgroups

KAFA. 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. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A chroma of 2 or more if there are no redox concentrations.

**Aeric Epiaquents**

KAFB. Other Epiaquents which 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* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by $NH_4OAc$) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

**Humaqueptic Epiaquents**

KAFC. Other Epiaquents which 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* the upper soil to a depth of 15 cm, after mixing, has these colors.

**Mollic Epiaquents**

KAFD. Other Epiaquents.

**Typic Epiaquents**

## Fluvaquents

Key to subgroups

KAEA. Fluvaquents which 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 the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0.

**Sulfic Fluvaquents**

KAEB. Other Fluvaquents which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Fluvaquents**

KAEC. Other Fluvaquents which have *both*:

1. A buried Histosol, or a buried histic epipedon, that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. A difference of less than 5°C between mean summer and mean winter soil temperatures, either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

**Thapto-Histic Tropic Fluvaquents**

KAED. Other Fluvaquents which have a buried Histosol, or a buried histic epipedon, that has its upper boundary within 100 cm of the mineral soil surface.

**Thapto-Histic Fluvaquents**

KAEE. Other Fluvaquents which 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/$cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Fluvaquents**

KAEF. Other Fluvaquents that have *both*:

1. A difference of less than 5°C between mean summer and mean winter soil temperatures either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower; *and*

2. 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:

   a. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

   b. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

   c. A hue of 5Y and a chroma of 3 or more; *or*

   d. A chroma of 2 or more if there are no redox concentrations.

**Aeric Tropic Fluvaquents**

KAEG. 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. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A chroma of 2 or more if there are no redox concentrations.

**Aeric Fluvaquents**

KAEH. Other Fluvaquents that have a difference of less than 5°C between mean summer and mean winter soil temperatures, either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

**Tropic Fluvaquents**

KAEI. Other Fluvaquents which 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* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by $NH_4OAc$) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

**Humaqueptic Fluvaquents**

KAEJ. Other Fluvaquents which 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* the upper soil to a depth of 15 cm, after mixing, has these colors.

**Mollic Fluvaquents**

KAEK. Other Fluvaquents.

**Typic Fluvaquents**

## Hydraquents

Key to subgroups

KABA. All Hydraquents (provisionally).

**Typic Hydraquents**

## Psammaquents

Key to subgroups

KADA. Psammaquents that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Psammaquents**

KADB. Other Psammaquents which 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. Aluminum plus 1/2 iron 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**

KADC. Other Psammaquents which 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* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by $NH_4OAc$) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

**Humaqueptic Psammaquents**

KADD. Other Psammaquents which 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* the upper soil to a depth of 15 cm, after mixing, has these colors.

**Mollic Psammaquents**

KADE. Other Psammaquents.

**Typic Psammaquents**

## Sulfaquents

Key to subgroups

KAAA. Sulfaquents that have a histic epipedon.

**Histic Sulfaquents**

KAAB. Other Sulfaquents which have *both*:

1. Sulfidic materials that have their upper boundary 30 cm or more below the mineral soil surface; *and*

2. An *n* value of 0.7 or less in one or more horizons between 20 and 50 cm from the mineral soil surface.

**Haplic Sulfaquents**

KAAC. Other Sulfaquents.

**Typic Sulfaquents**

## Arents

Key to great groups

KBA. Arents that have an ustic moisture regime.

**Ustarents,** p.135

KBB. Other Arents that have a xeric moisture regime.

**Xerarents,** p.136

KBC. Other Arents that have a torric moisture regime.

**Torriarents,** p.135

KBD. Other Arents.

**Udarents,** p.135

## Torriarents

Torriarents are the Arents that have a torric soil moisture regime.

## Udarents

Key to subgroups

KBDA. Udarents 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 Udarents**

KBDB. Other Udarents that have fragments of an argillic horizon within 100 cm of the mineral soil surface.

**Ultic Udarents**

KBDC. Other Udarents that have fragments of a mollic epipedon within 100 cm of the mineral soil surface.

**Mollic Udarents**

KBDD. Other Udarents.

**Udarents**

## Ustarents

Ustarents are the Arents that have an ustic soil moisture regime.

## Xerarents

Key to subgroups

KBBA. 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**

KBBB. Other Xerarents.

**Xerarents**

# Fluvents

Key to great groups

KDA. Fluvents that have a cryic soil temperature regime.

**Cryofluvents,** p.136

KDB. Other Fluvents that have a xeric moisture regime.

**Xerofluvents,** p.139

KDC. Other Fluvents that have an ustic moisture regime.

**Ustifluvents,** p. 138

KDD. Other Fluvents that have a torric moisture regime.

**Torrifluvents,** p.136

KDE. Other Fluvents that have an isomesic, isothermic, or isohyperthermic soil temperature regime.

**Tropofluvents,** p.138

KDF. Other Fluvents.

**Udifluvents,** p.138

## Cryofluvents

Key to subgroups

KDAA. Cryofluvents 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Cryofluvents**

KDAB. Other Cryofluvents 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Cryofluvents**

KDAC. Other Cryofluvents that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Cryofluvents**

KDAD. Other Cryofluvents that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Cryofluvents**

KDAE. Other Cryofluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

**Mollic Cryofluvents**

KDAF. Other Cryofluvents.

**Typic Cryofluvents**

## Torrifluvents

Key to subgroups

KDDA. Torrifluvents which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. A moisture control section which, in 6 or more out of 10 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 an *iso* soil temperature regime, and a torric moisture regime that borders on an ustic regime.

**Ustertic Torrifluvents**

KDDB. Other Torrifluvents which 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 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 lithic or paralithic contact, whichever is shallower.

**Vertic Torrifluvents**

KDDC. Other Torrifluvents which have:

1. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime; *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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrixerandic Torrifluvents**

KDDD. Other Torrifluvents 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Torrifluvents**

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

**Aquic Torrifluvents**

KDDF. Other Torrifluvents that are saturated with water, in one or more layers within 150 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Torrifluvents**

KDDG. Other Torrifluvents which have:

1. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime.

**Duridic Xeric Torrifluvents**

KDDH. Other Torrifluvents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Duridic Torrifluvents**

KDDI. Other Torrifluvents which have *both*:

1. A moisture control section which, in 6 or more out of 10 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 torric moisture regime that borders on an ustic regime.

**Ustic Torrifluvents**

KDDJ. Other Torrifluvents which have *both*:

1. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime.

**Xeric Torrifluvents**

KDDK. Other Torrifluvents that have an anthropic epipedon.

**Anthropic Torrifluvents**

KDDL. Other Torrifluvents.

**Typic Torrifluvents**

## Tropofluvents

Key to subgroups

KDEA. All Tropofluvents (provisionally).

**Typic Tropofluvents**

## Udifluvents

Key to subgroups

KDFA. Udifluvents 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Udifluvents**

KDFB. Other Udifluvents 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Udifluvents**

KDFC. Other Udifluvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 a chroma of 0 or a hue of 5GY, 5G, 5BG, or 5B, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Udifluvents**

KDFD. Other Udifluvents that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Udifluvents**

KDFE. Other Udifluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

**Mollic Udifluvents**

KDFF. Other Udifluvents.

**Typic Udifluvents**

## Ustifluvents

Key to subgroups

KDCA. Ustifluvents which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Ustifluvents**

KDCB. Other Ustifluvents that have anthraquic conditions.

**Anthraquic Ustifluvents**

KDCC. Other Ustifluvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 a chroma of 0 or a hue of 5GY, 5G, 5BG, or 5B, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Ustifluvents**

KDCD. Other Ustifluvents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Ustifluvents**

KDCE. Other Ustifluvents which, if 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 6 or more out or 10 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 which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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**

KDCF. Other Ustifluvents which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section that is dry, in 6 or more out or 10 years, 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 which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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**

KDCG. Other Ustifluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

**Mollic Ustifluvents**

KDCH. Other Ustifluvents.

**Typic Ustifluvents**

## Xerofluvents

Key to subgroups

KDBA. Xerofluvents which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Xerofluvents**

E N T

KDBB. Other Xerofluvents which have:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 a chroma of 0 or a hue bluer than 10Y, and also aquic conditions for some time in most 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Xerofluvents**

KDBC. 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Xerofluvents**

KDBD. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Xerofluvents**

KDBE. Other Xerofluvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 a chroma of 0 or a hue of 5GY, 5G, 5BG, or 5B; and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Xerofluvents**

KDBF. Other Xerofluvents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Xerofluvents**

KDBG. Other Xerofluvents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Durinodic Xerofluvents**

KDBH. Other Xerofluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

**Mollic Xerofluvents**

KDBI. Other Xerofluvents.

**Typic Xerofluvents**

## Orthents

Key to great groups

KEA. Orthents that have a cryic or pergelic soil temperature regime.

**Cryorthents**, p.141

KEB. Other Orthents that have a torric moisture regime.

**Torriorthents**, p.141

KEC. Other Orthents that have a xeric moisture regime.
**Xerorthents**, p.145

KED. Other Orthents that have a udic moisture regime, and a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface.
**Troporthents**, p.143

KEE. Other Orthents that have an ustic moisture regime.
**Ustorthents**, p.144

KEF. Other Orthents.
**Udorthents**, p.143

## Cryorthents

Key to subgroups

KEAA. Cryorthents that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Cryorthents**

KEAB. Other Cryorthents that have a mean annual soil temperature of 0°C or lower.
**Pergelic Cryorthents**

KEAC. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
**Vitrandic Cryorthents**

KEAD. Other Cryorthents that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Cryorthents**

KEAE. Other Cryorthents that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Cryorthents**

KEAF. Other Cryorthents which have lamellae within 150 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness.
**Alfic Cryorthents**

KEAG. Other Cryorthents.
**Typic Cryorthents**

## Torriorthents

Key to subgroups

KEBA. Torriorthents which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A moisture control section which, in 6 or more out of 10 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 an *iso* soil temperature regime, and a torric moisture regime that borders on an ustic regime.
**Lithic Ustic Torriorthents**

KEBB. Other Torriorthents which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime.
**Lithic Xeric Torriorthents**

KEBC. Other Torriorthents that have a lithic contact within 50 cm of the soil surface.
**Lithic Torriorthents**

KEBD. Other Torriorthents which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. A moisture control section which, in 6 or more out of 10 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 an *iso* soil temperature regime, and a torric moisture regime that borders on an ustic regime.

**Ustertic Torriorthents**

KEBE. Other Torriorthents which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime.

**Xerertic Torriorthents**

KEBF. Other Torriorthents which 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 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 lithic or paralithic contact, whichever is shallower.

**Vertic Torriorthents**

KEBG. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Torriorthents**

KEBH. Other Torriorthents that have *both*:

1. In one or more horizons within 100 cm of the soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Aquic Haplodurldic Torriorthents**

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

**Aquic Torriorthents**

KEBJ. Other Torriorthents that are saturated with water, in one or more layers within 150 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Torriorthents**

KEBK. Other Torriorthents which have:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime.

**Haploduridic Xeric Torriorthents**

KEBL. Other Torriorthents which have a horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Haploduridic Torriorthents**

KEBM. Other Torriorthents which have *both*:

1. A moisture control section which, in 6 or more out of 10 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 an *iso* soil temperature regime, and a torric moisture regime that borders on an ustic regime.

**Ustic Torriorthents**

KEBN. Other Torriorthents which have *both*:

1. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime.

**Xeric Torriorthents**

KEBO. Other Torriorthents.

**Typic Torriorthents**

## Troporthents

Key to subgroups

KEDA. Troporthents that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Troporthents**

KEDB. Other Troporthents 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Troporthents**

KEDC. Other Troporthents 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Troporthents**

KEDD. Other Troporthents.

**Typic Troporthents**

## Udorthents

Key to subgroups

KEFA. Udorthents that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Udorthents**

KEFB. 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, a fine-earth fraction with both a bulk density of 1.0 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Udorthents**

KEFC. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Udorthents**

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

**Aquic Udorthents**

KEFE. Other Udorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Udorthents**

KEFF. Other Udorthents that have 50 percent or more (by volume) wormholes, worm casts, 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 lithic, paralithic, or petroferric contact, whichever is shallower.

**Vermic Udorthents**

KEFG. Other Udorthents.

**Typic Udorthents**

## Ustorthents

Key to subgroups

KEEA. Ustorthents that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Ustorthents**

KEEB. Other Ustorthents which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Ustorthents**

KEEC. Other Ustorthents that have anthraquic conditions.

**Anthraquic Ustorthents**

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

**Aquic Ustorthents**

KEEE. Other Ustorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Ustorthents**

KEEF. Other Ustorthents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Durinodic Ustorthents**

KEEG. Other Ustorthents which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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**

KEEH. Other Ustorthents which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per years when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

**Udic Ustorthents**

KEEI. Other Ustorthents that have 50 percent or more (by volume) wormholes, worm casts, 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 lithic, paralithic, or petroferric contact, whichever is shallower.

**Vermic Ustorthents**

KEEJ. Other Ustorthents.

**Typic Ustorthents**

# Xerorthents

Key to subgroups

KECA. Xerorthents that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Xerorthents**

KECB. Other Xerorthents which have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Xerorthents**

KECC. 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, a fine-earth fraction with both a bulk density of 1.0 g/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Xerorthents**

KECD. 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 are cinders, pumice, and pumice-like fragments; *or*

ENT

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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Xerorthents**

KECE. Other Xerorthents that have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Aquic Durinodic Xerorthents**

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

**Aquic Xerorthents**

KECG. Other Xerorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Xerorthents**

KECH. Other Xerorthents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Durinodic Xerorthents**

KECI. Other Xerorthents that have a base saturation (by $NH_4OAc$) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

**Dystric Xerorthents**

KEDJ. Other Xerorthents.

**Typic Xerorthents**

## Psamments

Key to great groups

KCA. Psamments that have a cryic or pergelic soil temperature regime.

**Cryopsamments**, p.146

KCB. Other Psamments that have a torric moisture regime.

**Torripsamments**, p.148

KCC. Other Psamments that have, within the particle-size control section, more than 90 percent silica and other extremely durable minerals in the 0.02-to-2.0-mm fraction.

**Quartzipsamments**, p.147

KCD. Other Psamments that have a udic moisture regime, and a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface.

**Tropopsamments**, p.149

KCE. Other Psamments that have an ustic moisture regime.

**Ustipsamments**, p.149

KCF. Other Psamments that have a xeric moisture regime.

**Xeropsamments**, p.150

KCG. Other Psamments.

**Udipsamments**, p.149

## Cryopsamments

Key to subgroups

KCAA. Cryopsamments that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Cryopsamments**

KCAB. Other Cryopsamments that have a mean annual soil temperature of 0°C or lower.

**Pergelic Cryopsamments**

KCAC. Other Cryopsamments that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Cryopsamments**

KCAD. Other Cryopsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Cryopsamments**

KCAE. 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 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 Cryopsamments**

KCAF. Other Cryopsamments which 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. Aluminum plus 1/2 iron 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**

KCAG. Other Cryopsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except for thickness or clay content or both.
**Argic Cryopsamments**

KCAH. Other Cryopsamments.
**Typic Cryopsamments**

## Quartzipsamments

Key to subgroups

KCCA. Quartzipsamments that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Quartzipsamments**

KCCB. Other Quartzipsamments which have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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. Aluminum plus 1/2 iron 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**

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

KCCD. Other Quartzipsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Quartzipsamments**

KCCE. Other Quartzipsamments which have *both*:

1. An ustic moisture regime; *and*

2. A clay fraction with a CEC equal to that of the clay of an oxic horizon, and enough clay to coat 75 percent or more of the sand-grain surfaces.
**Ustoxic Quartzipsamments**

KCCF. Other Quartzipsamments which have *both*:

1. A udic moisture regime; *and*

2. A clay fraction with a CEC equal to that of the clay of an oxic horizon, and enough clay to coat 75 percent or more of the sand-grain surfaces.
**Udoxic Quartzipsamments**

KCCG. 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**

KCCH. Other Quartzipsamments which have *both*:

1. Lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness or clay content or both; *and*

2. An ustic moisture regime.

**Argic Ustic Quartzipsamments**

KCCI. Other Quartzipsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except for thickness or clay content or both.

**Argic Quartzipsamments**

KCCJ. Other Quartzipsamments that have an ustic moisture regime.

**Ustic Quartzipsamments**

KCCK. Other Quartzipsamments that have a xeric moisture regime.

**Xeric Quartzipsamments**

KCCL. Other Quartzipsamments which 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. Aluminum plus 1/2 iron 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**

KCCM. Other Quartzipsamments.

**Typic Quartzipsamments**

## Torripsamments

Key to subgroups

KCBA. Torripsamments that have a lithic contact within 50 cm of the soil surface.

**Lithic Torripsamments**

KCBB. 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 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 Torripsamments**

KCBC. Other Torripsamments which have:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime.

**Haploduridic Xeric Torripsamments**

KCBD. Other Torripsamments which have a horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Haploduridic Torripsamments**

KCBE. Other Torripsamments which have *both*:

1. A moisture control section which, in 6 or more out of 10 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 torric moisture regime that borders on an ustic regime.

**Ustic Torripsamments**

KCBF. Other Torripsamments which have *both*:

1. A moisture control section which, in 6 or more out of 10 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 a torric moisture regime that borders on a xeric regime.

**Xeric Torripsamments**

KCBG. Other Torripsamments.
**Typic Torripsamments**

## Tropopsamments

Key to subgroups

KCDA. Tropopsamments that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Tropopsamments**

KCDB. Tropopsamments that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Tropopsamments**

KCDC. Other Tropopsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Tropopsamments**

KCDD. Other Tropopsamments.
**Typic Tropopsamments**

## Udipsamments

Key to subgroups

KCGA. Udipsamments that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Udipsamments**

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

KCGC. Other Udipsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Udipsamments**

KCGD. Other Udipsamments which 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. Aluminum plus 1/2 iron 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**

KCGE. Other Udipsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness or clay content or both.
**Argic Udipsamments**

KCGF. Other Udipsamments which have a surface horizon between 25 and 50 cm thick that meets all the requirements for a plaggen epipedon except thickness.
**Plaggeptic Udipsamments**

KCGG. Other Udipsamments.
**Typic Udipsamments**

## Ustipsamments

Key to subgroups

KCEA. Ustipsamments that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Ustipsamments**

KCEB. 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 most years (or artificial drainage).
**Aquic Ustipsamments**

KCEC. Other Ustipsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Ustipsamments**

KCED. Other Ustipsamments which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 which, in 6 or more out of 10 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, an isomesic, or a warmer iso soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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**

KCEE. Other Ustipsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness or clay content or both.

**Argic Ustipsamments**

KCEF. Other Ustipsamments.

**Typic Ustipsamments**

## Xeropsamments

Key to subgroups

KCFA. Xeropsamments that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Xeropsamments**

KCFB. 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 most years (or artificial drainage); *and*

2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Aquic Durinodic Xeropsamments**

KCFC. 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 most years (or artificial drainage).

**Aquic Xeropsamments**

KCFD. Other Xeropsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Xeropsamments**

KCFE. 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 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 Xeropsamments**

KCFF. Other Xeropsamments which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Durinodic Xeropsamments**

KCFG. Other Xeropsamments which have lamellae within 200 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness or clay content or both.

**Argic Xeropsamments**

KCFH. Other Xeropsamments that have a base saturation (by $NH_4OAc$) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

**Dystric Xeropsamments**

KCFI. Other Xeropsamments.

**Typic Xeropsamments**

# Chapter 10

# Histosols

Key to suborders

AA. Histosols which are never saturated with water except for a few days following heavy rains, *and* which have *both*:

1. A lithic or paralithic contact within 100 cm of the soil surface, *and/or* a thickness of organic plus cindery, fragmental, or pumiceous materials totaling 40 cm or more between the soil surface and a depth of 50 cm; *and*

2. Organic soil materials, that are, by weighted average, less than three fourths (by volume) *Sphagnum* fibers.

**Folists**, p.155

AB. Other Histosols which *either*:

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; *or*

2. Are organic soil materials, that are, by weighted average, three fourths or more by volume, *Sphagnum* fibers and which rest on a lithic or paralithic contact, fragmental materials, or on organic materials frozen 2 months after the summer solstice.

**Fibrists**, p.151

AC. Other Histosols that have more thickness of hemic 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.

**Hemists**, p.155

AD. Other Histosols.

**Saprists**, p.158

## Fibrists

Key to great groups

ABA. Fibrists that have a surface mantle in which fibric *Sphagnum* constitutes three fourths or more of the volume and which is *either* 90 cm or more thick, *or* extends 10 cm or more below the upper boundary of frozen[1] soil materials, *or* rests on a lithic or paralithic contact, fragmental materials, or mineral soil materials.

**Sphagnofibrists**, p.153

ABB. Other Fibrists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

2. Never freeze below a depth of 5 cm from the soil surface but have a mean annual soil temperature lower than 8°C.

**Cryofibrists**, p.152

ABC. Other Fibrists that have a mean annual soil temperature lower than 8°C.

**Borofibrists**, p.151

ABD. Other Fibrists that have a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 30 cm from the soil surface.

**Tropofibrists**, p.154

ABE. Other Fibrists that have a horizon 2 cm or more thick in which humilluvic materials constitute one half or more of the volume.

**Luvifibrists**, p.152

ABF. Other Fibrists.

**Medifibrists**, p.153

## Borofibrists

Key to subgroups

ABCA. Borofibrists that have a layer of water within the control section below the surface tier.

**Hydric Borofibrists**

[1] Frozen 2 months after the summer solstice.

ABCB. Other Borofibrists that have a lithic contact within the control section.

**Lithic Borofibrists**

ABCC. Other Borofibrists which have *both*:

1. Three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Sphagnic Terric Borofibrists**

ABCD. Other Borofibrists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Hemic Terric Borofibrists**

ABCE. Other Borofibrists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Sapric Terric Borofibrists**

ABCF. Other Borofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Borofibrists**

ABCG. Other Borofibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Borofibrists**

ABCH. Other Borofibrists that have, within 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 Borofibrists**

ABCI. Other Borofibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

**Sphagnic Borofibrists**

ABCJ. Other Borofibrists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

**Hemic Borofibrists**

ABCK. Other Borofibrists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier.

**Sapric Borofibrists**

ABCL. Other Borofibrists.

**Typic Borofibrists**

## Cryofibrists

Key to subgroups

ABBA. Cryofibrists that have a lithic contact within the control section.

**Lithic Cryofibrists**

ABBB. Other Cryofibrists that have a mean annual soil temperature of 0°C or lower.

**Pergelic Cryofibrists**

ABBC. Other Cryofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Cryofibrists**

ABBD. Other Cryofibrists that have, within 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**

ABBE. Other Cryofibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

**Sphagnic Cryofibrists**

ABBF. Other Cryofibrists.

**Typic Cryofibrists**

## Luvifibrists

ABEA. All Luvifibrists (provisionally).

**Typic Luvifibrists**

## Medifibrists

Key to subgroups

ABFA. Medifibrists that have a layer of water within the control section below the surface tier.

**Hydric Medifibrists**

ABFB. Other Medifibrists that have a lithic contact within the control section.

**Lithic Medifibrists**

ABFC. Other Medifibrists which have *both*:

1. Three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Sphagnic Terric Medifibrists**

ABFD. Other Medifibrists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Hemic Terric Medifibrists**

ABFE. Other Medifibrists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Sapric Terric Medifibrists**

ABFF. Other Medifibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Medifibrists**

ABFG. Other Medifibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Medifibrists**

ABFH. Other Medifibrists that have, within 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 Medifibrists**

ABFI. Other Medifibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

**Sphagnic Medifibrists**

ABFJ. Other Medifibrists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

**Hemic Medifibrists**

ABFK. Other Medifibrists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier.

**Sapric Medifibrists**

ABFL. Other Medifibrists.

**Typic Medifibrists**

## Sphagnofibrists

Key to subgroups

ABAA. Sphagnofibrists which:

1. Have a mean annual soil temperature of 0°C or less; *and*

2. In most years, are *either* frozen in one or more layers within the control section 2 months after the summer solstice, *or* freeze to a depth of 5 cm or more below the soil surface.

**Pergelic Sphagnofibrists**

ABAB. Other Sphagnofibrists that have a layer of water within the control section below the surface tier.

**Hydric Sphagnofibrists**

ABAC. Other Sphagnofibrists that have a lithic contact within the control section.

**Lithic Sphagnofibrists**

ABAD. Other Sphagnofibrists which:

1. Have a mean annual soil temperature between 0°C and 8°C; *and*

2. In most years, are *either* frozen in one or more layers within the control section 2 months after the summer solstice, *or* freeze to a depth of 5 cm or more below the soil surface.

**Cryic Sphagnofibrists**

ABAE. Other Sphagnofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Sphagnofibrists**

ABAF. Other Sphagnofibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Sphagnofibrists**

ABAG. Other Sphagnofibrists that have, within 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**

ABAH. Other Sphagnofibrists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

**Hemic Sphagnofibrists**

ABAI. Other Sphagnofibrists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier.

**Sapric Sphagnofibrists**

ABAJ. Other Sphagnofibrists.

**Typic Sphagnofibrists**

## Tropofibrists

Key to subgroups

ABDA. Tropofibrists that have a layer of water within the control section below the surface tier.

**Hydric Tropofibrists**

ABDB. Other Tropofibrists that have a lithic contact within the control section.

**Lithic Tropofibrists**

ABDC. Other Tropofibrists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Hemic Terric Tropofibrists**

ABDD. Other Tropofibrists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Sapric Terric Tropofibrists**

ABDE. Other Tropofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Tropofibrists**

ABDF. Other Tropofibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Tropofibrists**

ABDG. Other Tropofibrists that have, within 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 Tropofibrists**

ABDH. Other Tropofibrists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

**Hemic Tropofibrists**

ABDI. Other Tropofibrists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier.

**Sapric Tropofibrists**

ABDJ. Other Tropofibrists.

**Typic Tropofibrists**

## Folists

Key to great groups

AAA. Folists that have a cryic or colder soil temperature regime.

**Cryofolists**, p.155

AAB. Other Folists that have an isomesic or warmer *iso* soil temperature regime.

**Tropofolists**, p.155

AAC. Other Folists that have a frigid soil temperature regime.

**Borofolists**, p.155

AAD. Other Folists.

**Medifolists**, p.155

## Borofolists

Key to subgroups

AACA. Borofolists that have a lithic contact within 100 cm of the soil surface.

**Lithic Borofolists**

AACB. Other Borofolists.

**Typic Borofolists**

## Cryofolists

Key to subgroups

AAAA. Cryofolists that have a lithic contact within 100 cm of the soil surface.

**Lithic Cryofolists**

AAAB. Other Cryofolists.

**Typic Cryofolists**

## Medifolists

Key to subgroups

AADA. Medifolists that have a lithic contact within 100 cm of the soil surface.

**Lithic Medifolists**

AADB. Other Medifolists.

**Typic Medifolists**

## Tropofolists

Key to subgroups

AABA. Tropofolists that have a lithic contact within 100 cm of the soil surface.

**Lithic Tropofolists**

AABB. Other Tropofolists.

**Typic Tropofolists**

## Hemists

Key to great groups

ACA. Hemists which have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.

**Sulfohemists**, p.157

ACB. Other Hemists that have sulfidic materials within 100 cm of the soil surface.

**Sulfihemists**, p.157

ACC. 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.156

ACD. Other Hemists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

2. Never freeze below a depth of 5 cm from the soil surface but have a mean annual soil temperature lower than 8°C.

**Cryohemists**, p.156

ACE. Other Hemists that have a mean annual soil temperature lower than 8°C.

**Borohemists**, p.156

ACF. Other Hemists that have a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 30 cm below the soil surface.

**Tropohemists**, p.157

ACG. Other Hemists.

**Medihemists**, p.157

## Borohemists

Key to subgroups

ACEA. Borohemists that have a layer of water within the control section below the surface tier.

**Hydric Borohemists**

ACEB. Other Borohemists that have a lithic contact within the control section.

**Lithic Borohemists**

ACEC. Other Borohemists which have *both*:

1. Other Borohemists that have one or more layers, with a total thickness of 25 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Fibric Terric Borohemists**

ACED. Other Borohemists which have *both*:

1. Other Borohemists that have one or more layers, with a total thickness of 25 cm or more, consisting of sapric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Sapric Terric Borohemists**

ACEE. Other Borohemists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Borohemists**

ACEF. Other Borohemists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Borohemists**

ACEG. Other Borohemists that have, within 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 Borohemists**

ACEH. Other Borohemists that have one or more layers, with a total thickness of 25 cm or more, consisting of fibric materials below the surface tier.

**Fibric Borohemists**

ACEI. Other Borohemists that have one or more layers, with a total thickness of 25 cm or more, consisting of sapric materials below the surface tier.

**Sapric Borohemists**

ACEJ. Other Borohemists.

**Typic Borohemists**

## Cryohemists

Key to subgroups

ACDA. Cryohemists that have a lithic contact within the control section.

**Lithic Cryohemists**

ACDB. Other Cryohemists that have a mean annual soil temperature of $0^{o}C$ or lower.

**Pergelic Cryohemists**

ACDC. Other Cryohemists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Cryohemists**

ACDD. Other Cryohemists that have, within 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**

ACDE. Other Cryohemists.

**Typic Cryohemists**

## Luvihemists

Key to subgroups

ACCA. All Luvihemists (provisionally).

**Typic Luvihemists**

## Medihemists

Key to subgroups

ACGA. Medihemists that have a layer of water within the control section below the surface tier.

**Hydric Medihemists**

ACGB. Other Medihemists that have a lithic contact within the control section.

**Lithic Medihemists**

ACGC. Other Medihemists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Fibric Terric Medihemists**

ACGD. Other Medihemists which have *both*:

1, One or more layers, with a total thickness of 25 cm or more, consisting of sapric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Sapric Terric Medihemists**

ACGE. Other Medihemists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Medihemists**

ACGF. Other Medihemists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Medihemists**

ACGG. Other Medihemists that have, within 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 Medihemists**

ACGH. Other Medihemists that have one or more layers, with a total thickness of 25 cm or more, consisting of fibric materials below the surface tier.

**Fibric Medihemists**

ACGI. Other Medihemists that have one or more layers, with a total thickness of 25 cm or more, consisting of sapric materials below the surface tier.

**Sapric Medihemists**

ACGJ. Other Medihemists.

**Typic Medihemists**

## Sulfihemists

Key to subgroups

ACBA. Sulfihemists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Sulfihemists**

ACBB. Other Sulfihemists.

**Typic Sulfihemists**

## Sulfohemists

Key to subgroups

ACAA. All Sulfohemists (provisionally).

**Typic Sulfohemists**

## Tropohemists

Key to subgroups

ACFA. Tropohemists that have a layer of water within the control section below the surface tier.

**Hydric Tropohemists**

ACFB. Other Tropohemists that have a lithic contact within the control section.

**Lithic Tropohemists**

ACFC. Other Tropohemists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary with in the control section below the surface tier.

**Fibric Terric Tropohemists**

ACFD. Other Tropohemists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of sapric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Sapric Terric Tropohemists**

ACFE. Other Tropohemists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Tropohemists**

ACFF. Other Tropohemists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Tropohemists**

ACFG. Other Tropohemists that have, within 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 Tropohemists**

ACFH. Other Tropohemists that have one or more layers, with a total thickness of 25 cm or more, consisting of fibric materials below the surface tier.

**Fibric Tropohemists**

ACFI. Other Tropohemists that have one or more layers, with a total thickness of 25 cm or more, consisting of sapric materials below the surface tier.

**Sapric Tropohemists**

ACFJ. Other Tropohemists.

**Typic Tropohemists**

# Saprists

Key to great groups

ADA. Saprists which have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.

**Sulfosaprists**, p.160

ADB. Other Saprists that have sulfidic materials within 100 cm of the soil surface.

**Sulfisaprists**, p.160

ADC. Other Saprists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

2. Never freeze below a depth of 5 cm from the soil surface but have a mean annual soil temperature lower than 8°C.

**Cryosaprists**, p.159

ADD. Other Saprists that have a mean annual soil temperature lower than 8° C.

**Borosaprists**, p.158

ADE. Other Saprists that have less than 5°C difference between mean summer and mean winter soil temperatures at a depth of 30 cm from the soil surface.

**Troposaprists**, p.160

ADF. Other Saprists.

**Medisaprists**, p. 159

## Borosaprists

Key to subgroups

ADDA. Borosaprists that have a lithic contact within the control section.

**Lithic Borosaprists**

ADDB. Other Borosaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Fibric Terric Borosaprists**

ADDC. Other Borosaprists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Hemic Terric Borosaprists**

ADDD. Other Borosaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Borosaprists**

ADDE. Other Borosaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Borosaprists**

ADDF. Other Borosaprists that have, within 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 Borosaprists**

ADDG. Other Borosaprists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier.

**Fibric Borosaprists**

ADDH. Other Borosaprists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

**Hemic Borosaprists**

ADDI. Other Borosaprists.

**Typic Borosaprists**

## Cryosaprists

Key to subgroups

ADCA. Cryosaprists that have a lithic contact within the control section.

**Lithic Cryosaprists**

ADCB. Other Cryosaprists that have a mean annual soil temperature of $0^{o}C$ or lower.

**Pergelic Cryosaprists**

ADCC. Other Cryosaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Cryosaprists**

ADCD. Other Cryosaprists that have, within 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**

ADCE. Other Cryosaprists.

**Typic Cryosaprists**

## Medisaprists

Key to subgroups

ADFA. Medisaprists that have a lithic contact within the control section.

**Lithic Medisaprists**

ADFB. Other Medisaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Fibric Terric Medisaprists**

ADFC. Other Medisaprists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Hemic Terric Medisaprists**

ADFD. Other Medisaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Medisaprists**

ADFE. Other Medisaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Medisaprists**

ADFF. Other Medisaprists that have, within 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 Medisaprists**

ADFG. Other Medisaprists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier.

**Fibric Medisaprists**

ADFH. Other Medisaprists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

**Hemic Medisaprists**

ADFI. Other Medisaprists.

**Typic Medisaprists**

## Sulfisaprists

Key to subgroups

ADBA. Sulfisaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Sulfisaprists**

ADBB. Other Sulfisaprists.

**Typic Sulfisaprists**

## Sulfosaprists

Key to subgroups

ADAA. All Sulfosaprists (provisionally).

**Typic Sulfosaprists**

## Troposaprists

Key to subgroups

ADEA. Troposaprists that have a lithic contact within the control section.

**Lithic Troposaprists**

ADEB. Other Troposaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Fibric Terric Troposaprists**

ADEC. Other Troposaprists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Hemic Terric Troposaprists**

ADED. Other Troposaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

**Terric Troposaprists**

ADEE. Other Troposaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

**Limnic Troposaprists**

ADEF. Other Troposaprists that have, within 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 Troposaprists**

ADEG. Other Troposaprists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier.

**Fibric Troposaprists**

ADEH. Other Troposaprists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of hemic materials below the surface tier.

**Hemic Troposaprists**

ADEI. Other Troposaprists.

**Typic Troposaprists**

# Chapter 11

# Inceptisols

Key to suborders

JA. Inceptisols which have:

1. In a layer above a lithic or paralithic contact or in a layer between 40 and 50 cm from the mineral soil surface, whichever is shallower, aquic conditions for some time in most 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 mollic, an ochric, or an umbric epipedon that is underlain directly, or within 50 cm of the mineral soil surface, by a horizon that has, on faces of peds or in the matrix if peds are absent, 50 percent or more chroma of *either*:

      (1) Two or less if there are redox concentrations; *or*

      (2) One or less; *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, and 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; *or*

3. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquepts**, p.161

JB. Other Inceptisols that have a plaggen epipedon.

**Plaggepts**, p.177

JC. Other Inceptisols that have an isomesic or a warmer *iso* temperature regime.

**Tropepts**, p.177

JD. Other Inceptisols that have *either*:

1. An ochric epipedon; *or*

2. A mesic or warmer soil temperature regime and an umbric or a mollic epipedon less than 25 cm thick.

**Ochrepts**, p.167

JE. Other Inceptisols.

**Umbrepts**, p.182

## Aquepts

Key to great groups

JAA. Aquepts which have a sulfuric horizon that has its upper boundary within 50 cm of the mineral soil surface.

**Sulfaquepts**, p.166

JAB. Other Aquepts that have, in half or more of each pedon, a placic horizon within 100 cm of the mineral soil surface.

**Placaquepts**, p.166

JAC. Other Aquepts that have, in one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, either 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.165

JAD. Other Aquepts that have a fragipan.

**Fragiaquepts**, p.164

JAE. Other Aquepts that have a cryic or pergelic soil temperature regime.

**Cryaquepts**, p.162

JAF. Other Aquepts 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.

**Plinthaquepts**, p.166

JAG. Other Aquepts that have a difference of less than 5°C between mean summer and mean winter soil temperatures either at a depth of 50 cm from the soil surface, or at a lithic or paralithic contact, whichever is shallower.

**Tropaquepts**, p.166

JAH. Other Aquepts that have a histic, a mollic, or an umbric epipedon.
**Humaquepts, p.165**

JAI. Other Aquepts that have episaturation.
**Epiaquepts, p.164**

JAJ. Other Aquepts.
**Endoaquepts, p.163**

## Cryaquepts

Key to subgroups

JAEA. Cryaquepts which 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 the characteristics of a sulfuric horizon, except that it has a pH between 3.5 and 4.0; *or*

3. Sulfidic materials.
**Sulfic Cryaquepts**

JAEB. Other Cryaquepts that have *both* a histic epipedon *and* a lithic contact within 50 cm of the mineral soil surface.
**Histic Lithic Cryaquepts**

JAEC. Other Cryaquepts that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Cryaquepts**

JAED. Other Cryaquepts which have *both*:

1. A histic epipedon that is continuous in each pedon; *and*

2. A mean annual soil temperature of 0°C or lower.
**Histic Pergelic Cryaquepts**

JAEE. Other Cryaquepts which have *both*:

1. A histic epipedon that is discontinuous in each pedon; *and*

2. A mean annual soil temperature of 0°C or lower.
**Pergelic Ruptic-Histic Cryaquepts**

JAEF. Other Cryaquepts which have *both*:

1. An umbric epipedon; *and*

2. A mean annual soil temperature of 0°C or lower.
**Humic Pergelic Cryaquepts**

JAEG. Other Cryaquepts that have a mean annual soil temperature of 0°C or lower.
**Pergelic Cryaquepts**

JAEH. Other Cryaquepts which 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 most 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 lithic or paralithic contact, whichever is shallower.
**Vertic Cryaquepts**

JAEI. Other Cryaquepts that have a histic epipedon.
**Histic Cryaquepts**

JAEJ. Other Cryaquepts which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
**Aquandic Cryaquepts**

JAEK. Other Cryaquepts that have *both*:

1. A chroma of 3 or more in 40 percent or more of the matrix of one or more horizons between 15 and 50 cm from the mineral soil surface; *and*

2. An umbric epipedon.

**Aeric Humic Cryaquepts**

JAEL. Other Cryaquepts that have a chroma of 3 or more in 40 percent or more of the matrix of one or more horizons between 15 and 50 cm from the mineral soil surface.

**Aeric Cryaquepts**

JAEM. Other Cryaquepts that have an umbric epipedon.

**Humic Cryaquepts**

JAEN. Other Cryaquepts.

**Typic Cryaquepts**

## Endoaquepts

Key to subgroups

JAJA. Endoaquepts which 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 the characteristics of a sulfuric horizon, except that it has a pH between 3.5 and 4.0; *or*

3. Sulfidic materials.

**Sulfic Endoaquepts**

JAJB. Other Endoaquepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Endoaquepts**

JAJC. Other Endoaquepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Endoaquepts**

JAJD. 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/$cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Endoaquepts**

JAJE. 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. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

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

   b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

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

   a. Both a color value, moist, and chroma of 3 or more; *or*

   b. A chroma of 2 or more if there are no redox concentrations.

**Aeric Endoaquepts**

JAJF. Other Endoaquepts which have:

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* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by $NH_4OAc$) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

**Humic Endoaquepts**

JAJG. Other Endoaquepts which 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* the upper soil to a depth of 15 cm, after mixing, has these colors.

**Mollic Endoaquepts**

JAJH. Other Endoaquepts.

**Typic Endoaquepts**

## Epiaquepts

Key to subgroups

JAIA. Epiaquepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Epiaquepts**

JAIB. 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. A hue of 7.5YR or redder in 50 percent or more of the matrix, *and*

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

   b. If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

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

   a. Both a color value, moist, and chroma of 3 or more; *or*

   b. A chroma of 2 or more if there are no redox concentrations.

**Aeric Epiaquepts**

JAIC. Other Epiaquepts which 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* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by $NH_4OAc$) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

**Humic Epiaquepts**

JAID. Other Epiaquepts which 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* the upper soil to a depth of 15 cm, after mixing, has these colors.

**Mollic Epiaquepts**

JAIE. Other Epiaquepts.

**Typic Epiaquepts**

## Fragiaquepts

Key to subgroups

JADA. 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 15 and 75 cm depth, a chroma of *either*

1. Three or more; *or*

2. Two or more if there are no redox concentrations.

**Aeric Fragiaquepts**

JADB. Other Fragiaquepts that have a histic, a mollic, or an umbric epipedon.

**Humic Fragiaquepts**

JADC. Other Fragiaquepts.

**Typic Fragiaquepts**

## Halaquepts

Key to subgroups

JACA. Halaquepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Halaquepts**

JACB. Other Halaquepts which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Halaquepts**

JACC. Other Halaquepts that have a chroma of 3 or more in 40 percent or more of the matrix of one or more horizons between 15 and 75 cm from the mineral soil surface.

**Aeric Halaquepts**

JACD. Other Halaquepts that have a mollic epipedon.

**Mollic Halaquepts**

JACE. Other Halaquepts.

**Typic Halaquepts**

## Humaquepts

Key to subgroups

JAHA. Humaquepts that have an $n$ value *either* of 0.7 in one or more layers between 20 and 50 cm from the mineral soil surface, *or* of 0.9 or more in one or more layers between 50 and 80 cm.

**Hydraquentic Humaquepts**

JAHB. Other Humaquepts which have a histic epipedon.

**Histic Humaquepts**

JAHC. Other Humaquepts which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Humaquepts**

JAHD. Other Humaquepts which have *both*:

1. An epipedon 60 cm or more thick; *and*

2. *Either* 0.2 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 lithic or paralithic contact if shallower.

**Cumulic Humaquepts**

JAHE. Other Humaquepts that have *either* 0.2 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 lithic or paralithic contact if shallower.

**Fluvaquentic Humaquepts**

JAHF. Other Humaquepts that have a hue of 5Y or redder and a chroma of 3 or more in more than 40 percent of the matrix of one or more subhorizons between 15 and 75 cm from the mineral soil surface.

**Aeric Humaquepts**

JAHG. Other Humaquepts.

**Typic Humaquepts**

## Placaquepts

Key to subgroups

JABA. Placaquepts that have a histic epipedon.

**Histic Placaquepts**

JABB. Other Placaquepts which 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 aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Placaquepts**

JABC. Other Placaquepts that do not, within 100 cm of the mineral soil surface, have a continuous placic horizon in each pedon.

**Haplic Placaquepts**

JABD. Other Placaquepts.

**Typic Placaquepts**

## Plinthaquepts

Key to subgroups

JAFA. All Plinthaquepts (provisionally).

**Typic Plinthaquepts**

## Sulfaquepts

Key to subgroups

JAAA. Sulfaquepts that have a salic horizon within 75 cm of the mineral soil surface.

**Salidic Sulfaquepts**

JAAB. Other Sulfaquepts that have *both*:

1. An *n* value of more than 0.7; *and*

2. Eight percent or more clay in the fine-earth fraction of all horizons between 20 and 50 cm from the mineral soil surface.

**Hydraquentic Sulfaquepts**

JAAC. Other Sulfaquepts.

**Typic Sulfaquepts**

## Tropaquepts

Key to subgroups

JAGA. Tropaquepts which 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 the characteristics of a sulfuric horizon, except that it has a pH between 3.5 and 4.0; *or*

3. Sulfidic materials.

**Sulfic Tropaquepts**

JAGB. Other Tropaquepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Tropaquepts**

JAGC. Other Tropaquepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Tropaquepts**

JAGD. Other Tropaquepts that have a histic epipedon.

**Histic Tropaquepts**

JAGE. Other Tropaquepts which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Tropaquepts**

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

**Plinthic Tropaquepts**

JAGG. Other Tropaquepts that have, in 50 percent or more of the matrix of 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 as follows:

1. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A chroma of 2 or more if there are no redox concentrations.

**Aeric Tropaquepts**

JAGH. Other Tropaquepts.

**Typic Tropaquepts**

## Ochrepts

<u>Key to great groups</u>

JDA. Ochrepts that have a sulfuric horizon within 50 cm of the mineral soil surface.

**Sulfochrepts,** p.172

JDB. Other Ochrepts that have a fragipan.

**Fragiochrepts,** p.172

JDC. Other Ochrepts which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

**Durochrepts,** p.168

JDD. Other Ochrepts that have a cryic or pergelic soil temperature regime.

**Cryochrepts,** p.168

JDE. Other Ochrepts that have an ustic moisture regime.

**Ustochrepts,** p.172

JDF. Other Ochrepts that have a xeric moisture regime.

**Xerochrepts,** p.176

JDG. Other Ochrepts that have *one or both* of the following:

1. Carbonates within the soil; *or*

2. A base saturation (by $NH_4OAc$) of 60 percent or more in one or more horizons between 25 and 75 cm from the mineral soil surface.

**Eutrochrepts,** p.171

JDH. Other Ochrepts.

**Dystrochrepts,** p.169

## Cryochrepts

Key to subgroups

JDDA. Cryochrepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Cryochrepts**

JDDB. Other Cryochrepts that have a mean annual soil temperature of $0^{o}C$ or lower.

**Pergelic Cryochrepts**

JDDC. Other Cryochrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Cryochrepts**

JDDD. Other Cryochrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Cryochrepts**

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

**Aquic Cryochrepts**

JDDF. Other Cryochrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Cryochrepts**

JDDG. Other Cryochrepts which have lamellae within 75 cm of the mineral soil surface that meet all the requirements for an argillic horizon except thickness.

**Alfic Cryochrepts**

JDDH. Other Cryochrepts that have a base saturation (by $NH_4OAc$) of less than 60 percent in all horizons within 75 cm of the mineral soil surface.

**Dystric Cryochrepts**

JDDI. Other Cryochrepts.

**Typic Cryochrepts**

## Durochrepts

Key to subgroups

JDCA. Durochrepts which have *both*:

1. 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 most 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Durochrepts**

JDCB. Other Durochrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Durochrepts**

JDCC. Other Durochrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Durochrepts**

JDCD. Other Durochrepts 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 most years (or artificial drainage).

**Aquic Durochrepts**

JDCE. Other Durochrepts that do not have a xeric moisture regime.

**Ustic Durochrepts**

JDCF. Other Durochrepts which have *both*:

1. A duripan that is not indurated in any subhorizon; *and*

2. A base saturation (by $NH_4OAc$) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

**Dystric Entic Durochrepts**

JDCG. Other Durochrepts which have a duripan that is not indurated in any subhorizon.

**Entic Durochrepts**

JDCH. Other Durochrepts that have a base saturation (by $NH_4OAc$) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

**Dystric Durochrepts**

JDCI. Other Durochrepts.

**Typic Durochrepts**

## Dystrochrepts

Key to subgroups

JDHA. Dystrochrepts that have:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon in less than half of each pedon; *and*

3. A base saturation (by sum of cations) of 35 percent or more in the horizon directly above the lithic contact.

**Lithic Ruptic-Alfic Dystrochrepts**

JDHB. Other Dystrochrepts that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon in less than half of each pedon.

**Lithic Ruptic-Ultic Dystrochrepts**

JDHC. Other Dystrochrepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Dystrochrepts**

JDHD. Other Dystrochrepts which have *both*:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

(2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
**Aquandic Dystrochrepts**

JDHE. Other Dystrochrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.
**Andic Dystrochrepts**

JDHF. Other Dystrochrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
**Vitrandic Dystrochrepts**

JDHG. Other Dystrochrepts which have:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.
**Fluvaquentic Dystrochrepts**

JDHH. Other Dystrochrepts that have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Dystrochrepts**

JDHI. Other Dystrochrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Dystrochrepts**

JDHJ. Other Dystrochrepts which have:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent; *and*

3. 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 which have these color values after mixing.
**Fluventic Umbric Dystrochrepts**

JDHK. Other Dystrochrepts which have *both*:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.
**Fluventic Dystrochrepts**

JDHL. Other Dystrochrepts 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 which have these color values after mixing.
**Umbric Dystrochrepts**

JDHM. Other Dystrochrepts that have *both*:

1. An argillic horizon in less than half of each pedon; *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 argillic horizon, or directly above a lithic or paralithic contact if shallower.
**Ruptic-Alfic Dystrochrepts**

JDHN. Other Dystrochrepts that have an argillic horizon in less than half of each pedon.
**Ruptic-Ultic Dystrochrepts**

JDHO. Other Dystrochrepts.

**Typic Dystrochrepts**

## Eutrochrepts

Key to subgroups

JDGA. Eutrochrepts that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon in less than half of each pedon.

**Lithic Ruptic-Alfic Eutrochrepts**

JDGB. Other Eutrochrepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Eutrochrepts**

JDGC. Other Eutrochrepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Eutrochrepts**

JDGD. Other Eutrochrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Eutrochrepts**

JDGE. Other Eutrochrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Eutrochrepts**

JDGF. Other Eutrochrepts that have anthraquic conditions.

**Anthraquic Eutrochrepts**

JDGG. Other Eutrochrepts that have:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Fluvaquentic Eutrochrepts**

JDGH. Other Eutrochrepts which:

1. Have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface.

**Aquic Dystric Eutrochrepts**

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

**Aquic Eutrochrepts**

JDGJ. Other Eutrochrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Eutrochrepts**

JDGK. Other Eutrochrepts which:

1. Do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface; *and*

2. Have *either* 0.2 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 lithic or paralithic contact if shallower; *and*

3. Have a slope of less than 25 percent.

**Dystric Fluventic Eutrochrepts**

JDGL. Other Eutrochrepts which have *both*:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Eutrochrepts**

JDGM. Other Eutrochrepts that have a sandy particle size in all horizons within 50 cm of the mineral soil surface.

**Arenic Eutrochrepts**

JDGN. Other Eutrochrepts that do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface.

**Dystric Eutrochrepts**

JDGO. Other Eutrochrepts that have 40 percent or more carbonates, including coarse fragments up to 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 lithic or paralithic contact if shallower.

**Rendollic Eutrochrepts**

JDGP. Other Eutrochrepts that have an argillic horizon in less than half of each pedon.

**Ruptic-Alfic Eutrochrepts**

JDGQ. Other Eutrochrepts.

**Typic Eutrochrepts**

## Fragiochrepts

Key to subgroups

JDBA. Fragiochrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Fragiochrepts**

JDBB. Other Fragiochrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Fragiochrepts**

JDBC. Other Fragiochrepts 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 most years (or artificial drainage).

**Aquic Fragiochrepts**

JDBD. Other Fragiochrepts that do not have an ochric epipedon.

**Umbric Fragiochrepts**

JDBE. Other Fragiochrepts.

**Typic Fragiochrepts**

## Sulfochrepts

Key to subgroups

JDAA. All Sulfochrepts (provisionally).

**Typic Sulfochrepts**

## Ustochrepts

Key to subgroups

JDEA. Ustochrepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Ustochrepts**

JDEB. Other Ustochrepts which have *both*:

1. If neither irrigated nor fallowed to store moisture, *one* of the following:

   a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $5^{o}C$; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $5^{o}C$; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $8^{o}C$; *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 most 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 lithic or paralithic contact, whichever is shallower.

**Udertic Ustochrepts**

JDEC. Other Ustochrepts which have *both*:

1. If neither irrigated nor fallowed to store moisture, *one* of the following:

   a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $5^{o}C$; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $5^{o}C$; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $8^{o}C$; *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 most 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 lithic or paralithic contact, whichever is shallower.

**Torrertic Ustochrepts**

JDED. Other Ustochrepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Ustochrepts**

JDEE. Other Ustochrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Ustochrepts**

JDEF. Other Ustochrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Ustochrepts**

JDEG. Other Ustochrepts that have anthraquic conditions.

**Anthraquic Ustochrepts**

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

**Aquic Ustochrepts**

JDEI. Other Ustochrepts which have:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent; *and*

3. If neither irrigated nor fallowed to store moisture, *one* of the following:

   a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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$^{o}$C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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$^{o}$C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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$^{o}$C.

**Torrifluventic Ustochrepts**

JDEJ. Other Ustochrepts which have:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent; *and*

3. If neither irrigated nor fallowed to store moisture, *one* of the following:

   a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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$^{o}$C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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$^{o}$C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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$^{o}$C.

**Udifluventic Ustochrepts**

JDEK. Other Ustochrepts which have *both*:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Ustochrepts**

JDEL. Other Ustochrepts which have *both*:

1. A calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. If neither irrigated nor fallowed to store moisture, *one* of the following:

   a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.

**Haplocalcidic Ustochrepts**

JDEM. Other Ustochrepts which have *both*:

1. A calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. If neither irrigated nor fallowed to store moisture, *one* of the following:

a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Ustochrepts**

JDEN. Other Ustochrepts which have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Calcic Ustochrepts**

JDEO. Other Ustochrepts which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Ustochrepts**

JDEP. Other Ustochrepts that have a base saturation (by sum of cations) of less than 60 percent in all 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 lithic or paralithic contact, whichever is shallower.

**Dystric Ustochrepts**

JDEQ. Other Ustochrepts which, if neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Ustochrepts**

JDER. Other Ustochrepts.

**Typic Ustochrepts**

## Xerochrepts

Key to subgroups

JDFA. Xerochrepts that have a lithic contact within 50 cm of the mineral soil surface in less than half of each pedon.

**Ruptic-Lithic Xerochrepts**

JDFB. Other Xerochrepts that have *both*:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A base saturation (by $NH_4OAc$) of less than 60 percent in all horizons between 25 cm from the mineral soil surface and the lithic contact.

**Dystric Lithic Xerochrepts**

JDFC. Other Xerochrepts that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. A discontinuous cambic horizon in each pedon.

**Lithic Ruptic-Xerorthentic Xerochrepts**

JDFD. Other Xerochrepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Xerochrepts**

JDFE. Other Xerochrepts that have a petrocalcic horizon within 100 cm of the mineral soil surface.

**Petrocalcic Xerochrepts**

JDFF. Other Xerochrepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Xerochrepts**

JDFG. Other Xerochrepts which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Xerochrepts**

JDFH. Other Xerochrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Xerochrepts**

JDFI. Other Xerochrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
**Vitrandic Xerochrepts**

JDFJ. Other Xerochrepts that have a gypsic horizon within 100 cm of the mineral soil surface.
**Gypsic Xerochrepts**

JDFK. Other Xerochrepts that have *both*:

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

2. A base saturation (by $NH_4OAc$) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.
**Aquic Dystric Xerochrepts**

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

JDFM. Other Xerochrepts which have:

1. A base saturation (by $NH_4OAc$) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface; *and*

2. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.
**Dystric Fluventic Xerochrepts**

JDFN. Other Xerochrepts which have *both*:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.
**Fluventic Xerochrepts**

JDFO. Other Xerochrepts that have a base saturation (by $NH_4OAc$) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.
**Dystric Xerochrepts**

JDFP. Other Xerochrepts that have a calcic horizon or identifiable secondary carbonates, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

1. Sandy: within 150 cm of the mineral soil surface; *or*

2. Loamy: within 110 cm of the mineral soil surface; *or*

3. Clayey: within 90 cm of the mineral soil surface.
**Calcixerollic Xerochrepts**

JDFQ. Other Xerochrepts.
**Typic Xerochrepts**

## Plaggepts

Key to subgroups

JBA. All Plaggepts (provisionally).
**Typic Plaggepts**

## Tropepts

Key to great groups

JCA. Tropepts which:

1. Have a base saturation of less than 50 percent (by $NH_4OAc$) in one or more horizons between 25 and 100 cm from the mineral soil surface; *and*

2. Have 12 $kg/m^2$ or more organic carbon between the mineral soil surface and either a depth of 100 cm or a lithic, paralithic, or petroferric contact, whichever is shallower; *and*

3. Do not have a sombric horizon.
**Humitropepts, p.180**

JCB. Other Tropepts that have a sombric horizon.
**Sombritropepts, p.181**

JCC. Other Tropepts that have *both*:

1. An ustic moisture regime; *and*

2. A base saturation (by $NH_4OAc$) of 50 percent or more in all horizons between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a lithic, paralithic, or petroferric contact if shallower.

**Ustropepts**, p.181

JCD. Other Tropepts that have a base saturation (by $NH_4OAc$) of 50 percent or more in all horizons between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a lithic, paralithic, or petroferric contact if shallower.

**Eutropepts**, p.179

JCE. Other Tropepts.

**Dystropepts**, p.178

## Dystropepts

Key to subgroups

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

**Lithic Dystropepts**

JCEB. Other Dystropepts that have a petroferric contact within 50 cm of the mineral soil surface.

**Petroferric Dystropepts**

JCEC. Other Dystropepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Dystropepts**

JCED. Other Dystropepts 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 Dystropepts**

JCEE. Other Dystropepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Dystropepts**

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

**Aquic Dystropepts**

JCEG. Other Dystropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Dystropepts**

JCEH. Other Dystropepts which have *both*:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Dystropepts**

JCEI. Other Dystropepts that have *both*:

1. An ustic moisture regime; *and*

2. A CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[1] 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 lithic or paralithic contact if shallower.
**Ustoxic Dystropepts**

JCEJ. Other Dystropepts that have a CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[2] 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 lithic or paralithic contact if shallower.
**Oxic Dystropepts**

JCEK. Other Dystropepts that have an ustic moisture regime.
**Ustic Dystropepts**

JCEL. Other Dystropepts.
**Typic Dystropepts**

## Eutropepts

Key to subgroups

JCDA. Eutropepts that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Eutropepts**

JCDB. Other Eutropepts which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquertic Eutropepts**

JCDC. Other Eutropepts which 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 most 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 lithic or paralithic contact, whichever is shallower.
**Vertic Eutropepts**

JCDD. Other Eutropepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.
**Andic Eutropepts**

JCDE. Other Eutropepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

    b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
**Vitrandic Eutropepts**

JCDF. Other Eutropepts that have:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

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[1] Some cambic horizons with properties that approach those of an oxic horizon do not disperse well. If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay in the fine-earth fraction is 0.6 or more, then the percentage of clay is considered to equal either (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but not more than 100.

[2] See footnote 1.

2. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Fluvaquentic Eutropepts**

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

**Aquic Eutropepts**

JCDH. Other Eutropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Eutropepts**

JCDI. Other Eutropepts which have *both*:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Eutropepts**

JCDJ. Other Eutropepts.

**Typic Eutropepts**

## Humitropepts

Key to subgroups

JCAA. Humitropepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Humitropepts**

JCAB. Other Humitropepts which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquertic Humitropepts**

JCAC. Other Humitropepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Humitropepts**

JCAD. Other Humitropepts 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Ustandic Humitropepts**

JCAE. Other Humitropepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Humitropepts**

JCAF. Other Humitropepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Humitropepts**

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

**Aquic Humitropepts**

JCAH. Other Humitropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Humitropepts**

JCAI. Other Humitropepts which have *both*:

1. An organic-carbon content that decreases irregularly with increasing depth to the lower boundary of the cambic horizon; *and*

2. A slope of less than 25 percent.

**Fluventic Humitropepts**

JCAJ. Other Humitropepts that have *both*:

1. An ustic moisture regime; *and*

2. A CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[3] 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 lithic or paralithic contact if shallower.

**Ustoxic Humitropepts**

JCAK. Other Humitropepts that have a CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[4] 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 lithic or paralithic contact if shallower.

**Oxic Humitropepts**

JCAL. Other Humitropepts that have an ustic moisture regime.

**Ustic Humitropepts**

JCAM. Other Humitropepts.

**Typic Humitropepts**

## Sombritropepts

Key to subgroups

JBCA. All Sombritropepts (provisionally).

**Typic Sombritropepts**

## Ustropepts

Key to subgroups

JCCA. Ustropepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Ustropepts**

JCCB. Other Ustropepts which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Ustropepts**

[3] Some cambic horizons with properties that approach those of an oxic horizon do not disperse well. If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay in the fine-earth fraction is 0.6 or more, then the percentage of clay is considered to equal either (1) the measured percentage of clay, or (2) thre times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

[4] See footnote 3.

INC

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

**Aquic Ustropepts**

JCCD. Other Ustropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Ustropepts**

JCCE. Other Ustropepts that have a CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[5] 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 lithic or paralithic contact if shallower.

**Oxic Ustropepts**

JCCF. Other Ustropepts which have *both*:

1. *Either* 0.2 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Ustropepts**

JCCG. Other Ustropepts.

**Typic Ustropepts**

## Umbrepts

Key to great groups

JEA. Umbrepts that have a fragipan.

**Fragiumbrepts, p.183**

JEB. Other Umbrepts that have a cryic or pergelic soil temperature regime.

**Cryumbrepts, p.182**

JEC. Other Umbrepts that have a xeric moisture regime.

**Xerumbrepts, p.184**

JED. Other Umbrepts.

**Haplumbrepts, p.183**

[5] See footnote 3.

## Cryumbrepts

Key to subgroups

JEBA. Cryumbrepts that have a lithic contact within 50 cm of the mineral soil surface in less than half of each pedon.

**Ruptic-Lithic Cryumbrepts**

JEBB. Other Cryumbrepts which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An umbric epipedon that is discontinuous in each pedon.

**Lithic Ruptic-Entic Cryumbrepts**

JEBC. Other Cryumbrepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Cryumbrepts**

JEBD. Other Cryumbrepts that have a mean annual soil temperature of 0°C or lower.

**Pergelic Cryumbrepts**

JEBE. Other Cryumbrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Cryumbrepts**

JEBF. Other Cryumbrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Cryumbrepts**

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

**Aquic Cryumbrepts**

JEBH. Other Cryumbrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Cryumbrepts**

JEBI. Other Cryumbrepts that do not have a cambic horizon.

**Entic Cryumbrepts**

JEBJ. Other Cryumbrepts.

**Typic Cryumbrepts**

## Fragiumbrepts

Key to subgroups

JEAA. Fragiumbrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Fragiumbrepts**

JEAB. Other Fragiumbrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Fragiumbrepts**

JEAC. Other Fragiumbrepts that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Fragiumbrepts**

JEAD. Other Fragiumbrepts.

**Typic Fragiumbrepts**

## Haplumbrepts

Key to subgroups

JEDA. Haplumbrepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haplumbrepts**

JEDB. Other Haplumbrepts that have *both*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, one or more of the following:

   a. A fine-earth fraction with both a bulk density of 1.0 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Haplumbrepts**

JEDC. Other Haplumbrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Haplumbrepts**

INC

JEDD. Other Haplumbrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Haplumbrepts**

JEDE. Other Haplumbrepts that have, in all horizons within 100 cm of the mineral soil surface, *both*:

1. A sandy particle size; *and*

2. More than 90 percent silica and other extremely durable minerals in the 0.02-to-2.0-mm fraction.

**Quartzipsammentic Haplumbrepts**

JEDF. Other Haplumbrepts that have a sandy particle size in all horizons within 100 cm of the mineral soil surface.

**Psammentic Haplumbrepts**

JEDG. Other Haplumbrepts which have:

1. An umbric or a mollic epipedon that is 50 cm or more thick; *and*

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; *and*

3. A slope of less than 25 percent.

**Cumulic Haplumbrepts**

JEDH. Other Haplumbrepts that have an umbric or a mollic epipedon that is 50 cm or more thick.

**Pachic Haplumbrepts**

JEDI. Other Haplumbrepts that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Haplumbrepts**

JEDJ. Other Haplumbrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Haplumbrepts**

JEDK. Other Haplumbrepts which have *both*:

1. 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; *and*

2. A slope of less 25 percent.

**Fluventic Haplumbrepts**

JEDL. Other Haplumbrepts that do not have a cambic horizon.

**Entic Haplumbrepts**

JEDM. Other Haplumbrepts.

**Typic Haplumbrepts**

## Xerumbrepts

Key to subgroups

JECA. Xerumbrepts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Xerumbrepts**

JECB. Other Xerumbrepts 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Xerumbrepts**

JECC. Other Xerumbrepts 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Xerumbrepts**

JECD. Other Xerumbrepts that have an umbric or a mollic epipedon that is 50 cm or more thick.

**Pachic Xerumbrepts**

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

**Aquic Xerumbrepts**

JECF. Other Xerumbrepts which have *both*:

1. 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; *and*

2. A slope of less than 25 percent.

**Fluventic Xerumbrepts**

JECG. Other Xerumbrepts that do not have a cambic horizon.

**Entic Xerumbrepts**

JECH. Other Xerumbrepts.

**Typic Xerumbrepts**

# Chapter 12

# Mollisols

Key to suborders

HA. Mollisols that have:

1. An argillic or a natric horizon; *and*

2. An albic horizon with a chroma of 2 or less that 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 the requirements for a mollic epipedon; *and*

3. In one or more subhorizons of the albic and/or 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 most years (or artificial drainage).

**Albolls**, p.188

HB. Other Mollisols that have in a layer above a lithic or paralithic contact or in a layer between 40 and 50 cm from the mineral soil surface, whichever is shallower, aquic conditions for some time in most 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. *One* of the following colors:

   a. 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*

      (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) Fifty percent or more chroma of 1 on faces of peds or in the matrix, a hue of 10YR or redder, and redox concentrations; *or*

         (b) Fifty percent or more chroma of 2 or less on faces of peds or in the matrix, a hue of 2.5Y, and redox concentrations; *or*

         (c) Fifty percent or more chroma of 1 on faces of peds or in the matrix, and a hue of 2.5Y or yellower; *or*

         (d) Fifty percent or more chroma of 3 or less on faces of peds or in the matrix, a hue of 5Y, and redox concentrations; *or*

         (e) Fifty percent or more chroma of 0 on faces of peds or in the matrix; *or*

         (f) A hue of 5GY, 5G, 5BG, or 5B; *or*

         (g) Any color if it results from uncoated sand grains; *or*

   b. A 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, a chroma of 2, and some redox depletions with a color value, moist, of 4 or more and a chroma of 1 or less; *or*

         (b) A color value, moist, of 5 or more, a chroma of 2 or less, and redox concentrations; *or*

         (c) A color value, moist, of 4 and a chroma of 1 or less; *or*

5. Between 40 and 50 cm from the mineral soil surface, enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquolls**, p.189

[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.

M
O
L

HC. Other Mollisols which:

1. Have a mollic epipedon less than 50 cm thick; *and*

2. Do not have an argillic or a 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 $CaCO_3$ equivalent of 40 percent or more; *and*

4. Have either a udic moisture regime or a cryic soil temperature regime.

**Rendolls**, p.203

HD. Other Mollisols that have either a xeric moisture regime or an aridic moisture regime bordering on a xeric regime, but do not have a cryic soil temperature regime.

**Xerolls**, p.220

HE. Other Mollisols that have a frigid, cryic, or pergelic soil temperature regime.

**Borolls**, p.193

HF. Other Mollisols that have either an ustic moisture regime, or an aridic moisture regime that borders on an ustic regime.

**Ustolls**, p.209

HG. Other Mollisols.

**Udolls**, p.204

## Albolls

Key to great groups

HAA. Albolls that have a natric horizon.

**Natralbolls**, p.189

HAB. Other Albolls.

**Argialbolls**, p.188

## Argialbolls

Key to subgroups

HABA. Argialbolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If not irrigated, a moisture control section which, in 6 or more out of 10 years, is dry in all parts for 45 or more consecutive days during the 120 days following the summer solstice.

**Xerertic Argialbolls**

HABB. Other Argialbolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Argialbolls**

HABC. Other Argialbolls which:

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 which, in 6 or more out of 10 years, is dry in all parts for 45 or more consecutive days during the 120 days following the summer solstice.

**Argiaquic Xeric Argialbolls**

HABD. Other Argialbolls that do not have an abrupt textural change from the albic to the argillic horizon.

**Argiaquic Argialbolls**

HABE. Other Argialbolls which, if not irrigated, have a moisture control section which, in 6 or more out of 10 years, is dry in all parts for 45 or more consecutive days during the 120 days following the summer solstice.

**Xeric Argialbolls**

HABF. Other Argialbolls which 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/$cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Argialbolls**

HABG. Other Argialbolls.

**Typic Argialbolls**

## Natralbolls

Key to subgroups

HAAA. All Natralbolls (provisionally).

**Typic Natralbolls**

## Aquolls

Key to great groups

HBA. Aquolls that have a cryic or pergelic soil temperature regime.

**Cryaquolls**, p.190

HBB. Other Aquolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

**Duraquolls**, p.190

HBC. Other Aquolls that have a natric horizon.

**Natraquolls**, p.193

HBD. Other Aquolls which 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.190

HBE. Other Aquolls that have an argillic horizon.

**Argiaquolls**, p.189

HBF. Other Aquolls that have episaturation.

**Epiaquolls**, p.192

HBG. Other Aquolls.

**Endoaquolls**, p.191

## Argiaquolls

Key to subgroups

HBEA. Argiaquolls that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm to 100 cm.

**Arenic Argiaquolls**

HBEB. Other Argiaquolls that have a sandy particle size 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**

HBEC. Other Argiaquolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Argiaquolls**

HBED. Other Argiaquolls which have an argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

**Abruptic Argiaquolls**

MOL

HBEE. Other Argiaquolls.

**Typic Argiaquolls**

## Calciaquolls

Key to subgroups

HBDA. Calciaquolls which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Petrocalcic Calciaquolls**

HBDB. 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 have, directly below the mollic epipedon, colors as follows:

1. A hue of 2.5Y or yellower and a chroma of 3 or more; *or*

2. A hue of 10YR or redder and a chroma of 2 or more; *or*

3. A hue of 2.5Y or yellower and a chroma of 2 or more if there are no distinct or prominent redox concentrations.

**Aeric Calciaquolls**

HBDC. Other Calciaquolls.

**Typic Calciaquolls**

## Cryaquolls

Key to subgroups

HBAA. Cryaquolls that have a mean annual soil temperature of 0°C or lower.

**Pergelic Cryaquolls**

HBAB. Other Cryaquolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Cryaquolls**

HBAC. Other Cryaquolls that have a histic epipedon.

**Histic Cryaquolls**

HBAD. Other Cryaquolls which have a buried Histosol that has its upper boundary within 100 cm of the mineral soil surface.

**Thapto-Histic Cryaquolls**

HBAE. Other Cryaquolls which 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Cryaquolls**

HBAF. Other Cryaquolls that have an argillic horizon.

**Argic Cryaquolls**

HBAG. Other Cryaquolls that have a calcic horizon either within or directly below the mollic epipedon.

**Calcic Cryaquolls**

HBAH. Other Cryaquolls that have a mollic epipedon 50 cm or more thick.

**Cumulic Cryaquolls**

HBAI. Other Cryaquolls.

**Typic Cryaquolls**

## Duraquolls

Key to subgroups

HBBA. Duraquolls that have a natric horizon.

**Natric Duraquolls**

HBBB. Other Duraquolls which 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 most 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**

HBBC. Other Duraquolls that have an argillic horizon.

**Argic Duraquolls**

HBBD. Other Duraquolls.

**Typic Duraquolls**

## Endoaquolls

Key to subgroups

HBGA. Endoaquolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Endoaquolls**

HBGB. Other Endoaquolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. A mollic epipedon 60 cm or more thick.

**Cumulic Vertic Endoaquolls**

HBGC. Other Endoaquolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Fluvaquentic Vertic Endoaquolls**

HBGD. Other Endoaquolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Endoaquolls**

HBGE. Other Endoaquolls that have a histic epipedon.

**Histic Endoaquolls**

HBGF. Other Endoaquolls which have a buried Histosol that has its upper boundary within 100 cm of the mineral soil surface.

**Thapto-Histic Endoaquolls**

HBGG. Other Endoaquolls 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Endoaquolls**

HBGH. Other Endoaquolls which have a horizon 15 cm or more thick within 100 cm of the mineral soil surface that either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Duric Endoaquolls**

HBGI. Other Endoaquolls that have a mollic epipedon 60 cm or more thick.

**Cumulic Endoaquolls**

HBGJ. Other Endoaquolls which have *both*:

1. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluvaquentic Endoaquolls**

HBGK. Other Endoaquolls.

**Typic Endoaquolls**

## Epiaquolls

Key to subgroups

HBFA. 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. A mollic epipedon 60 cm or more thick.

**Cumulic Vertic Epiaquolls**

HBFB. Other Epiaquolls 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Fluvaquentic Vertic Epiaquolls**

HBFC. 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Epiaquolls**

HBFD. Other Epiaquolls that have a histic epipedon.

**Histic Epiaquolls**

HBFE. Other Epiaquolls which have a buried Histosol that has its upper boundary within 100 cm of the mineral soil surface.

**Thapto-Histic Epiaquolls**

HBFF. 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/ $cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Epiaquolls**

HBFG. Other Epiaquolls which have a horizon 15 cm or more thick within 100 cm of the mineral soil surface that either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Duric Epiaquolls**

HBFH. Other Epiaquolls that have a mollic epipedon 60 cm or more thick.

**Cumulic Epiaquolls**

HBFI. Other Epiaquolls which have:

1. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluvaquentic Epiaquolls**

HBFJ. Other Epiaquolls.

**Typic Epiaquolls**

## Natraquolls

Key to subgroups

HBCA. Natraquolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Natraquolls**

HBCB. Other Natraquolls (provisionally).

**Typic Natraquolls**

## Borolls

Key to great groups

HEA. Borolls which 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.

**Paleborolls**, p.202

HEB. Other Borolls that have a cryic or pergelic soil temperature regime.

**Cryoborolls**, p.197

HEC. Other Borolls which have a natric horizon, but do not have a cambic horizon that is above the natric horizon and separated from it by an albic horizon.

**Natriborolls**, p.202

HED. Other Borolls which have an argillic horizon, but do not have a cambic horizon that is above the argillic horizon and separated from it by an albic horizon.

**Argiborolls**, p.194

HEE. Other Borolls that have a mollic epipedon which:

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, worm casts, 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, worm

casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.

**Vermiborolls, p.203**

HEF. Other Borolls which:

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, are either calcareous or have a texture of loamy fine sand or coarser.

**Calciborolls, p.196**

HEG. Other Borolls.

**Haploborolls, p.199**

## Argiborolls

Key to subgroups

HEDA. Argiborolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Argiborolls**

HEDB. Other Argiborolls that have a sandy particle size 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 Argiborolls**

HEDC. Other Argiborolls which have:

1. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm; *and*

2. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

3. A moisture control section which, in 6 or more out of 10 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.

**Paleargidic Argiborolls**

HEDD. Other Argiborolls which have *both*:

1. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm; *and*

2. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

**Abruptic Udic Argiborolls**

HEDE. Other Argiborolls which have an argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

**Abruptic Argiborolls**

HDEF. Other Argiborolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquertic Argiborolls**

HEDG. Other Argiborolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. *Both* of the following:

    a. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

b. If not irrigated, a moisture control section which, in 6 or more out of 10 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 from the soil surface is 5°C or higher.

**Torrertic Argiborolls**

HEDH. Other Argiborolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. *Both* of the following:

   a. A color value, dry, of 5 or more in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

   b. If not irrigated, a moisture control section which, in 6 or more out of 10 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 from the soil surface is 5°C or higher.

**Ustertic Argiborolls**

HEDI. Other Argiborolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Argiborolls**

HEDJ. Other Argiborolls 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Argiborolls**

HEDK. Other Argiborolls 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Argiborolls**

HEDL. Other Argiborolls which have *both*:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*

2. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

**Pachic Udic Argiborolls**

HEDM. Other Argiborolls that have a mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand.

**Pachic Argiborolls**

HEDN. Other Argiborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 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.

**Aridic Argiborolls**

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

**Aquic Argiborolls**

HEDP. Other Argiborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Argiborolls**

HEDQ. Other Argiborolls which have *both*:

1. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years; *and*

2. *Either*:

   a. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

   b. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

**Boralfic Udic Argiborolls**

HEDR. Other Argiborolls which have *either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a 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* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

**Boralfic Argiborolls**

HEDS. Other Argiborolls that have *either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

**Udic Argiborolls**

HEDT. Other Argiborolls that have an albic horizon directly below the mollic epipedon.

**Albollic Argiborolls**

HEDU. Other Argiborolls.

**Typic Argiborolls**

## Calciborolls

Key to subgroups

HEFA. Calciborolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Calciborolls**

HEFB. Other Calciborolls which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Petrocalcic Calciborolls**

HEFC. Other Calciborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 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.

**Aridic Calciborolls**

HEFD. Other Calciborolls 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 most years (or artificial drainage).

**Aquic Calciborolls**

HEFE. Other Calciborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Calciborolls**

HEFF. Other Calciborolls that have a udic moisture regime.

**Udic Calciborolls**

HEFG. Other Calciborolls.

**Typic Calciborolls**

## Cryoborolls

Key to subgroups

HEBA. Cryoborolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon, *and either*:

   a. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

   b. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

**Boralfic Lithic Cryoborolls**

HEBB. Other Cryoborolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon that is discontinuous in each pedon.

**Lithic Ruptic-Argic Cryoborolls**

HEBC. Other Cryoborolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon.

**Argic Lithic Cryoborolls**

HEBD. Other Cryoborolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. A mollic epipedon that is discontinuous in each pedon.

**Lithic Ruptic-Entic Cryoborolls**

HEBE. Other Cryoborolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Cryoborolls**

HEBF. Other Cryoborolls that have a mean annual soil temperature of $0^{o}C$ or less.

**Pergelic Cryoborolls**

HEBG. Other Cryoborolls which have an argillic horizon that has, in half or more of its thickness, an exchangeable sodium percentage of 15 percent or more (or a sodium adsorption ratio of 13 or more).

**Natric Cryoborolls**

HEBH. Other Cryoborolls which have an argillic horizon and *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 most 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 lithic or paralithic contact, whichever is shallower.

**Argic Vertic Cryoborolls**

HEBI. Other Cryoborolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Cryoborolls**

HEBJ. Other Cryoborolls 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Cryoborolls**

HEBK. Other Cryoborolls 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Cryoborolls**

HEBL. Other Cryoborolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

**Duric Cryoborolls**

HEBM. Other Cryoborolls which have *both*:

1. An albic horizon directly below the mollic epipedon; *and*

2. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

**Abruptic Cryoborolls**

HEBN. Other Cryoborolls which have an argillic horizon, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a 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* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

**Boralfic Cryoborolls**

HEBO. Other Cryoborolls which have:

1. A mollic epipedon 40 cm or more thick with 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 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 most years (or artificial drainage).

**Aquic Cumulic Cryoborolls**

HEBP. Other Cryoborolls which have:

1. A mollic epipedon 40 cm or more thick with 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Cumulic Cryoborolls**

HEBQ. Other Cryoborolls which have *both*:

1. A mollic epipedon 40 cm or more thick with 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 Cryoborolls**

HEBR. Other Cryoborolls that have *both*:

1. An argillic horizon; *and*

2. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand.

**Argic Pachic Cryoborolls**

HEBS. Other Cryoborolls that have a mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand.

**Pachic Cryoborolls**

HEBT. Other Cryoborolls that have *both*:

1. An argillic horizon; *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 most years (or artificial drainage).

**Argiaquic Cryoborolls**

HEBU. Other Cryoborolls that have:

1. *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 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 most years (or artificial drainage); *and*

3. A slope of less than 25 percent.

**Fluvaquentic Cryoborolls**

HEBV. Other Cryoborolls 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 most years (or artificial drainage).

**Aquic Cryoborolls**

HEBW. Other Cryoborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Cryoborolls**

HEBX. Other Cryoborolls which have *both*:

1. *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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Cryoborolls**

HEBY. Other Cryoborolls that have an argillic horizon.

**Argic Cryoborolls**

HEBZ. Other Cryoborolls that have a calcic horizon either within or directly below the mollic epipedon.

**Calcic Cryoborolls**

HEBZa. Other Cryoborolls that have an albic horizon directly below the mollic epipedon.

**Albic Cryoborolls**

HEBZb. Other Cryoborolls.

**Typic Cryoborolls**

## Haploborolls

Key to subgroups

HEGA. Haploborolls which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

**Salidic Haploborolls**

HEGB. Other Haploborolls that have, in part but not all of each pedon, a lithic contact within 50 cm of the mineral soil surface.

**Ruptic-Lithic Haploborolls**

HEGC. Other Haploborolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haploborolls**

HEGD. Other Haploborolls which have *both*:

1. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is not dry in all its parts throughout the year in 6 or more out or of 10 years; *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 most 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 lithic or paralithic contact, whichever is shallower.

**Udertic Haploborolls**

HEGE. Other Haploborolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Haploborolls**

MOL

HEGF. Other Haploborolls 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Haploborolls**

HEGG. Other Haploborolls 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Haploborolls**

HEGH. Other Haploborolls which have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy particle size, and no paralithic contact or sandy contrasting layer between 40 and 50 cm from the mineral soil surface; *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 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Cumulic Haploborolls**

HEGI. Other Haploborolls which have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy particle size, and no paralithic contact or sandy contrasting layer between 40 and 50 cm from the mineral soil surface; *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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent and a concave shape; *and*

4. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

**Cumulic Udic Haploborolls**

HEGJ. Other Haploborolls which have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy particle size, and no paralithic contact or sandy contrasting layer between 40 and 50 cm from the mineral soil surface; *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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent and a concave shape.

**Cumulic Haploborolls**

HEGK. Other Haploborolls that have *both*:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy particle size, and no paralithic contact or sandy contrasting layer between 40 and 50 cm from the mineral soil surface; *and*

2. *Either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

**Pachic Udic Haploborolls**

HEGL. Other Haploborolls that have a mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy particle size, and no paralithic contact or sandy contrasting layer between 40 and 50 cm from the mineral soil surface.

**Pachic Haploborolls**

HEGM. Other Haploborolls that have:

1. *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 lithic or paralithic contact if shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

3. A slope of less than 25 percent.

**Fluvaquentic Haploborolls**

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

**Aquic Haploborolls**

HEGO. Other Haploborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Haploborolls**

HEGP. Other Haploborolls which have:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. If not irrigated, a moisture control section which, in 6 or more out of 10 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 5°C or higher; *and*

3. *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 lithic or paralithic contact if shallower; *and*

4. A slope of less than 25 percent.

**Torrifluventic Haploborolls**

HEGQ. Other Haploborolls which:

1. Have a color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. If not irrigated, have a moisture control section which, in 6 or more out of 10 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 from the soil surface is 5°C or higher; *and*

3. 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 color.

**Torriorthentic Haploborolls**

HEGR. Other Haploborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 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.

**Aridic Haploborolls**

HEGS. Other Haploborolls which have *both*:

1. *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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Haploborolls**

HEGT. Other Haploborolls which:

1. Have *either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years; *and*

2. 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 color.

**Udorthentic Haploborolls**

HEGU. Other Haploborolls that have *either* a chroma of 1 or less (crushed and smoothed sample) in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick, *or* a moisture control section that is moist in some or all of its parts throughout the year in 6 or more out of 10 years.

**Udic Haploborolls**

HEGV. Other Haploborolls that 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 color.

**Entic Haploborolls**

HEGW. Other Haploborolls.

**Typic Haploborolls**

## Natriborolls

Key to subgroups

HECA. Natriborolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Natriborolls**

HECB. Other Natriborolls that have visible crystals of gypsum and/or more soluble salts within 40 cm of the mineral soil surface.

**Leptic Natriborolls**

HECC. Other Natriborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

**Aridic Natriborolls**

HECD. Other Natriborolls that have *both*:

1. A glossic horizon, or interfingering of albic materials into the natric horizon; *and*

2. A chroma of 1 or less (crushed and smoothed sample) either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick.

**Glossic Udic Natriborolls**

HECE. Other Natriborolls that have a chroma of 1 or less (crushed and smoothed sample) either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick.

**Udic Natriborolls**

HECF. Other Natriborolls that have a glossic horizon, or interfingering of albic materials into the natric horizon.

**Glossic Natriborolls**

HECG. Other Natriborolls.

**Typic Natriborolls**

## Paleborolls

Key to subgroups

HEAA. Paleborolls that have *both*:

1. A mollic epipedon 50 cm or more thick; *and*

2. A mean summer soil temperature either at a depth of 50 cm below the soil surface or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon, or of less than 8°C if there is an O horizon.

**Cryic Pachic Paleborolls**

HEAB. Other Paleborolls which have *both*:

1. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm; and

2. A mean summer soil temperature either at a depth of 50cm below the soil surface or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon, or of less than 8°C if there is an O horizon.

**Abruptic Cryic Paleborolls**

HEAC. Other Paleborolls which have an argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

**Abruptic Paleborolls**

HEAD. Other Paleborolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Paleborolls**

HEAE. Other Paleborolls that have a mean summer soil temperature either at a depth of 50 cm below the soil surface or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon, or of less than 8°C if there is an O horizon.

**Cryic Paleborolls**

HEAF. Other Paleborolls that have a mollic epipedon 50 cm or more thick.

**Pachic Paleborolls**

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

**Aquic Paleborolls**

HEAH. Other Paleborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Paleborolls**

HEAI. Other Paleborolls.

**Typic Paleborolls**

## Vermiborolls

Key to subgroups

HEEA. Vermiborolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Vermiborolls**

HEEB. Other Vermiborolls which have *both*:

1. A color value, dry, of 5 either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 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.

**Aridic Vermiborolls**

HEEC. Other Vermiborolls that have both:

1. A mollic epipedon less than 75 cm thick; *and*

2. A chroma of 1 or less (crushed and smoothed sample) either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick.

**Hapludic Vermiborolls**

HEED. Other Vermiborolls that have a chroma of 1 or less (crushed and smoothed sample) either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick.

**Udic Vermiborolls**

HEEE. Other Vermiborolls that have a mollic epipedon less than 75 cm thick.

**Haplic Vermiborolls**

HEEF. Other Vermiborolls.

**Typic Vermiborolls**

## Rendolls

Key to subgroups

HCAA. Rendolls that have *both*:

1. A cryic or pergelic soil temperature regime; *and*

2. A lithic contact within 50 cm of the mineral soil surface.

**Cryic Lithic Rendolls**

HCAB. Other Rendolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Rendolls**

HCAC. Other Rendolls that have a cryic or pergelic soil temperature regime.

**Cryic Rendolls**

HCAD. Other Rendolls which 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 most 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 lithic or paralithic contact, whichever is shallower.
**Vertic Rendolls**

HCAE. Other Rendolls that have *both*:

1. A cambic horizon; *and*

2. A difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm below the soil surface.
**Eutropeptic Rendolls**

HCAF. Other Rendolls that have a cambic horizon.
**Eutrochreptic Rendolls**

HCAG. Other Rendolls 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 Rendolls**

HCAH. Other Rendolls.
**Typic Rendolls**

## Udolls

Key to great groups

HGA. Udolls which have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*

2. *Both*:

   a. Within 150 cm of the mineral soil surface, neither a lithic or paralithic contact nor a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *and*

   b. An argillic horizon which has *either*:

      (1) In its lowest subhorizon, a hue of 7.5YR or redder and a chroma of 5 or more in 50 percent or more of the matrix; *or*

      (2) In one or more of its subhorizons, many coarse redox concentrations with a hue of 5YR or redder or a chroma of 6 or more, or both.
**Paleudolls**, p.208

HGB. Other Udolls which:

1. Have a calcic 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 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, are either calcareous or have a texture of loamy fine sand or coarser.
**Calciudolls**, p.206

HGC. Other Udolls that have an argillic horizon.
**Argiudolls**, p.204

HGD. Other Udolls that have a mollic epipedon which:

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, worm casts, 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, worm casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.
**Vermudolls**, p.209

HGE. Other Udolls.
**Hapludolls**, p.206

## Argiudolls

Key to subgroups

HGCA. Argiudolls that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Argiudolls**

HGCB. Other Argiudolls which have *both*:

1. Aquic conditions for some time in most 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 a chroma of 2 or less; *or*

(2) A hue of 10YR or redder and a chroma of 2 or less; *or*

(3) A hue of 2.5Y or yellower and a 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 most 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 lithic or paralithic contact, whichever is shallower.

**Aquertic Argiudolls**

HGCC. 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 most 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 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, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Vertic Argiudolls**

HGCD. Other Argiudolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Argiudolls**

HGCE. Other Argiudolls which have an argillic horizon that either has a texture of loamy fine sand or coarser, or consists entirely of lamellae.

**Psammentic Argiudolls**

HGCF. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Argiudolls**

HGCG. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Argiudolls**

HGCH. Other Argiudolls which have aquic conditions for some time in most 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 a chroma of 2 or less; *or*

b. A hue of 10YR or redder and a chroma of 2 or less; *or*

c. A hue of 2.5Y or yellower and a chroma of 3 or less.
**Aquic Argiudolls**

HGCI. Other Argiudolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Argiudolls**

HGCJ. Other Argiudolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.
**Pachic Argiudolls**

HGCK. Other Argiudolls that have a CEC of less than 24 cmol(+)/kg clay (by 1N $NH_4OAc$ 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**

HGCL. Other Argiudolls that have a calcic horizon within 100 cm of the mineral soil surface.
**Calcic Argiudolls**

HGCM. Other Argiudolls.
**Typic Argiudolls**

## Calciudolls

Key to subgroups

HGBA. Calciudolls that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Calciudolls**

HGBB. Other Calciudolls which 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 most 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 lithic or paralithic contact, whichever is shallower.
**Vertic Calciudolls**

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

HGBD. Other Calciudolls.
**Typic Calciudolls**

## Hapludolls

Key to subgroups

HGEA. Hapludolls that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Hapludolls**

HGEB. Other Hapludolls which have *both*:

1. Aquic conditions for some time in most 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 a chroma of 2 or less; *or*

        (2) A hue of 10YR or redder and a chroma of 2 or less; *or*

        (3) A hue of 2.5Y or yellower and a 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 most 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 lithic or paralithic contact, whichever is shallower.
**Aquertic Hapludolls**

HGEC. Other Hapludolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Hapludolls**

HGED. 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/cm$^3$ 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**

HGEE. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Hapludolls**

HGEF. Other Hapludolls which have:

1. A mollic epipedon 60 cm or more thick with 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 lithic or paralithic contact if shallower; *and*

3. A slope of 25 percent or less; *and*

4. Aquic conditions for some time in most 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 a chroma of 2 or less; *or*

      (2) A hue of 10YR or redder and a chroma of 2 or less; *or*

      (3) A hue of 2.5Y or yellower and a chroma of 3 or less.

**Aquic Cumulic Hapludolls**

HGEG. Other Hapludolls which have:

1. A mollic epipedon 60 cm or more thick with 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 lithic or paralithic contact if shallower; *and*

3. A slope of 25 percent or less.

**Cumulic Hapludolls**

HGEH. Other Hapludolls that have:

1. Aquic conditions for some time in most 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 a chroma of 2 or less; *or*

      (2) A hue of 10YR or redder and a chroma of 2 or less; *or*

      (3) A hue of 2.5Y or yellower and a chroma of 3 or less; *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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Fluvaquentic Hapludolls**

HGEI. Other Hapludolls which have aquic conditions for some time in most 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 a chroma of 2 or less; *or*

   b. A hue of 10YR or redder and a chroma of 2 or less; *or*

   c. A hue of 2.5Y or yellower and a chroma of 3 or less.

**Aquic Hapludolls**

HGEJ. Other Hapludolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Hapludolls**

HGEK. Other Hapludolls which have *both*:

1. *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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Hapludolls**

HGEL. Other Hapludolls which 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, worm casts, 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 the requirements for a cambic horizon except color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

**Vermic Hapludolls**

HGEM. Other Hapludolls that have a calcic horizon within 100 cm of the mineral soil surface.

**Calcic Hapludolls**

HGEN. 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 the requirements for a cambic horizon except color; *or*

2. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

**Entic Hapludolls**

HGEO. Other Hapludolls.

**Typic Hapludolls**

## Paleudolls

Key to subgroups

HGAA. Paleudolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Paleudolls**

HGAB. Other Paleudolls that have a petrocalcic horizon within 150 cm of the mineral soil surface.

**Petrocalcic Paleudolls**

HGAC. Other Paleudolls that have, in one or more subhorizons within the upper 50 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Paleudolls**

HGAD. Other Paleudolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Paleudolls**

HGAE. Other Paleudolls which:

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, are either calcareous or have a texture of loamy fine sand or coarser.

**Calcic Paleudolls**

HGAF. Other Paleudolls.

**Typic Paleudolls**

## Vermudolls

Key to subgroups

HGDA. Vermudolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Vermudolls**

HGDB. Other Vermudolls that have a cambic horizon.

**Haplic Vermudolls**

HGDC. Other Vermudolls that have a mollic epipedon less than 75 cm thick.

**Entic Vermudolls**

HGDD. Other Vermudolls.

**Typic Vermudolls**

## Ustolls

Key to great groups

HFA. Ustolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

**Durustolls**, p.213

HFB. Other Ustolls that have a natric horizon.

**Natrustolls**, p.217

HFC. Other Ustolls which have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface, *and* either an argillic horizon or, after the materials between the soil surface and a depth of 18 cm have been mixed, one or more noncalcareous horizons above the petrocalcic horizon; *or*

2. An argillic horizon that has *one or both* of the following:

   a. *No* clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content within 150 cm of the mineral soil surface (and there is no lithic or paralithic contact within that depth), *and either*:

      (1) A hue of 7.5YR or redder and a chroma of 5 or more in the matrix; *or*

      (2) Common coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

   b. A clayey particle size in its upper part, and at its upper boundary, a clay increase 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, in the fine-earth fraction (and there is no lithic or paralithic contact within 50 cm of the mineral soil surface).

**Paleustolls**, p.218

HFD. Other Ustolls which:

1. Have *either* a calcic or gypsic horizon that has its upper boundary within 100 cm of the 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, are either calcareous or have a texture of loamy fine sand or coarser.

**Calciustolls**, p.212

HFE. Other Ustolls that have an argillic horizon.

**Argiustolls**, p.210

HFF. Other Ustolls that have a mollic epipedon which:

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, worm casts, 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, worm

casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.
**Vermustolls, p.220**

HFG. Other Ustolls.
**Haplustolls, p.214**

## Argiustolls

Key to subgroups

HFEA. Argiustolls which 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 a chroma too high for an albic horizon.
**Alfic Lithic Argiustolls**

HFEB. Other Argiustolls that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Argiustolls**

HFEC. 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Argiustolls**

HFED. Other Argiustolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.
**Udertic Argiustolls**

HFEE. Other Argiustolls which 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 most 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 lithic or paralithic contact, whichever is shallower.
**Vertic Argiustolls**

HFEF. 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Argiustolls**

HFEG. Other Argiustolls which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitritorrandic Argiustolls**

HFEH. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Argiustolls**

HFEI. Other Argiustolls which have a mean annual soil temperature lower than 10°C, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a 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* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

**Boralfic Argiustolls**

HFEJ. Other Argiustolls which have *either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a 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* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

**Ustalfic Argiustolls**

HFEK. Other Argiustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

**Pachic Argiustolls**

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

**Aquic Argiustolls**

HFEM. Other Argiustolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Argiustolls**

HFEN. Other Argiustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Argiustolls**

HFEO. Other Argiustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Argiustolls**

HFEP. Other Argiustolls which have a brittle horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and contains either some opal coatings or 20 percent or more (by volume) durinodes.

**Duric Argiustolls**

HFEQ. Other Argiustolls.

**Typic Argiustolls**

## Calciustolls

Key to subgroups

HFDA. Calciustolls which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

**Salidic Calciustolls**

HFDB. Other Calciustolls that have a petrocalcic horizon and a lithic contact within 50 cm of the mineral soil surface.

**Lithic Petrocalcic Calciustolls**

HFDC. Other Calciustolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Calciustolls**

HFDD. Other Calciustolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Calciustolls**

HFDE. Other Calciustolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.
**Udertic Calciustolls**

HFDF. Other Calciustolls which 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 most 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 lithic or paralithic contact, whichever is shallower.
**Vertic Calciustolls**

HFDG. Other Calciustolls which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.
**Petrocalcic Calciustolls**

HFDH. Other Calciustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.
**Pachic Calciustolls**

HFDI. 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 most years (or artificial drainage).
**Aquic Calciustolls**

HFDJ. Other Calciustolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
**Oxyaquic Calciustolls**

HFDK. Other Calciustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Calciustolls**

HFDL. Other Calciustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for four tenths or less 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Calciustolls**

HFDM. Other Calciustolls.
**Typic Calciustolls**

## Durustolls

Key to subgroups

HFAA. Durustolls that have a natric horizon above the duripan.
**Natric Durustolls**

HFAB. Other Durustolls which:

1. Do not have an argillic horizon above the duripan; *and*

2. Have an aridic moisture regime that borders on an ustic regime.
**Haploduridic Durustolls**

HFAC. Other Durustolls that have an aridic moisture regime that borders on an ustic regime.
**Argiduridic Durustolls**

HFAD. Other Durustolls that do not have an argillic horizon above the duripan.
**Entic Durustolls**

HFAE. Other Durustolls which have a duripan that is not indurated in any subhorizon.

**Haplic Durustolls**

HFAF. Other Durustolls.

**Typic Durustolls**

## Haplustolls

Key to subgroups

HFGA. Haplustolls which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

**Salidic Haplustolls**

HFGB. Other Haplustolls that have, in part of each pedon, a lithic contact within 50 cm of the mineral soil surface.

**Ruptic-Lithic Haplustolls**

HFGC. Other Haplustolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haplustolls**

HFGD. Other Haplustolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Haplustolls**

HFGE. Other Haplustolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.

**Udertic Haplustolls**

HFGF. Other Haplustolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Haplustolls**

HFGG. Other Haplustolls which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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. A CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[2] 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 lithic or paralithic contact if shallower.

**Torroxic Haplustolls**

HFGH. Other Haplustolls that have a CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[3] 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 lithic or paralithic contact if shallower.

**Oxic Haplustolls**

HFGI. 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Haplustolls**

HFGJ. Other Haplustolls which have *both*:

1. If neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitritorrandic Haplustolls**

HFGK. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Haplustolls**

HFGL. Other Haplustolls which have:

1. A mollic epipedon 50 cm or more thick with 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent; *and*

[2] Some soils with properties that approach those of an oxic horizon do not disperse well. 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 (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

[3] See footnote 2.

4. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Cumulic Haplustolls**

HFGM. Other Haplustolls which have:

1. A mollic epipedon 50 cm or more thick with 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Cumulic Haplustolls**

HFGN. Other Haplustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

**Pachic Haplustolls**

HFGO. Other Haplustolls that have anthraquic conditions.

**Anthraquic Haplustolls**

HFGP. Other Haplustolls that have:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Fluvaquentic Haplustolls**

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

**Aquic Haplustolls**

HFGR. Other Haplustolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Haplustolls**

HFGS. Other Haplustolls which have:

1. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $5^{\circ}C$; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $8^{\circ}C$; *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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Torrifluventic Haplustolls**

HFGT. Other Haplustolls which:

1. Have, if neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $5^{\circ}C$; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 $8^{\circ}C$; *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 the requirements for a cambic horizon except color; *or*

   b. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

**Torriorthentic Haplustolls**

HFGU. Other Haplustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Haplustolls**

HFGV. Other Haplustolls which have *both*:

1. *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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Haplustolls**

HFGW. Other Haplustolls which have a brittle horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and contains either some opal coatings or 20 percent or more (by volume) durinodes.

**Duric Haplustolls**

HFGX. Other Haplustolls which:

1. Have, if neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 days per year when the 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 color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

**Udorthentic Haplustolls**

HFGY. Other Haplustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

**Udic Haplustolls**

HFGZ. 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 the requirements for a cambic horizon except color; *or*

2. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

**Entic Haplustolls**

HFGZa. Other Haplustolls.

**Typic Haplustolls**

## Natrustolls

Key to subgroups

HFBA. Natrustolls which 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 most 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 lithic or paralithic contact, whichever is shallower.
**Vertic Natrustolls**

HFBB. 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**

HFBC. Other Natrustolls that have, in one or more horizons between 50 and 100 cm from the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and one* of the following:

1. Fifty percent or more chroma of 1 or less, and a hue of 2.5Y or yellower; *or*

2. Fifty percent or more chroma of 2 or less, and redox concentrations; *or*

3. Fifty 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**

HFBD. Other Natrustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Natrustolls**

HFBE. Other Natrustolls which have a brittle horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and contains either some opal coatings or 20 percent or more (by volume) durinodes.
**Duric Natrustolls**

HFBF. Other Natrustolls that have a glossic horizon, or interfingering of albic materials into a natric horizon.
**Glossic Natrustolls**

HFBG. Other Natrustolls.
**Typic Natrustolls**

## Paleustolls

Key to subgroups

HFCA. Paleustolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Paleustolls**

HFCB. Other Paleustolls which 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 most 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 lithic or paralithic contact, whichever is shallower; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.

**Udertic Paleustolls**

HFCC. Other Paleustolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Paleustolls**

HFCD. Other Paleustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

**Pachic Paleustolls**

HFCE. Other Paleustolls that have a petrocalcic horizon within 150 cm of the mineral soil surface.

**Petrocalcic Paleustolls**

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

**Aquic Paleustolls**

HFCG. Other Paleustolls which:

1. Are calcareous throughout after the soil has been mixed to a depth of 18 cm, and have a calcic horizon within the following depths if the particle-size control section is

a. Sandy: within 100 cm of the mineral soil surface; *or*

b. Loamy: within 60 cm of the mineral soil surface; *or*

c. Clayey: within 50 cm of the mineral soil surface; *and*

2. Have, if neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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.

**Calciargidic Paleustolls**

HFCH. Other Paleustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Paleustolls**

HFCI. Other Paleustolls which have, if neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Paleustolls**

HFCJ. Other Paleustolls which are calcareous throughout after the soil has been mixed to a depth of 18 cm, and have a calcic horizon within the following depths if the particle-size control section is

1. Sandy: within 100 cm of the mineral soil surface; *or*

2. Loamy: within 60 cm of the mineral soil surface; *or*

3. Clayey: within 50 cm of the mineral soil surface.

**Calcic Paleustolls**

HFCK. Other Paleustolls that are calcareous throughout after the soil has been mixed to a depth of 18 cm.

**Entic Paleustolls**

HFCL. Other Paleustolls.

**Typic Paleustolls**

## Vermustolls

Key to subgroups

HFFA. Vermustolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Vermustolls**

HFFB. Other Vermustolls that have a mollic epipedon 75 cm or more thick.

**Pachic Vermustolls**

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

**Aquic Vermustolls**

HFFD. Other Vermustolls that have a cambic horizon.

**Haplic Vermustolls**

HFFE. Other Vermustolls that have a mollic epipedon less than 50 cm thick.

**Entic Vermustolls**

HFFF. Other Vermustolls.

**Typic Vermustolls**

## Xerolls

Key to great groups

HDA. Xerolls that have a duripan within 100 cm of the mineral soil surface.

**Durixerolls, p.224**

HDB. Other Xerolls which have a natric horizon, but do not have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Natrixerolls, p.229**

HDC. Other Xerolls which 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. *No* clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content within 150 cm of the mineral soil surface (and there is no lithic or paralithic contact within that depth), *and either*:

      (1) A hue of 7.5YR or redder and a chroma of 5 or more in the matrix; *or*

      (2) Common coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

   b. A clayey particle size in its upper part, and at its upper boundary, a clay increase 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, in the fine-earth fraction (and there is no lithic or paralithic contact within 50 cm of the mineral soil surface).

**Palexerolls**, p.230

HDD. Other Xerolls which:

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 soil has been mixed to a depth of 18 cm, are either calcareous or have a texture of loamy fine sand or coarser.

**Calcixerolls**, p.223

HDE. Other Xerolls that have an argillic horizon.

**Argixerolls**, p.221

HDF. Other Xerolls.

**Haploxerolls**, p.226

## Argixerolls

Key to subgroups

HDEA. 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**

HDEB. Other Argixerolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Argixerolls**

HDEC. Other Argixerolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Torrertic Argixerolls**

HDED. Other Argixerolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Argixerolls**

HDEE. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Argixerolls**

HDEF. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitritorrandic Argixerolls**

HDEG. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Argixerolls**

HDEH. Other Argixerolls which have a mean annual soil temperature lower than 10°C, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a 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* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

**Boralfic Argixerolls**

HDEI. Other Argixerolls that have *both*:

1. A calcic horizon or identifiable secondary carbonates, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

   a. Sandy: within 150 cm of the mineral soil surface; *or*

   b. Loamy: within 110 cm of the mineral soil surface; *or*

   c. Clayey: within 90 cm of the mineral soil surface; *and*

2. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

**Calcic Pachic Argixerolls**

HDEJ. Other Argixerolls that have *both*:

1. A mollic epipedon 50 cm or more thick with 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 lithic or paralithic contact, whichever is shallower.

**Pachic Ultic Argixerolls**

HDEK. Other Argixerolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

**Pachic Argixerolls**

HDEL. Other Argixerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 lithic or paralithic contact, whichever is shallower.

**Aquultic Argixerolls**

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

**Aquic Argixerolls**

HDEN. Other Argixerolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Argixerolls**

HDEO. Other Argixerolls which 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 contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Argiduridic Argixerolls**

HDEP. Other Argixerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Duric Argixerolls**

HDEQ. Other Argixerolls that have *both*:

1. An aridic moisture regime; *and*

2. A calcic horizon or identifiable secondary carbonates, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

   a. Sandy: within 150 cm of the mineral soil surface; *or*

   b. Loamy: within 110 cm of the mineral soil surface; *or*

   c. Clayey: within 90 cm of the mineral soil surface.

**Aridic Calcic Argixerolls**

HDER. Other Argixerolls that have an aridic moisture regime.

**Aridic Argixerolls**

HDES. Other Argixerolls that have a calcic horizon or identifiable secondary carbonates, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

1. Sandy: within 150 cm of the mineral soil surface; *or*

2. Loamy: within 110 cm of the mineral soil surface; *or*

3. Clayey: within 90 cm of the mineral soil surface.

**Calcic Argixerolls**

HDET. 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 lithic or paralithic contact, whichever is shallower.

**Ultic Argixerolls**

HDEU. Other Argixerolls that have an albic horizon above the argillic horizon.

**Albic Argixerolls**

HDEV. Other Argixerolls.

**Typic Argixerolls**

## Calcixerolls

Key to subgroups

HDDA. Calcixerolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Calcixerolls**

HDDB. Other Calcixerolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Calcixerolls**

HDDC. Other Calcixerolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

**Pachic Calcixerolls**

HDDD. 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 most years (or artificial drainage).

**Aquic Calcixerolls**

HDDE. Other Calcixerolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Calcixerolls**

HDDF. 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 are cinders, pumice, and pumice-like 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 Calcixerolls**

HDDG. Other Calcixerolls that have an aridic moisture regime.

**Aridic Calcixerolls**

HDDH. Other Calcixerolls which have a mollic epipedon that contains, below any Ap horizon, 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows.

**Vermic Calcixerolls**

HDDI. Other Calcixerolls.

**Typic Calcixerolls**

## Durixerolls

Key to subgroups

HDAA. Durixerolls which 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 most 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**

HDAB. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitritorrandic Durixerolls**

HDAC. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Durixerolls**

HDAD. Other Durixerolls that have, in one or more horizons above the duripan, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Durixerolls**

HDAE. Other Durixerolls which have:

1. An aridic moisture regime; *and*

2. An argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within 7.5 cm, *or* of 15 percent or more (absolute) within 2.5 cm; *and*

3. A duripan that is neither very strongly cemented nor indurated in any subhorizon.

**Paleargidic Durixerolls**

HDAF. Other Durixerolls which have *both*:

1. An aridic moisture regime; *and*

2. An argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within 7.5 cm, *or* of 15 percent or more (absolute) within 2.5 cm.

**Abruptic Argiduridic Durixerolls**

HDAG. Other Durixerolls which:

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**

HDAH. Other Durixerolls which:

1. Have an aridic moisture regime; *and*

2. Do not have an argillic horizon above the duripan.

**Haploduridic Durixerolls**

HDAI. Other Durixerolls which have;

1. An aridic moisture regime; *and*

2. A duripan that is neither very strongly cemented nor indurated in any subhorizon.

**Argidic Durixerolls**

HDAJ. Other Durixerolls that have an aridic moisture regime.

**Argiduridic Durixerolls**

HDAK. Other Durixerolls which have: *both*

1. An argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within 7.5 cm, *or* of 15 percent or more (absolute) within 2.5 cm; *and*

2. A duripan that is neither very strongly cemented nor indurated in any subhorizon.

**Haplic Palexerollic Durixerolls**

HDAL. Other Durixerolls which have an argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within 7.5 cm, *or* of 15 percent or more (absolute) within 2.5 cm.

**Palexerollic Durixerolls**

HDAM. Other Durixerolls which:

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**

HDAN. Other Durixerolls which do not have an argillic horizon above the duripan.

**Haploxerollic Durixerolls**

HDAO. Other Durixerolls which have a duripan that is neither very strongly cemented nor indurated in any subhorizon.

**Haplic Durixerolls**

HDAP. Other Durixerolls.

**Typic Durixerolls**

## Haploxerolls

Key to subgroups

HDFA. 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**

HDFB. Other Haploxerolls that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haploxerolls**

HDFC. Other Haploxerolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Torrertic Haploxerolls**

HDFD. Other Haploxerolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Haploxerolls**

HDFE. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitritorrandic Haploxerolls**

HDFF. 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Vitrandic Haploxerolls**

HDFG. Other Haploxerolls which have:

1. A mollic epipedon 50 cm or more thick with 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 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Cumulic Haploxerolls**

HDFH. Other Haploxerolls which have:

1. A mollic epipedon 50 cm or more thick with 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 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 lithic or paralithic contact, whichever is shallower.

**Cumulic Ultic Haploxerolls**

HDFI. Other Haploxerolls which have:

1. A mollic epipedon 50 cm or more thick with 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Cumulic Haploxerolls**

HDFJ. Other Haploxerolls that have *both*:

1. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. A calcic horizon or identifiable secondary carbonates, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

   a. Sandy: within 150 cm of the mineral soil surface; *or*

   b. Loamy: within 110 cm of the mineral soil surface; *or*

   c. Clayey: within 90 cm of the mineral soil surface.

**Calcic Pachic Haploxerolls**

HDFK. Other Haploxerolls that have *both*:

1. A mollic epipedon 50 cm or more thick with 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 lithic or paralithic contact, whichever is shallower.

**Pachic Ultic Haploxerolls**

HDFL. Other Haploxerolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

**Pachic Haploxerolls**

HDFM. Other Haploxerolls that have:

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

2. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Fluvaquentic Haploxerolls**

HDFN. Other Haploxerolls that have *both*:

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

2. A horizon 15 cm or more thick within 100 cm of the mineral soil surface that either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Aquic Duric Haploxerolls**

HDFO. Other Haploxerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most 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 lithic or paralithic contact, whichever is shallower.

**Aquultic Haploxerolls**

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

**Aquic Haploxerolls**

HDFQ. Other Haploxerolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Haploxerolls**

HDFR. Other Haploxerolls which have:

1. An aridic moisture regime; *and*

2. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of 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 lithic or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

**Torrifluventic Haploxerolls**

HDFS. Other Haploxerolls which 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 contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Aridic Duric Haploxerolls**

HDFT. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*

2. A calcic horizon or identifiable secondary carbonates, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

   a. Sandy: within 150 cm of the mineral soil surface; *or*

   b. Loamy: within 110 cm of the mineral soil surface; *or*

   c. Clayey: within 90 cm of the mineral soil surface.

**Calcidic Haploxerolls**

HDFU. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*

2. A sandy particle size in all horizons within 100 cm of the mineral soil surface.

**Torripsammentic Haploxerolls**

HDFV. Other Haploxerolls which:

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 the requirements for a cambic horizon except color; *or*

   b. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

**Torriorthentic Haploxerolls**

HDFW. Other Haploxerolls that have an aridic moisture regime.

**Aridic Haploxerolls**

HDFX. Other Haploxerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Duric Haploxerolls**

HDFY. Other Haploxerolls which have *both*:

1. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of 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 lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

**Fluventic Haploxerolls**

HDFZ. Other Haploxerolls that have a mollic epipedon which has granular structure and which contains, below any Ap horizon, 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows.

**Vermic Haploxerolls**

HDFZa. Other Haploxerolls that have a calcic horizon or identifiable secondary carbonates, either within the following depths or above a lithic or paralithic contact if shallower, if the particle-size control section is

1. Sandy: within 150 cm of the mineral soil surface; *or*

2. Loamy: within 110 cm of the mineral soil surface; *or*

3. Clayey: within 90 cm of the mineral soil surface.

**Calcic Haploxerolls**

HDFZb. Other Haploxerolls which:

1. 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 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 lithic or paralithic contact, whichever is shallower.

**Entic Ultic Haploxerolls**

HDFZc. 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 lithic or paralithic contact, whichever is shallower.

**Ultic Haploxerolls**

HDFZd. 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 the requirements for a cambic horizon except color; *or*

2. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

**Entic Haploxerolls**

HDFZe. Other Haploxerolls.

**Typic Haploxerolls**

## Natrixerolls

Key to subgroups

HDBA. Natrixerolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Natrixerolls**

HDBB. Other Natrixerolls that have *both*:

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

2. A horizon 15 cm or more thick within 100 cm of the mineral soil surface that either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Aquic Duric Natrixerolls**

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

**Aquic Natrixerolls**

HDBD. Other Natrixerolls that have an aridic moisture regime.

**Aridic Natrixerolls**

HDBE. Other Natrixerolls which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

**Duric Natrixerolls**

HDBF. Other Natrixerolls.

**Typic Natrixerolls**

## Palexerolls

Key to subgroups

HDCA. Palexerolls that have a natric horizon.

**Natric Palexerolls**

HDCB. Other Palexerolls which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Palexerolls**

HDCC. Other Palexerolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

**Pachic Palexerolls**

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

**Aquic Palexerolls**

HDCE. Other Palexerolls which 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.

**Petrocalcidic Palexerolls**

HDCF. Other Palexerolls that have an aridic moisture regime.

**Aridic Palexerolls**

HDCG. Other Palexerolls which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Petrocalcic Palexerolls**

HDCH. 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**

HDCI. Other Palexerolls which have an argillic horizon that *either*:

1. Does not have a clayey particle size in its upper part; *or*

2. At its upper boundary, has a clay increase either of less than 20 percent (absolute) within a vertical distance of 7.5 cm, or of less than 15 percent (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.
**Haplic Palexerolls**

HDCJ. Other Palexerolls.
**Typic Palexerolls**

# Chapter 13

# Oxisols[1]

Key to suborders

DA. Oxisols that have aquic conditions for some time in most years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface, *and 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 a 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. Fifty percent or more hue of 2.5Y or yellower; *or*

   b. A 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquox**, p.233

DB. Other Oxisols that have an aridic moisture regime.

**Torrox**, p.238

DC. Other Oxisols that have an ustic or a xeric moisture regime.

**Ustox**, p.244

DD. Other Oxisols that have a perudic moisture regime.

**Perox**, p.234

DE. Other Oxisols.

**Udox**, p.239

[1] This chapter on Oxisols was rewritten in 1987 following the 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.

## Aquox

Key to great groups

DAA. Aquox that have, in one or more subhorizons of the oxic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

**Acraquox**, p.233

DAB. Other Aquox that have plinthite forming a continuous phase within 125 cm of the mineral soil surface.

**Plinthaquox**, p.234

DAC. Other Aquox that have a base saturation (by $NH_4OAc$) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

**Eutraquox**, p.233

DAD. Other Aquox.

**Haplaquox**, p.234

## Acraquox

Key to subgroups

DAAA. 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**

DAAB. Other Acraquox which 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**

DAAC. Other Acraquox.

**Typic Acraquox**

## Eutraquox

Key to subgroups

DACA. Eutraquox that have a histic epipedon.

**Histic Eutraquox**

DACB. 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**

DACC. Other Eutraquox which 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**

DACD. Other Eutraquox that have 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Eutraquox**

DACE. Other Eutraquox.

**Typic Eutraquox**

## Haplaquox

Key to subgroups

DADA. Haplaquox that have a histic epipedon.

**Histic Haplaquox**

DADB. 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**

DADC. Other Haplaquox which 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**

DADD. Other Haplaquox that have 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Haplaquox**

DADE. Other Haplaquox.

**Typic Haplaquox**

## Plinthaquox

Key to subgroups

DABA. Plinthaquox which 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**

DABB. Other Plinthaquox.

**Typic Plinthaquox**

## Perox

Key to great groups

DDA. Perox that have a sombric horizon within 150 cm of the mineral soil surface.

**Sombriperox, p.238**

DDB. Other Perox that have, in one or more subhorizons of the oxic or kandic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

**Acroperox, p.234**

DDC. Other Perox that have a base saturation (by $NH_4OAc$) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

**Eutroperox, p.235**

DDD. Other Perox which have *both*:

1. A clay content of 40 percent or more between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Kandiperox, p.237**

DDE. Other Perox.

**Haploperox, p.236**

## Acroperox

Key to subgroups

DDBA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Acroperox**

DDBB. Other Acroperox that have a petroferric contact within 125 cm of the soil surface.

**Petroferric Acroperox**

DDBC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Acroperox**

DDBD. Other Acroperox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Acroperox**

DDBE. Other Acroperox 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 Acroperox**

DDBF. Other Acroperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

**Plinthic Acroperox**

DDBG. Other Acroperox 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Acroperox**

DDBH. Other Acroperox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Acroperox**

DDBI. Other Acroperox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Acroperox**

DDBJ. Other Acroperox that have 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Acroperox**

DDBK. Other Acroperox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Acroperox**

DDBL. Other Acroperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Acroperox**

DDBM. Other Acroperox.

**Typic Acroperox**

## Eutroperox

Key to subgroups

DDCA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Eutroperox**

DDCB. Other Eutroperox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Eutroperox**

DDCC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Eutroperox**

DDCD. Other Eutroperox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Eutroperox**

DDCE. Other Eutroperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Plinthaquic Eutroperox**

DDCF. 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**

DDCG. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Eutroperox**

DDCH. Other Eutroperox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.
**Kandiudalfic Eutroperox**

DDCI. Other Eutroperox which 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.
**Umbreptic Eutroperox**

DDCJ. Other Eutroperox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.
**Inceptic Eutroperox**

DDCK. 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. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.
**Humic Rhodic Eutroperox**

DDCL. 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. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.
**Humic Xanthic Eutroperox**

DDCM. Other Eutroperox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.
**Humic Eutroperox**

DDCN. Other Eutroperox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.
**Rhodic Eutroperox**

DDCO. Other Eutroperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.
**Xanthic Eutroperox**

DDCP. Other Eutroperox.
**Typic Eutroperox**

## Haploperox

Key to subgroups

DDEA. Haploperox 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Petroferric Haploperox**

DDEB. Other Haploperox that have a petroferric contact within 125 cm of the mineral soil surface.
**Petroferric Haploperox**

DDEC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Lithic Haploperox**

DDED. Other Haploperox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Haploperox**

DDEE. Other Haploperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Haploperox**

DDEF. 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**

DDEG. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Haploperox**

DDEH. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Haploperox**

DDEI. Other Haploperox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Haploperox**

DDEJ. Other Haploperox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Haploperox**

DDEK. Other Haploperox that have 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Haploperox**

DDEL. Other Haploperox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Haploperox**

DDEM. Other Haploperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Haploperox**

DDEN. Other Haploperox.

**Typic Haploperox**

## Kandiperox

Key to subgroups

DDDA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Kandiperox**

DDDB. Other Kandiperox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Kandiperox**

DDDC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Kandiperox**

DDDD. Other Kandiperox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Kandiperox**

DDDE. Other Kandiperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Kandiperox**

DDDF. 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**

DDDG. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kandiperox**

DDDH. 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Kandiperox**

DDDI. Other Kandiperox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Kandiperox**

DDDJ. Other Kandiperox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Kandiperox**

DDDK. Other Kandiperox that have 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Kandiperox**

DDDL. Other Kandiperox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Kandiperox**

DDDM. Other Kandiperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Kandiperox**

DDDN. Other Kandiperox.

**Typic Kandiperox**

## Sombriperox

Key to subgroups

DDAA. Sombriperox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Sombriperox**

DDAB. Other Sombriperox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Sombriperox**

DDAC. Other Sombriperox that have 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Sombriperox**

DDAD. Other Sombriperox.

**Typic Sombriperox**

## Torrox

Key to great groups

DBA. Torrox that have, in one or more subhorizons of the oxic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

**Acrotorrox, p.239**

DBB. Other Torrox that have a base saturation (by $NH_4OAc$) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

**Eutrotorrox**, p.239

DBC. Other Torrox.

**Haplotorrox**, p.239

## Acrotorrox

Key to subgroups

DBAA. Acrotorrox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Acrotorrox**

DBAB. Other Acrotorrox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Acrotorrox**

DBAC. Other Acrotorrox.

**Typic Acrotorrox**

## Eutrotorrox

Key to subgroups

DBBA. Eutrotorrox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Eutrotorrox**

DBBB. Other Eutrotorrox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Eutrotorrox**

DBBC. Other Eutrotorrox.

**Typic Eutrotorrox**

## Haplotorrox

Key to subgroups

DBCA. Haplotorrox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Haplotorrox**

DBCB. Other Haplotorrox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Haplotorrox**

DBCC. Other Haplotorrox.

**Typic Haplotorrox**

## Udox

Key to great groups

DEA. Udox that have a sombric horizon within 150 cm of the mineral soil surface.

**Sombriudox**, p.244

DEB. Other Udox that have, in one or more subhorizons of the oxic or kandic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

**Acrudox**, p.239

DEC. 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

DED. Other Udox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Kandiudox**, p.243

DEE. Other Udox.

**Hapludox**, p.242

## Acrudox

Key to subgroups

DEBA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Acrudox**

DEBB. Other Acrudox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Acrudox**

DEBC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Acrudox**

DEBD. Other Acrudox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Acrudox**

DEBE. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Anionic Aquic Acrudox**

DEBF. 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**

DEBG. 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**

DEBH. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Acrudox**

DEBI. 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**

DEBJ. Other Acrudox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Acrudox**

DEBK. Other Acrudox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Acrudox**

DEBL. Other Acrudox that have 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Acrudox**

DEBM. Other Acrudox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Acrudox**

DEBN. Other Acrudox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Acrudox**

DEBO. Other Acrudox.

**Typic Acrudox**

## Eutrudox

Key to subgroups

DECA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Eutrudox**

DECB. Other Eutrudox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Eutrudox**

DECC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Eutrudox**

DECD. Other Eutrudox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Eutrudox**

DECE. Other Eutrudox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Eutrudox**

DECF. 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**

DECG. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Eutrudox**

DECH. Other Eutrudox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Kandiudalfic Eutrudox**

DECI. Other Eutrudox which have *both*:

1. 16 kg/m$^2$ 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.

**Umbreptic Eutrudox**

DECJ. Other Eutrudox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

**Inceptic Eutrudox**

DECK. Other Eutrudox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Eutrudox**

DECL. Other Eutrudox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Eutrudox**

DECM. Other Eutrudox that have 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Eutrudox**

DECN. Other Eutrudox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Eutrudox**

DECO. Other Eutrudox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Eutrudox**

DECP. Other Eutrudox.

**Typic Eutrudox**

## Hapludox

Key to subgroups

DEEA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Petroferric Hapludox**

DEEB. Other Hapludox that have a petroferric contact within 125 cm of the mineral soil surface.
**Petroferric Hapludox**

DEEC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Lithic Hapludox**

DEED. Other Hapludox that have a lithic contact within 125 cm of the mineral soil surface.
**Lithic Hapludox**

DEEE. Other Hapludox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Plinthaquic Hapludox**

DEEF. 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**

DEEG. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Hapludox**

DEEH. Other Hapludox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.
**Inceptic Hapludox**

DEEI. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.
**Andic Hapludox**

DEEJ. Other Hapludox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.
**Humic Rhodic Hapludox**

DEEK. Other Hapludox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.
**Humic Xanthic Hapludox**

DEEL. Other Hapludox that have 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.
**Humic Hapludox**

DEEM. Other Hapludox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.
**Rhodic Hapludox**

DEEN. Other Hapludox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.
**Xanthic Hapludox**

DEEO. Other Hapludox.
**Typic Hapludox**

## Kandiudox

Key to subgroups

DEDA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Kandiudox**

DEDB. Other Kandiudox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Kandiudox**

DEDC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Kandiudox**

DEDD. Other Kandiudox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Kandiudox**

DEDE. Other Kandiudox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Kandiudox**

DEDF. 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**

DEDG. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kandiudox**

DEDH. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Kandiudox**

DEDI. Other Kandiudox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Kandiudox**

DEDJ. Other Kandiudox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Kandiudox**

DEDK. Other Kandiudox that have 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Kandiudox**

DEDL. Other Kandiudox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Kandiudox**

DEDM. Other Kandiudox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Kandiudox**

DEDN. Other Kandiudox.

**Typic Kandiudox**

## Sombriudox

Key to subgroups

DEAA. Sombriudox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Sombriudox**

DEAB. Other Sombriudox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Sombriudox**

DEAC. Other Sombriudox that have 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Sombriudox**

DEAD. Other Sombriudox.

**Typic Sombriudox**

## Ustox

Key to great groups

DCA. Ustox that have a sombric horizon within 150 cm of the mineral soil surface.

**Sombriustox, p.248**

DCB. Other Ustox that have, in one or more subhorizons of the oxic or kandic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

**Acrustox, p.244**

DCC. Other Ustox that have a base saturation (by $NH_4OAc$) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

**Eutrustox, p.245**

DCD. Other Ustox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Kandiustox, p.247**

DCE. Other Ustox.

**Haplustox, p.246**

## Acrustox

Key to subgroups

DCBA. Acrustox 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Acrustox**

DCBB. Other Acrustox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Acrustox**

DCBC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Acrustox**

DCBD. Other Acrustox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Acrustox**

DCBE. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Anionic Aquic Acrustox**

DCBF. 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 a depth of 125 cm of the soil surface.

**Anionic Acrustox**

DCBG. 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 Acrusto:**

DCBH. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Acrustox**

DCBI. 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**

DCBJ. Other Acrustox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Acrustox**

DCBK. Other Acrustox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Acrustox**

DCBL. Other Acrustox that have 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Acrustox**

DCBM. Other Acrustox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Acrustox**

DCBN. Other Acrustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Acrustox**

DCBO. Other Acrustox.

**Typic Acrustox**

## Eutrustox

Key to subgroups

DCCA. Eutrustox 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Eutrustox**

DCCB. Other Eutrustox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Eutrustox**

DCCC. Other Eutrustox 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Eutrustox**

DCCD. Other Eutrustox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Eutrustox**

DCCE. Other Eutrustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Eutrustox**

DCCF. Other Eutrustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

**Plinthic Eutrustox**

DCCG. Other Eutrustox 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Eutrustox**

DCCH. Other Eutrustox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Kandiustalfic Eutrustox**

DCCI. Other Eutrustox which have *both*:

1. 16 kg/m$^2$ 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.

**Umbreptic Eutrustox**

DCCJ. Other Eutrustox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

**Inceptic Eutrustox**

DCCK. Other Eutrustox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Eutrustox**

DCCL. Other Eutrustox that have *both*:

1. 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Eutrustox**

DCCM. Other Eutrustox that have 16 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Eutrustox**

DCCN. Other Eutrustox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Eutrustox**

DCCO. Other Eutrustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Eutrustox**

DCCP. Other Eutrustox.

**Typic Eutrustox**

## Haplustox

Key to subgroups

DCEA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Haplustox**

DCEB. Other Haplustox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Haplustox**

DCEC. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Haplustox**

DCED. Other Haplustox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Haplustox**

DCEE. Other Haplustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Haplustox**

DCEF. 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**

DCEG. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aqueptic Haplustox**

DCEH. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Haplustox**

DCEI. Other Haplustox that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Haplustox**

DCEJ. Other Haplustox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

**Inceptic Haplustox**

DCEK. Other Haplustox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Haplustox**

DCEL. Other Haplustox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Haplustox**

DCEM. Other Haplustox that have 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Haplustox**

DCEN. Other Haplustox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Haplustox**

DCEO. Other Haplustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Haplustox**

DCEP. Other Haplustox.

**Typic Haplustox**

## Kandiustox

Key to subgroups

DCDA. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Petroferric Kandiustox**

DCDB. Other Kandiustox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Kandiustox**

DCDC. Other Kandiustox 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Lithic Kandiustox**

DCDD. Other Kandiustox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Kandiustox**

DCDE. Other Kandiustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Kandiustox**

DCDF. Other Kandiustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

**Plinthic Kandiustox**

DCDG. Other Kandiustox 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kandiustox**

DCDH. Other Kandiustox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Humic Rhodic Kandiustox**

DCDI. Other Kandiustox that have *both*:

1. 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Humic Xanthic Kandiustox**

DCDJ. Other Kandiustox that have 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Kandiustox**

DCDK. Other Kandiustox that have 50 percent or more hue of 2.5YR or redder and color value, moist, of 3 or less between 25 and 125 cm from the mineral soil surface.

**Rhodic Kandiustox**

DCDL. Other Kandiustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

**Xanthic Kandiustox**

DCDM. Other Kandiustox.

**Typic Kandiustox**

## Sombriustox

Key to subgroups

DCAA. Sombriustox that have a petroferric contact within 125 cm of the mineral soil surface.

**Petroferric Sombriustox**

DCAB. Other Sombriustox that have a lithic contact within 125 cm of the mineral soil surface.

**Lithic Sombriustox**

DCAC. Other Sombriustox that have 16 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humic Sombriustox**

DCAD. Other Sombriustox.

**Typic Sombriustox**

# Chapter 14

# Spodosols[1]

Key to Suborders

BA. Spodosols that have aquic conditions for some time in most 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. 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

BB. Other Spodosols that have a cryic or pergelic soil temperature regime.

**Cryods**, p.251

BC. 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

BD. Other Spodosols.

**Orthods**, p.254

## Aquods

Key to great groups

BAA. Aquods that have a cryic or pergelic soil temperature regime.

**Cryaquods**, p.250

BAB. 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

BAC. Other Aquods that have a fragipan.

**Fragiaquods**, p.251

BAD. 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**

BAE. Other Aquods which 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.

**Duraquods, p.250**

BAF. Other Aquods that have episaturation.

**Epiaquods, p.251**

BAG. Other Aquods.

**Endoaquods, p.250**

## Alaquods

Key to subgroups

BABA. Alaquods that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Alaquods**

BABB. Other Alaquods which 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**

BABC. Other Alaquods that have a histic epipedon.

**Histic Alaquods**

BABD. Other Alaquods which have *both*:

1. Within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part; *and*

2. A sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

**Alfic Arenic Alaquods**

[1] This chapter on Spodosols was rewritten in 1992 following the recommendations of the International Committee on the Classification of Spodosols (ICOMOD), chaired initially by F. Ted Miller, then by Robert V. Rourke (since 1986).

BABE. Other Alaquods that have *both*:

1. An argillic or a kandic horizon within 200 cm of the mineral soil surface; *and*

2. A sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

**Arenic Ultic Alaquods**

BABF. Other Alaquods that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

**Arenic Alaquods**

BABG. Other Alaquods that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 125 cm or more.

**Grossarenic Alaquods**

BABH. Other Alaquods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

**Alfic Alaquods**

BABI. Other Alaquods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

**Ultic Alaquods**

BABJ. Other Alaquods that have an ochric epipedon.

**Aeric Alaquods**

BABK. Other Alaquods.

**Typic Alaquods**

## Cryaquods

Key to subgroups

BAAA. Cryaquods that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Cryaquods**

BAAB. Other Cryaquods that have a mean annual soil temperature of 0°C or less.

**Pergelic Cryaquods**

BAAC. 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**

BAAD. Other Cryaquods which 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**

BAAE. Other Cryaquods which 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**

BAAF. Other Cryaquods that do not have a spodic horizon 10 cm or more thick in 50 percent or more of each pedon.

**Entic Cryaquods**

BAAG. Other Cryaquods.

**Typic Cryaquods**

## Duraquods

Key to subgroups

BAEA. Duraquods that have a histic epipedon.

**Histic Duraquods**

BAEB. Other Duraquods which 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**

BAEC. Other Duraquods.

**Typic Duraquods**

## Endoaquods

Key to subgroups

BAGA. Endoaquods that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Endoaquods**

BAGB. Other Endoaquods that have a histic epipedon.

**Histic Endoaquods**

BAGC. Other Endoaquods which 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**

BAGD. Other Endoaquods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

**Argic Endoaquods**

BAGE. Other Endoaquods that have an umbric epipedon.

**Umbric Endoaquods**

BAGF. Other Endoaquods.

**Typic Endoaquods**

## Epiaquods

Key to subgroups

BAFA. Epiaquods that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Epiaquods**

BAFB. Other Epiaquods that have a histic epipedon.

**Histic Epiaquods**

BAFC. Other Epiaquods which 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**

BAFD. Other Epiaquods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

**Alfic Epiaquods**

BAFE. Other Epiaquods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

**Ultic Epiaquods**

BAFF. Other Epiaquods that have an umbric epipedon.

**Umbric Epiaquods**

BAFG. Other Epiaquods.

**Typic Epiaquods**

## Fragiaquods

Key to subgroups

BACA. Fragiaquods that have a histic epipedon.

**Histic Fragiaquods**

BACB. Other Fragiaquods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

**Plaggeptic Fragiaquods**

BACC. Other Fragiaquods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon.

**Argic Fragiaquods**

BACD. Other Fragiaquods.

**Typic Fragiaquods**

## Placaquods

Key to subgroups

BADA. Placaquods which 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**

BADB. Other Placaquods.

**Typic Placaquods**

## Cryods

Key to great groups

BBA. 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**

BBB. Other Cryods which 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**

BBC. 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.253**

BBD. Other Cryods.

**Haplocryods, p.252**

## Duricryods

Key to subgroups

BBBA. Duricryods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most 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**

BBBB. Other Duricryods which 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**

BBBC. Other Duricryods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Duricryods**

BBBD. Other Duricryods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6.0 or more out of 10 years.

**Oxyaquic Duricryods**

BBBE. Other Duricryods that have 6 percent or more organic carbon throughout a layer 10 cm or more thick within the spodic horizon.

**Humic Duricryods**

BBBF. Other Duricryods.

**Typic Duricryods**

## Haplocryods

Key to subgroups

BBDA. Haplocryods that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haplocryods**

BBDB. Other Haplocryods that have a mean annual soil temperature of $0^{o}C$ or less.

**Pergelic Haplocryods**

BBDC. Other Haplocryods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most 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**

BBDD. Other Haplocryods which 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**

BBDD. Other Haplocryods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Haplocryods**

BBDE. Other Haplocryods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Haplocryods**

BBDF. Other Haplocryods that have 1.1 percent or less organic carbon in the upper 10 cm of the spodic horizon.

**Entic Haplocryods**

BBDG. Other Haplocryods.

**Typic Haplocryods**

## Humicryods

Key to subgroups

BBCA. Humicryods that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Humicryods**

BBCB. Other Humicryods that have a mean annual soil temperature of 0°C or less.

**Pergelic Humicryods**

BBCC. Other Humicryods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most 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**

BBBD. Other Humicryods which 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**

BBBE. Other Humicryods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Humicryods**

BBBF. Other Humicryods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Humicryods**

BBCG. Other Humicryods.

**Typic Humicryods**

## Placocryods

Key to subgroups

BBAA. Placocryods which 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**

BBAB. 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**

BBAC. Other Placocryods.

**Typic Placocryods**

## Humods

Key to great groups

BCA. 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

BCB. Other Humods which 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.254

BCC. Other Humods that have a fragipan.

**Fragihumods**, p.254

BCD. Other Humods.

**Haplohumods**, p.254

## Durihumods

Key to subgroups

BCBA. Durihumods which 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**

BCBB. Other Durihumods.

**Typic Durihumods**

## Fragihumods

Key to subgroups

BCCA. All Fragihumods (provisionally).

**Typic Fragihumods**

## Haplohumods

Key to subgroups

BCDA. Haplohumods that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haplohumods**

BCDB. Other Haplohumods which 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**

BCDC. Other Haplohumods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

**Plaggeptic Haplohumods**

BCDD. Other Haplohumods.

**Typic Haplohumods**

## Placohumods

Key to subgroups

BCAA. Placohumods which 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**

BCAB. Other Placohumods.

**Typic Placohumods**

# Orthods

Key to great groups

BDA. 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

BDB. Other Orthods which 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

BDC. Other Orthods that have a fragipan.

**Fragiorthods,** p.255

BDD. 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

BDE. Other Orthods.

**Haplorthods,** p.256

## Alorthods

Key to subgroups

BDDA. Alorthods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Alorthods**

BDDB. Other Alorthods that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm; *and*

2. An argillic or a kandic horizon below the spodic horizon.

**Arenic Ultic Alorthods**

BDDC. Other Alorthods that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

**Arenic Alorthods**

BDDD. Other Alorthods that have *both*:

1. A sandy particle size throughout a layer extending from the mineral soil surface to the top of the 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**

BDDE. 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**

BDDF. Other Alorthods that have a sandy particle size throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 125 cm or more.

**Grossarenic Alorthods**

BDDG. Other Alorthods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

**Plaggeptic Alorthods**

BDDH. Other Alorthods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

**Alfic Alorthods**

BDDI. Other Alorthods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

**Ultic Alorthods**

BDDJ. Other Alorthods.

**Typic Alorthods**

## Durorthods

Key to subgroups

BDBA. Durorthods which 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**

BDBB. Other Durorthods.

**Typic Durorthods**

## Fragiorthods

Key to subgroups

BDCA. Fragiorthods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Fragiorthods**

BDCB. Other Fragiorthods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Fragiorthods**

BDCC. Other Fragiorthods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

**Plaggeptic Fragiorthods**

BDCD. Other Fragiorthods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

**Alfic Fragiorthods**

BDCE. Other Fragiorthods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

**Ultic Fragiorthods**

BDCF. Other Fragiorthods which 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**

BDCG. Other Fragiorthods.

**Typic Fragiorthods**

## Haplorthods

Key to subgroups

BDEA. Haplorthods which 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**

BDEB. Other Haplorthods that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haplorthods**

BDEC. Other Haplorthods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

**Aqualfic Haplorthods**

BDED. Other Haplorthods which have in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most 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**

BDEE. Other Haplorthods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Haplorthods**

BDEF. Other Haplorthods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Haplorthods**

BDEG. Other Haplorthods which 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**

BDEH. Other Haplorthods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

**Alfic Haplorthods**

BDEI. Other Haplorthods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

**Ultic Haplorthods**

BDEJ. Other Haplorthods which 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**

BDEK. Other Haplorthods.

**Typic Haplorthods**

## Placorthods

Key to subgroups

BDAA. All Placorthods (provisionally).

**Typic Placorthods**

SPO

# Chapter 15

# Ultisols

Key to suborders

GA. Ultisols that have aquic conditions for some time in most 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 a chroma of 2 or less either on faces of peds or in the matrix; *or*

   b. Fifty percent or more redox depletions with a 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 α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquults**, p.259

GB. Other Ultisols that have *one or both* of the following:

1. 0.9 percent or more organic carbon in the upper 15 cm of the argillic or kandic horizon; *or*

2. 12 kg/m$^2$ or more organic carbon between the mineral soil surface and a depth of 100 cm.

**Humults**, p.263

GC. Other Ultisols that have a udic moisture regime.

**Udults**, p.266

GD. Other Ultisols that have an ustic moisture regime.

**Ustults**, p.273

GE. Other Ultisols.

**Xerults**, p.277

## Aquults

Key to great groups

GAA. 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

GAB. Other Aquults which have a fragipan that has its upper boundary *either*:

1. Within 200 cm of the mineral soil surface if no horizon contains 5 percent or more (by volume) plinthite; *or*

2. Within 100 cm of the mineral soil surface if there is 5 percent or more (by volume) plinthite in one or more horizons of the soil.

**Fragiaquults**, p.261

GAC. Other Aquults that have an abrupt textural change between the ochric epipedon or albic horizon and the argillic or kandic horizon, *and* have low hydraulic conductivity in the argillic or kandic horizon.

**Albaquults**, p.260

GAD. Other Aquults which:

1. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *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; *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.

**Kandiaquults**, p.261

GAE. Other Aquults that have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7,

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plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

**Kanhaplaquults**, p.262

GAF. Other Aquults which:

1. Do not have a 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. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *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.

**Paleaquults**, p.262

GAG. Other Aquults that have an umbric or a mollic epipedon.

**Umbraquults**, p.263

GAH. Other Aquults that have episaturation.

**Epiaquults**, p.260

GAI. Other Aquults.

**Endoaquults**, p.260

## Albaquults

GACA. Albaquults which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Albaquults**

GACB. 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**

GACC. Other Albaquults.

**Typic Albaquults**

## Endoaquults

Key to subgroups

GAIA. Endoaquults that have a sandy particle size 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 Endoaquults**

GAIB. Other Endoaquults that have a sandy particle size 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 Endoaquults**

GAIC. Other Endoaquults 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 Endoaquults**

GAID. Other Endoaquults.

**Typic Endoaquults**

## Epiaquults

Key to subgroups

GAHA. Epiaquults 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Epiaquults**

GAHB. Other Epiaquults that have a sandy particle size 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**

GAHC. Other Epiaquults that have a sandy particle size 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**

GAHD. 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**

GAHE. Other Epiaquults.

**Typic Epiaquults**

## Fragiaquults

Key to subgroups

GABA. Fragiaquults that have *both*:

1. Fifty 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; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Plinthudic Fragiaquults**

GABB. Other 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**

GABC. 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**

GABD. Other Fragiaquults that do not have an ochric epipedon.

**Umbric Fragiaquults**

GABE. Other Fragiaquults.

**Typic Fragiaquults**

## Kandiaquults

Key to subgroups

GADA. Kandiaquults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

**Acraquoxic Kandiaquults**

GADB. Other Kandiaquults that have *both*:

1. A sandy particle size 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; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Arenic Plinthic Kandiaquults**

GADC. Other Kandiaquults that:

1. Do not have an ochric epipedon; *and*

2. Have a sandy particle size 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 Umbric Kandiaquults**

GADD. Other Kandiaquults that have a sandy particle size 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 Kandiaquults**

GADE. Other Kandiaquults that have a sandy particle size 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 Kandiaquults**

GADF. 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**

GADG. 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**

GADH. Other Kandiaquults that do not have an ochric epipedon.

**Umbric Kandiaquults**

GADI. Other Kandiaquults.

**Typic Kandiaquults**

## Kanhaplaquults

Key to subgroups

GAEA. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron 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 are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Kanhaplaquults**

GAEB. 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**

GAEC. Other Kanhaplaquults which:

1. Do not have an ochric 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**

GAED. 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**

GAEE. Other Kanhaplaquults that do not have an ochric epipedon.

**Umbric Kanhaplaquults**

GAEF. Other Kanhaplaquults.

**Typic Kanhaplaquults**

## Paleaquults

Key to subgroups

GAFA. Paleaquults which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Paleaquults**

GAFB. Other Paleaquults that have *both:*

1. A sandy particle size 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. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Arenic Plinthic Paleaquults**

GAFC. Other Paleaquults which:

1. Do not have an ochric epipedon; *and*

2. Have a sandy particle size 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**

GAFD. Other Paleaquults that have a sandy particle size 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**

GAFE. Other Paleaquults that have a sandy particle size 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**

GAFF. 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**

GAFG. 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**

GAFH. Other Paleaquults that do not have an ochric epipedon.
**Umbric Paleaquults**

GAFI. Other Paleaquults.
**Typic Paleaquults**

## Plinthaquults

Key to subgroups

GAAA. Plinthaquults that have a CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[1] 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**

GAAB. Other Plinthaquults.
**Typic Plinthaquults**

[1] Some soils with properties that approach those of an Oxisol do not disperse well. 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 (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

## Umbraquults

Key to subgroups

GAGA. Umbraquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
**Plinthic Umbraquults**

GAGB. Other Umbraquults.
**Typic Umbraquults**

## Humults

Key to great groups

GBA. Humults that have a sombric horizon within 100 cm of the mineral soil surface.
**Sombrihumults**, p.266

GBB. 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

GBC. Other Humults which:

1. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *and*

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

   a. Do not have a clay decrease with depth of 20 percent or more (relative) from the maximum clay content; *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.
**Kandihumults**, p.264

GBD. Other Humults that have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

**Kanhaplohumults**, p.265

GBE. Other Humults which:

1. Do not have a 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. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *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.

**Palehumults**, p.265

GBF. Other Humults.

**Haplohumults**, p.264

## Haplohumults

Key to subgroups

GBFA. Haplohumults that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haplohumults**

GBFB. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Haplohumults**

GBFC. 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Haplohumults**

GBFD. 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**

GBFE. Other Haplohumults that have an ustic moisture regime.

**Ustic Haplohumults**

GBFF. Other Haplohumults that have a xeric moisture regime.

**Xeric Haplohumults**

GBFG. Other Haplohumults.

**Typic Haplohumults**

## Kandihumults

Key to subgroups

GBCA. 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. In one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

**Andic Ombroaquic Kandihumults**

GBCB. 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. An ustic moisture regime.

**Ustandic Kandihumults**

GBCC. 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Kandihumults**

GBCD. Other Kandihumults 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kandihumults**

GBCE. Other Kandihumults that 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 a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

**Ombroaquic Kandihumults**

GBCF. 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**

GBCG. Other Kandihumults that have an ustic moisture regime.

**Ustic Kandihumults**

GBCH. Other Kandihumults that have a xeric moisture regime.

**Xeric Kandihumults**

GBCI. Other Kandihumults that have an anthropic epipedon.

**Anthropic Kandihumults**

GBCJ. Other Kandihumults.

**Typic Kandihumults**

## Kanhaplohumults

Key to subgroups

GBDA. Kanhaplohumults that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Kanhaplohumults**

GBDB. 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Ustandic Kanhaplohumults**

GBDC. 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Kanhaplohumults**

GBDD. Other Kanhaplohumults 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kanhaplohumults**

GBDE. Other Kanhaplohumults that 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 a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

**Ombroaquic Kanhaplohumults**

GBDF. Other Kanhaplohumults that have an ustic moisture regime.

**Ustic Kanhaplohumults**

GBDG. Other Kanhaplohumults that have a xeric moisture regime.

**Xeric Kanhaplohumults**

GBDH. Other Kanhaplohumults that have an anthropic epipedon.

**Anthropic Kanhaplohumults**

GBDI. Other Kanhaplohumults.

**Typic Kanhaplohumults**

## Palehumults

Key to subgroups

GBEA. 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Palehumults**

GBEB. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Palehumults**

GBEC. 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**

GBED. Other Palehumults that have an ustic moisture regime.

**Ustic Palehumults**

GBEF. Other Palehumults that have a xeric moisture regime.

**Xeric Palehumults**

GBEG. Other Palehumults.

**Typic Palehumults**

## Plinthohumults

Key to subgroups

GBBA. All Plinthohumults (provisionally).

**Typic Plinthohumults**

## Sombrihumults

Key to subgroups

GBAA. All Sombrihumults (provisionally).

**Typic Sombrihumults**

# Udults

Key to great groups

GCA. 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.273

GCB. Other Udults that have a fragipan within or below the argillic or kandic horizon.

**Fragiudults**, p.267

GCC. Other Udults which:

1. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *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; *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.

**Kandiudults**, p.268

GCD. Other Udults that have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

**Kanhapludults**, p.270

GCE. Other Udults which:

1. Do not have a 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. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *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.

**Paleudults**, p.271

GCF. Other Udults which have *both*:

1. An epipedon that has a color value, moist, of 3 or less throughout; *and*

2. An argillic horizon that has a color value, dry, of 4 or less, and a color value, moist, that is no more than 1 unit lower than the value, dry.

**Rhodudults**, p.273

GCG. Other Udults.

**Hapludults**, p.268

## Fragiudults

Key to subgroups

GCBA. Fragiudults that have a sandy particle size 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 Fragiudults**

GCBB. Other Fragiudults which have:

1. *Either* of the following:

   a. Above the fragipan, no argillic or kandic horizon that has clay films on both vertical and horizontal surfaces of any structural aggregates; *or*

   b. Between the argillic or kandic horizon and the fragipan, 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 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, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

3. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Plinthaquic Fragiudults**

GCBC. Other Fragiudults that have *both*:

1. *Either* of the following:

   a. Above the fragipan, no argillic or kandic horizon that has clay films on both vertical and horizontal surfaces of any structural aggregates; *or*

   b. Between the argillic or kandic horizon and the fragipan, 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 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, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Glossaquic Fragiudults**

GCBD. 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 a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Fragiudults**

GCBE. 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**

GCBF. Other Fragiudults that have *either*:

1. Above the fragipan, no argillic or kandic horizon that has clay films on both vertical and horizontal surfaces of any structural aggregates; *or*

2. Between the argillic or kandic horizon and the fragipan, 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 in both the argillic or kandic horizon and the fragipan.

**Glossic Fragiudults**

GCBG. Other Fragiudults which have either an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

**Humic Fragiudults**

GCBH. Other Fragiudults.

**Typic Fragiudults**

## Hapludults

Key to subgroups

GCGA. Hapludults which have *both*:

1. A 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**

GCGB. Other Hapludults that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Hapludults**

GCGC. Other Hapludults which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Hapludults**

GCGD. Other Hapludults that have a texture of loamy fine sand or coarser throughout the argillic horizon, or lamellae within its upper 25 cm.

**Psammentic Hapludults**

GCGE. Other Hapludults that have a sandy particle size 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**

GCGF. Other Hapludults that have a sandy particle size 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**

GCGG. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Hapludults**

GCGH. Other Hapludults that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Hapludults**

GCGI. Other Hapludults which have either an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

**Humic Hapludults**

GCGJ. Other Hapludults that have an argillic horizon 25 cm or less thick.

**Ochreptic Hapludults**

GCGK. Other Hapludults.

**Typic Hapludults**

## Kandiudults

Key to subgroups

GCCA. Kandiudults that have:

1. A sandy particle size 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. Five 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 argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Arenic Plinthaquic Kandiudults**

GCCB. Other Kandiudults that have *both*:

1. A sandy particle size 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 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 or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Arenic Kandiudults**

GCCC. Other Kandiudults that have *both*:

1. A sandy particle size 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; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Arenic Plinthic Kandiudults**

GCCD. Other Kandiudults that have *both*:

1. A sandy particle size 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; *and*

2. Throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Arenic Rhodic Kandiudults**

GCCE. Other Kandiudults that have a sandy particle size 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 Kandiudults**

GCCF. Other Kandiudults that have *both*:

1. A sandy particle size 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; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Grossarenic Plinthic Kandiudults**

GCCG. Other Kandiudults that have a sandy particle size 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 Kandiudults**

GCCH. Other Kandiudults that have *both*:

1. An ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Acrudoxic Plinthic Kandiudults**

GCCI. Other Kandiudults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

**Acrudoxic Kandiudults**

GCCJ. Other Kandiudults that have *both*:

1. Five 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Kandiudults**

GCCK. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammo-nium oxalate) totaling more than 1.0; *or*

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b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like 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 fraction, 5 percent or more volcanic glass, and

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

**Aquandic Kandiudults**

GCCL. 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/cm$^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Kandiudults**

GCCM. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kandiudults**

GCCN. 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**

GCCO. Other Kandiudults that 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 a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

**Ombroaquic Kandiudults**

GCCP. Other Kandiudults that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Kandiudults**

GCCQ. Other Kandiudults that have a sombric horizon within 150 cm of the mineral soil surface.

**Sombric Kandiudults**

GCCR. Other Kandiudults that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Kandiudults**

GCCS. Other Kandiudults.

**Typic Kandiudults**

## Kanhapludults

Key to subgroups

GCDA. Kanhapludults that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Kanhapludults**

GCDB. Other Kanhapludults that have *both*:

1. A sandy particle size 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; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Arenic Plinthic Kanhapludults**

GCDC. Other Kanhapludults that have a sandy particle size 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 Kanhapludults**

GCDD. Other Kanhapludults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

**Acrudoxic Kanhapludults**

GCDE. Other Kanhapludults that have *both:*

1. Five 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Plinthaquic Kanhapludults**

GCDF. 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Kanhapludults**

GCDG. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kanhapludults**

GCDH. 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**

GCDI. Other Kanhapludults that 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 a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

**Ombroaquic Kanhapludults**

GCDJ. Other Kanhapludults that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Kanhapludults**

GCDK. Other Kanhapludults that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Kanhapludults**

GCDL. Other Kanhapludults.

**Typic Kanhapludults**

## Paleudults

Key to subgroups

GCEA. Paleudults which 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 most 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 lithic or paralithic contact, whichever is shallower.

**Vertic Paleudults**

GCEB. Other Paleudults which 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. Aluminum plus 1/2 iron 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**

GCEC. Other Paleudults that have *both*:

1. A texture of loamy fine sand or coarser throughout the argillic horizon, or lamellae within its upper 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 argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Psammaquentic Paleudults**

GCED. Other Paleudults that have a texture of loamy fine sand or coarser throughout the argillic horizon, or lamellae within its upper 100 cm.

**Psammentic Paleudults**

GCEE. 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 or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy particle size 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*

3. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
**Arenic Plinthaquic Paleudults**

GCEF. Other Paleudults that have *both*:

1. A sandy particle size 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 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 or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Arenic Paleudults**

GCEG. Other Paleudults that have *both*:

1. A sandy particle size 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. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
**Arenic Plinthic Paleudults**

GCEH. Other Paleudults which have *both*:

1. A sandy particle size 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. Throughout the upper 100 cm of the argillic horizon,

   a. A color value, moist, of 3 or less and a color value, dry, that is no more than 1 unit higher than the value, moist; *and*

   b. No redox concentrations with a chroma of 3 or more.
**Arenic Rhodic Paleudults**

GCEI. Other Paleudults that have a sandy particle size 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**

GCEJ. Other Paleudults that have *both*:

1. A sandy particle size 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. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
**Grossarenic Plinthic Paleudults**

GCEK. Other Paleudults that have a sandy particle size 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**

GCEL. Other Paleudults that have *both*:

1. Five 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).
**Plinthaquic Paleudults**

GCEM. Other Paleudults that have *both*:

1. Within 125 cm of the mineral soil surface, one or more subhorizons in the argillic horizon with all the properties of a fragipan, except that only 40 to 60 percent of the volume is brittle; *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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Fragiaquic Paleudults**

GCEN. Other Paleudults that have anthraquic conditions.

**Anthraquic Paleudults**

GCEO. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Paleudults**

GCEP. 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**

GCEQ. Other Paleudults that have, within 125 cm of the mineral soil surface, one or more subhorizons in the argillic horizon with all the properties of a fragipan, except that only 0 to 60 percent of the volume is brittle.

**Fragic Paleudults**

GCER. Other Paleudults which have, throughout the upper 100 cm of the argillic horizon:

1. A color value, moist, of 3 or less and a color value, dry, that is no more than 1 unit higher than the value, moist; *and*

2. No redox concentrations with a chroma of 3 or more.

**Rhodic Paleudults**

GCES. Other Paleudults.

**Typic Paleudults**

## Plinthudults

Key to subgroups

GCBA. All Plinthudults (provisionally).

**Typic Plinthudults**

## Rhodudults

Key to subgroups

GCFA. Rhodudults that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Rhodudults**

GCFB. Other Rhodudults that have a texture of loamy fine sand or coarser throughout the argillic horizon.

**Psammentic Rhodudults**

GCFC. Other Rhodudults.

**Typic Rhodudults**

## Ustults

Key to great groups

GDA. 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

GDB. Other Ustults which:

1. Do not have a lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *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; *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.

**Kandiustults**, p.274

GDC. Other Ustults that have a CEC of 16 cmol(+)/kg clay or less (by 1N $NH_4OAc$ pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

**Kanhaplustults**, p.275

GDD. Other Ustults which:

1. Do not have a 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. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *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.

**Paleustults**, p.277

GDE. Other Ustults which have *both*:

1. An epipedon that has a color value, moist, of 3 or less throughout; *and*

2. An argillic horizon that has a color value, dry, of 4 or less, and a color value, moist, that is no more than 1 unit lower than the value, dry.

**Rhodustults**, p.277

GDF. Other Ustults.

**Haplustults**, p.274

## Haplustults

Key to subgroups

GDFA. Haplustults that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haplustults**

GDFB. Other Haplustults that have a petroferric contact within 100 cm of the mineral soil surface.

**Petroferric Haplustults**

GDFC. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Haplustults**

GDFD. Other Haplustults that have a sandy particle size 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 Haplustults**

GDFE. Other Haplustults that 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 a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

**Ombroaquic Haplustults**

GDFF. 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**

GDFG. Other Haplustults that have a CEC (by 1N $NH_4OAc$ pH 7) of less than 24 cmol(+)/kg clay[2] in 50 percent or more of the argillic horizon if less than 100 cm thick, or of its upper 100 cm.

**Kanhaplic Haplustults**

GDFH. Other Haplustults.

**Typic Haplustults**

## Kandiustults

Key to subgroups

GDBA. Kandiustults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

**Acrustoxic Kandiustults**

GDBB. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kandiustults**

[2] Some soils with properties that approach those of an oxic horizon do not disperse well. 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 (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

GDBC. Other Kandiustults that have *both*:

1. A sandy particle size 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; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

**Arenic Plinthic Kandiustults**

GDBD. Other Kandiustults that have a sandy particle size 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 Kandiustults**

GDBE. Other Kandiustults which 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. If 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 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, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section that 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.

**Udandic Kandiustults**

GDBF. 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Kandiustults**

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

**Plinthic Kandiustults**

GDBH. Other Kandiustults which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A thermic, mesic, or colder soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Kandiustults**

GDBI. Other Kandiustults which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 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 Kandiustults**

GDBJ. Other Kandiustults that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Kandiustults**

GDBK. Other Kandiustults.

**Typic Kandiustults**

## Kanhaplustults

Key to subgroups

GDCA. Kanhaplustults that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Kanhaplustults**

GDCB. Other Kanhaplustults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N $NH_4OAc$ pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

**Acrustoxic Kanhaplustults**

GDCC. 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

**Aquic Kanhaplustults**

GDCD. Other Kanhaplustults that have a sandy particle size 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 Kanhaplustults**

GDCE. Other Kanhaplustults which 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. If neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 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*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 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.

**Udandic Kanhaplustults**

GDCF. 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 $g/cm^3$ or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

**Andic Kanhaplustults**

GDCG. 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**

GDCH. Other Kanhaplustults that 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 a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

**Ombroaquic Kanhaplustults**

GDCI. Other Kanhaplustults which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A thermic, mesic, or colder soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 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 Kanhaplustults**

GDCJ. Other Kanhaplustults which, if neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 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, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 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 Kanhaplustults**

GDCK. Other Kanhaplustults that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, that is no more than one unit higher than the value, moist.

**Rhodic Kanhaplustults**

GDCL. Other Kanhaplustults.
**Typic Kanhaplustults**

## Paleustults

Key to the subgroups

GDDA. All Paleustults (provisionally).
**Typic Paleustults**

## Plinthustults

Key to subgroups

GDAA. All Plinthustults (provisionally).
**Typic Plinthustults**

## Rhodustults

Key to subgroups

GDEA. Rhodustults that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Rhodustults**

GDEB. Other Rhodustults that have a texture of loamy fine sand or coarser throughout the argillic horizon.
**Psammentic Rhodustults**

GDEC. Other Rhodustults.
**Typic Rhodustults**

## Xerults

Key to great groups

GEA. Xerults which:

1. Do not have a 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; *or*

   b. Have 5 percent or more (by volume) skeletans 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.278

GEB. Other Xerults.
**Haploxerults**, p.277

## Haploxerults

Key to subgroups

GEBA. Haploxerults which have *both*:

1. A 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-Xerochreptic Haploxerults**

GEBB. Other Haploxerults that have a lithic contact within 50 cm of the mineral soil surface.
**Lithic Haploxerults**

GEBC. Other Haploxerults 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 a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).
**Aquic Haploxerults**

GEBD. Other Haploxerults that have a texture of loamy fine sand or coarser throughout the argillic horizon, or lamellae within its upper 25 cm.
**Psammentic Haploxerults**

GEBE. Other Haploxerults that have a sandy particle size 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 Haploxerults**

GEBF. Other Haploxerults that have a sandy particle size 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 Haploxerults**

GEBG. 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 aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.
**Andic Haploxerults**

GEBH. Other Haploxerults.

**Typic Haploxerults**

## Palexerults

Key to subgroups

GEAA. All Palexerults (provisionally).

**Typic Palexerults**

# Chapter 16

# Vertisols[1]

Key to suborders

EA. Vertisols which have, in one or more horizons between 40 and 50 cm from the mineral soil surface, aquic conditions for some time in most 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. Two or less if redox concentrations are present; *or*

   b. One or less; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquerts**, p.279

EB. Other Vertisols that have a cryic soil temperature regime.

**Cryerts**, p.283

EC. Other Vertisols which, in 6 or more out of 10 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. Five 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.290

ED. Other Vertisols which, if not irrigated during the year, have cracks in 6 or more out of 10 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.

**Torrerts**, p.284

EE. Other Vertisols which, if not irrigated during the year, have 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 90 or more cumulative days per year.

**Usterts**, p.286

EF. Other Vertisols.

**Uderts**, p.285

## Aquerts

Key to great groups

EAA. Aquerts which have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Salaquerts**, p.283

EAB. Other Aquerts which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

**Duraquerts**, p.280

EAC. Other Aquerts that have a natric horizon.

**Natraquerts**, p.283

EAD. Other Aquerts which have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Calciaquerts**, p.279

EAE. Other Aquerts 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 of 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 $CaCl_2$ (5.0 or less in 1:1 water).

**Dystraquerts**, p.280

EAF. Other Aquerts that have episaturation.

**Epiaquerts**, p.282

EAG. Other Aquerts.

**Endoaquerts**, p.281

## Calciaquerts

Key to subgroups

EADA. 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

[1] This chapter on Vertisols was rewritten in 1992 following the recommendations of the International Committee on the Classification of Vertisols (ICOMERT), chaired by Juan Comerma.

75 cm or the upper boundary of a duripan if shallower, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

**Aeric Calciaquerts**

EADB. Other Calciaquerts.

**Typic Calciaquerts**

## Duraquerts

Key to subgroups

EABA. Duraquerts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Duraquerts**

EABB. Other Duraquerts which have a thermic, mesic, or frigid soil temperature regime and which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain *both*:

1. Five 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**

EABC. Other Duraquerts which, if not irrigated during the year, have 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 90 or more cumulative days per year.

**Ustic Duraquerts**

EABD. 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. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

**Aeric Duraquerts**

EABE. 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**

EABF. Other Duraquerts.

**Typic Duraquerts**

## Dystraquerts

Key to subgroups

EAEA. 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**

EAEB. Other Dystraquerts that have more than 2.0 cmol(+)/kg $Al^{3+}$ (by 1N KCl) in the fine-earth fraction throughout a layer 10 cm or more thick with an upper boundary between 25 and 50 cm from the mineral soil surface.

**Alic Dystraquerts**

EAEC. Other Dystraquerts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Dystraquerts**

EAED. Other Dystraquerts which, if not irrigated during the year, have 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 90 or more cumulative days per year.

**Ustic Dystraquerts**

EAEE. 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. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

**Aeric Dystraquerts**

EAEF. Other Dystraquerts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

**Leptic Dystraquerts**

EAEG. Other Dystraquerts which 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**

EAEH. 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**

EAEI. Other Dystraquerts.

**Typic Dystraquerts**

## Endoaquerts

Key to subgroups

EAGA. 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 (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

**Halic Endoaquerts**

EAGB. 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 per year in 6 or more out of 10 years.

**Sodic Endoaquerts**

EAGC. Other Endoaquerts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Endoaquerts**

EAGD. Other Endoaquerts which have a thermic, mesic, or frigid soil temperature regime and which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain *both*:

1. Five 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**

EAGE. Other Endoaquerts which, if not irrigated during the year, have 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 90 or more cumulative days per year.

**Ustic Endoaquerts**

EAGF. 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. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

**Aeric Endoaquerts**

EAGG. Other Endoaquerts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

**Leptic Endoaquerts**

EAGH. Other Endoaquerts which 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**

EAGI. 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**

EAGJ. Other Endoaquerts.

**Typic Endoaquerts**

## Epiaquerts

Key to subgroups

EAFA. 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 (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

**Halic Epiaquerts**

EAFB. 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 per year in 6 or more out of 10 years.

**Sodic Epiaquerts**

EAFC. Other Epiaquerts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Epiaquerts**

EAFD. Other Epiaquerts which have a thermic, mesic, or frigid soil temperature regime and which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain *both*:

1. Five 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**

EAFE. Other Epiaquerts which, if not irrigated during the year, have 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 90 or more cumulative days per year.

**Ustic Epiaquerts**

EAFF. 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. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

**Aeric Epiaquerts**

EAFG. Other Epiaquerts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

**Leptic Epiaquerts**

EAFH. Other Epiaquerts which 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**

EAFI. 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**

EAFJ. Other Epiaquerts.

**Typic Epiaquerts**

## Natraquerts

Key to subgroups

EAAC. All Natraquerts.

**Typic Natraquerts**

## Salaquerts

Key to subgroups

EAAA. Salaquerts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Salaquerts**

EAAB. Other Salaquerts which, if not irrigated during the year, have 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 90 or more cumulative days per year.

**Ustic Salaquerts**

EAAC. Other Salaquerts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

**Leptic Salaquerts**

EAAD. Other Salaquerts which 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**

EAAE. 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. A chroma of 3 or more.

**Chromic Salaquerts**

EAAF. Other Salaquerts.

**Typic Salaquerts**

## Cryerts

Key to great groups

EBA. Cryerts that have 10 $kg/m^2$ or more organic carbon between the mineral soil surface and a depth of 50 cm.

**Humicryerts, p.284**

EBB. Other Cryerts.

**Haplocryerts, p.283**

## Haplocryerts

Key to subgroups

EBBA. 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 per year in 6 or more out of 10 years.

**Sodic Haplocryerts**

EBBB. 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. A chroma of 3 or more.

**Chromic Haplocryerts**

EBBC. Other Haplocryerts.

**Typic Haplocryerts**

## Humicryerts

Key to subgroups

EBAA. 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 per year in 6 or more out of 10 years.

**Sodic Humicryerts**

EBAB. Other Humicryerts.

**Typic Humicryerts**

## Torrerts

Key to great groups

EDA. Torrerts which have a salic horizon that has its upper boundary within 100 cm of the soil surface.

**Salitorrerts, p.285**

EDB. Other Torrerts which have a gypsic horizon that has its upper boundary within 100 cm of the soil surface.

**Gypsitorrerts, p.284**

EDC. Other Torrerts which have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

**Calcitorrerts, p.284**

EDD. Other Torrerts.

**Haplotorrerts, p.284**

## Calcitorrerts

Key to subgroups

EDCA. Calcitorrerts which have a petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

**Petrocalcic Calcitorrerts**

EDCB. Other Calcitorrerts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the soil surface.

**Leptic Calcitorrerts**

EDCC. Other Calcitorrerts which 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**

EDCD. 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. A chroma of 3 or more.

**Chromic Calcitorrerts**

EDCE. Other Calcitorrerts.

**Typic Calcitorrerts**

## Gypsitorrerts

Key to subgroups

EDBA. Gypsitorrerts 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. A chroma of 3 or more.

**Chromic Gypsitorrerts**

EDBB. Other Gypsitorrerts.

**Typic Gypsitorrerts**

## Haplotorrerts

Key to subgroups

EDDA. 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 (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

**Halic Haplotorrerts**

EDDB. 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 per year in 6 or more out of 10 years.

**Sodic Haplotorrerts**

EDDC. Other Haplotorrerts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the soil surface.

**Leptic Haplotorrerts**

EDDD. Other Haplotorrerts which 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**

EDDE. 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. A chroma of 3 or more.

**Chromic Haplotorrerts**

EDDF. Other Haplotorrerts.

**Typic Haplotorrerts**

## Salitorrerts

Key to subgroups

EDAA. Salitorrerts that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to $\alpha,\alpha'$-dipyridyl at a time when the soil is not being irrigated.

**Aquic Salitorrerts**

EDAB. Other Salitorrerts that have a lithic or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the soil surface.

**Leptic Salitorrerts**

EDAC. Other Salitorrerts which 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**

EDAD. 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. A chroma of 3 or more.

**Chromic Salitorrerts**

EDAE. Other Salitorrerts.

**Typic Salitorrerts**

## Uderts

Key to great groups

EFA.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 of 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 $CaCl_2$ (5.0 or less in 1:1 water).

**Dystruderts,** p.285

EFB.Other Uderts.

**Hapluderts,** p.286

## Dystruderts

Key to subgroups

EFAA. Other Dystruderts that have more than 2.0 cmol(+)/kg $Al^{3+}$ (by 1N KCl) in the fine-earth fraction throughout a layer 10 cm or more thick with an upper boundary between 25 and 50 cm from the mineral soil surface.

**Alic Dystruderts**

EFAB. Other Dystruderts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Dystruderts**

EFAC. Other Dystruderts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Dystruderts**

EFAD. Other Dystruderts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

**Leptic Dystruderts**

EFAE. Other Dystruderts which 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**

EFAF. 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. A chroma of 3 or more.

**Chromic Dystruderts**

EFAG. Other Dystruderts.

**Typic Dystruderts**

## Hapluderts

Key to subgroups

EFBA. Hapluderts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Hapluderts**

EFBB. Other Hapluderts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Hapluderts**

EFBC. Other Hapluderts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

**Oxyaquic Hapluderts**

EFBD. Other Hapluderts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

**Leptic Hapluderts**

EFBE. Other Hapluderts which 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**

EFBF. 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. A chroma of 3 or more.

**Chromic Hapluderts**

EFBG. Other Hapluderts.

**Typic Hapluderts**

## Usterts

Key to great groups

EEA. 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 of 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 $CaCl_2$ (5.0 or less in 1:1 water).

**Dystrusterts**, p.287

EEB. Other Usterts which have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Salusterts**, p.289

EEC. Other Usterts which have a gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Gypsiusterts, p.288**

EED. Other Usterts which have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Calciusterts, p.287**

EEE. Other Usterts.

**Haplusterts, p.288**

## Calciusterts

Key to subgroups

EEDA. Calciusterts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Calciusterts**

EEDB. 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 (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

**Halic Calciusterts**

EEDC. 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 per year in 6 or more out of 10 years.

**Sodic Calciusterts**

EEDD. Other Calciusterts which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Petrocalcic Calciusterts**

EEDE. Other Calciusterts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Calciusterts**

EEDF. Other Calciusterts which, if not irrigated during the year, have 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.

**Udic Calciusterts**

EEDG. Other Calciusterts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

**Leptic Calciusterts**

EEDH. Other Calciusterts which 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**

EEDI. 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. A chroma of 3 or more.

**Chromic Calciusterts**

EEDJ. Other Calciusterts.

**Typic Calciusterts**

## Dystrusterts

Key to subgroups

EEAA. Dystrusterts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Dystrusterts**

EEAB. Other Dystrusterts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) ***and either***:

1. Redoximorphic features; *or*
2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Dystrusterts**

EEAC. Other Dystrusterts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Dystrusterts**

EEAD. Other Dystrusterts which, if not irrigated during the year, have 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.

**Udic Dystrusterts**

EEAE. Other Dystrusterts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

**Leptic Dystrusterts**

EEAF. Other Dystrusterts which 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**

EEAG. 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. A chroma of 3 or more.

**Chromic Dystrusterts**

EEAH. Other Dystrusterts.

**Typic Dystrusterts**

## Gypsiusterts

Key to subgroups

EECA. Gypsiusterts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Gypsiusterts**

EECB. 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 (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

**Halic Gypsiusterts**

EECC. 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 per year in 6 or more out of 10 years.

**Sodic Gypsiusterts**

EECD. Other Gypsiusterts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Gypsiusterts**

EECE. Other Gypsiusterts which, if not irrigated during the year, have 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.

**Udic Gypsiusterts**

EECF. Other Gypsiusterts that have a lithic or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the mineral soil surface.

**Leptic Gypsiusterts**

EECG. Other Gypsiusterts which 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**

EECH. 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. A chroma of 3 or more.

**Chromic Gypsiusterts**

EECI. Other Gypsiusterts.

**Typic Gypsiusterts**

## Haplusterts

Key to subgroups

EEEA. Haplusterts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haplusterts**

EEEB. 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 (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

**Halic Haplusterts**

EEEC. 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 per year in 6 or more out of 10 years.

**Sodic Haplusterts**

EEED. Other Haplusterts which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

**Petrocalcic Haplusterts**

EEEE. Other Haplusterts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Haplusterts**

EEEF. Other Haplusterts which have *both*:

1. A 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**

EEEG. Other Haplusterts which 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 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

**Entic Udic Haplusterts**

EEEH. Other Haplusterts which 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. A chroma of 3 or more; *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

**Chromic Udic Haplusterts**

EEEI. Other Haplusterts which, if not irrigated during the year, have 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.

**Udic Haplusterts**

EEEJ. Other Haplusterts that have a lithic or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

**Leptic Haplusterts**

EEEK. Other Haplusterts which 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**

EEEL. 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. A chroma of 3 or more.

**Chromic Haplusterts**

EEEM. Other Haplusterts.

**Typic Haplusterts**

## Salusterts

Key to subgroups

EEBA. Salusterts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Salusterts**

EEBB. 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 per year in 6 or more out of 10 years.

**Sodic Salusterts**

EEBC. Other Salusterts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to α,α'-dipyridyl at a time when the soil is not being irrigated.

**Aquic Salusterts**

EEBD. Other Salusterts which, if not irrigated during the year, have 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 210 or more cumulative days per year.

**Aridic Salusterts**

EEBE. Other Salusterts that have a lithic or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the mineral soil surface.

**Leptic Salusterts**

EEBF. Other Salusterts which 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**

EEBG. 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. A chroma of 3 or more.

**Chromic Salusterts**

EEBH. Other Salusterts.

**Typic Salusterts**

## Xererts

Key to great groups

ECA. Xererts which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

**Durixererts**, p.291

ECB. Other Xererts which have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Calcixererts**, p.290

ECC. Other Xererts.

**Haploxererts**, p.291

## Calcixererts

Key to subgroups

ECBA. Calcixererts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Calcixererts**

ECBB. Other Calcixererts which, if not irrigated during the year, have cracks in 6 or more out of 10 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**

ECBC. Other Calcixererts which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

**Petrocalcic Calcixererts**

ECBD. Other Calcixererts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

**Leptic Calcixererts**

ECBE. Other Calcixererts which 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**

ECBF. 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. A chroma of 3 or more.

**Chromic Calcixererts**

ECBG. Other Calcixererts.

**Typic Calcixererts**

## Durixererts

Key to subgroups

ECAA. Durixererts that have, throughout a layer 15 cm or more thick above the duripan, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year *in* 6 or more out of 10 years.

**Halic Durixererts**

ECAB. 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 per year in 6 or more out of 10 years.

**Sodic Durixererts**

ECAC. Other Durixererts that have, in one or more horizons above the duripan, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to $\alpha,\alpha'$-dipyridyl at a time when the soil is not being irrigated.

**Aquic Durixererts**

ECAD. Other Durixererts which, if not irrigated during the year, have cracks in 6 or more out of 10 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**

ECAE. Other Durixererts which, if not irrigated during the year, have cracks in 6 or more out of 10 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**

ECAF. Other Durixererts which have a duripan that is not indurated in any subhorizon.

**Haplic Durixererts**

ECAG. 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. A chroma of 3 or more.

**Chromic Durixererts**

ECAH. Other Durixererts.

**Typic Durixererts**

## Haploxererts

Key to subgroups

ECCA. Haploxererts that have a lithic contact within 50 cm of the mineral soil surface.

**Lithic Haploxererts**

ECCB. 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 (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

**Halic Haploxererts**

ECCC. 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 per year in 6 or more out of 10 years.

**Sodic Haploxererts**

ECCD. Other Haploxererts which, if not irrigated during the year, have cracks in 6 or more out of 10 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**

ECCE. Other Haploxererts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to $\alpha,\alpha'$-dipyridyl at a time when the soil is not being irrigated.

**Aquic Haploxererts**

ECCF. Other Haploxererts which, if not irrigated during the year, have cracks in 6 or more out of 10 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**

ECCG. Other Haploxererts that have a lithic or paralithic contact within 100 cm of the mineral soil surface.

**Leptic Haploxererts**

ECCH. Other Haploxererts which 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**

ECCI. 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. A chroma of 3 or more.

**Chromic Haploxererts**

ECCJ. Other Haploxererts.

**Typic Haploxererts**

# Designations for Horizons and Layers

Genetic soil 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 which are used to differentiate between taxa. A diagnostic horizon may encompass several genetic horizons, and changes implied by genetic horizon designations may not be large enough to justify recognizing different diagnostic horizons. Genetic horizons are designated as follows.

## Master Horizons and Layers

The capital letters O, A, E, B, C, and R represent the master horizons and layers of soils. These capital 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 its volume 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 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 which have formed at the surface or below an O horizon; they exhibit obliteration of all or much of the original rock structure*[1] *and show one or both of the following*: (1) *an accumulation of humified organic matter intimately 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 an A horizon. In some places, as in 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 A because it is at the surface; however, 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 loss of silicate clay, iron, or 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*[2].

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 the symbol E can be used for eluvial horizons which are within or between parts of the B horizon, or which extend to depths greater than normal observation if the horizon is pedogenic.

**B horizons**: *Horizons which 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 removal of carbonates*;
(3) *Residual concentration of sesquioxides*;

[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.

[2] See footnote 1.

(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, than overlying and underlying horizons;*
(5) *Alteration which forms silicate clay or liberates oxides, or both, and which forms a granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; or*
(6) *Brittleness.*

All 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 which 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 which 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 hard 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, unconsolidated bedrock, and other geologic materials which are commonly noncemented and characterized by low or moderate excavation difficulty. 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 C. Changes not considered pedogenic are those not related to overlying horizons. Layers that contain accumulations of silica, carbonates, gypsum, or more soluble salts are included in C horizons, even if indurated. However, if an indurated layer is obviously affected by pedogenic processes, it is considered a B horizon.

**R layers:** *Hard Bedrock*

Granite, basalt, quartzite, and indurated limestone or sandstone are examples of bedrock designated R. R layers are cemented, and excavation difficulty exceeds moderate. The R layer is sufficiently coherent when moist to make hand-digging with a spade impractical, although it may be chipped or scraped. Some R layers can be ripped with heavy power equipment. The bedrock may contain cracks, but these are generally too few and too small to allow roots to penetrate. The cracks may be coated or filled with clay or other material.

**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 than like the B.

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 has to be done. For example, Alfic 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 contains several lamellae and eluvial layers and can be designated an "E and Bt" horizon. The complete horizon sequence for this soil could be: Ap-Bw-E and Bt1-E and Bt2-C.

## Subordinate Distinctions Within Master Horizons and Layers

Lower-case 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 rubbed fiber content of less than 17 percent of the volume.

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 or to separate an organic from a mineral layer.

c *Concretions or nodules*

This symbol indicates a significant accumulation of concretions or nodules. Cementation is required, but the cementing agent is not specified, except that it cannot be silica. This symbol is not used if the concretions or nodules consist of dolomite or calcite or more soluble salts, but it is used if the nodules or concretions are enriched with minerals that contain iron, aluminum, manganese, or titanium.

d *Physical root restriction*

This symbol indicates root-restricting layers in naturally occurring or man-made unconsolidated sediments or materials, such as dense basal till, plow pans, and other mechanically compacted zones.

e *Organic material of intermediate decomposition*

This symbol is used with O to indicate organic materials of intermediate decomposition. Their rubbed fiber content is 17 to 40 percent (by volume).

f *Frozen soil*

This symbol indicates that a horizon or layer contains permanent ice. The symbol is not used for seasonally frozen layers or for so-called dry permafrost (material that is colder than 0°C but does not contain ice).

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 a 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 organic-matter-sesquioxide complexes 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 sesquioxide component is significant but the color value and chroma, moist, of the horizon is 3 or less.

i *Slightly decomposed organic material*

This symbol is used with O to indicate the least decomposed of the organic materials. Its rubbed fiber content is 40 percent or more (by volume).

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 using 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 root-restrictive layers of saprolite such as weathered igneous rock, or of soft bedrock such as partly consolidated sandstone, siltstone, and shale. 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 organic-matter-sesquioxide complexes if both the organic-matter and sesquioxide components are significant, and if the color value and 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, is 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 has either formed and subsequently 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, or 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, brittleness, very coarse prisms with few to many bleached vertical faces, and commonly a higher bulk density than adjacent layers. Some part of the layer is physically root-restrictive.

y *Accumulation of gypsum*

This symbol indicates a gypsum accumulation.

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 lower-case letter suffixes. The following rules apply:

> Letter suffixes should immediately follow the capital letter.
>
> More than three suffixes are rarely used.
>
> 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 Crt[3] horizon designations, none of these letters are used in combination in a single horizon.
>
> If more than one suffix is needed and the horizon is not buried, the following symbols, if used, are written last: c, f, g, m, v, and x. Some examples: Btc, Bkm, and Bsv.
>
> 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 contains accumulations of carbonates, sodium, silica, gypsum, 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 is also present, t precedes the other symbol: Bto.

The suffixes h, s, and w are not used with g, k, n, q, y, z, or o, unless needed for explanatory purposes.

### 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.; or, if the lower part is gleyed and the upper part is not, 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 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, too, are identified by Arabic numerals which 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 comment can be added stating that the horizon has been subdivided for sampling purposes only.

### Discontinuities

In mineral soils, Arabic numerals are used as prefixes to horizon designations (preceding A, E, B, C, and R) to indicate discontinuities. These prefixes are distinct from the Arabic numerals that are used as suffixes to denote vertical subdivisions.

A discontinuity which 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 to identify discontinuities are used only when they can contribute substantially to an understanding of the relationships among horizons. Stratification common to soils 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

[3] Indicates weathered bedrock or saprolite in which clay films are present.

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. But the prefix is used 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 b) presents special problems. It is obviously not in the same deposit as the overlying horizons. Some buried horizons, however, have formed in material which is lithologically like the overlying deposit. A prefix is not used to distinguish material of such a buried horizon. If, however, the material in which a horizon of a buried soil has formed is lithologically unlike the overlying material, the discontinuity is indicated by a number prefix, and the symbol for the buried horizon is used in addition, e.g.: Ap-Bt1-Bt2-BC-C-2ABb-2Btb1-2Btb2-2C.

In organic soils, discontinuities between different kinds of layers 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

If a pedon contains two or more horizons of the same kind which are separated by one or more horizons of a different kind, 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 (the 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, when appropriate, is applied to the capital-letter horizon designation, and any lower-case letter symbols follow it: B't. It 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, a double prime can be used for the lowest of these layers: E".

The same principle applies in designating layers of organic soils. The prime 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.

# SI Unit Conversion Table

## CEC and ECEC:

1 meq/100 g soil = 1 cmol(+)/kg soil

## Conductivity:

1mmho/cm = 1 dS/m

## Pressure:

15-bar water = 1500 kPa water retention

1/3-bar water = 33 kPa water retention

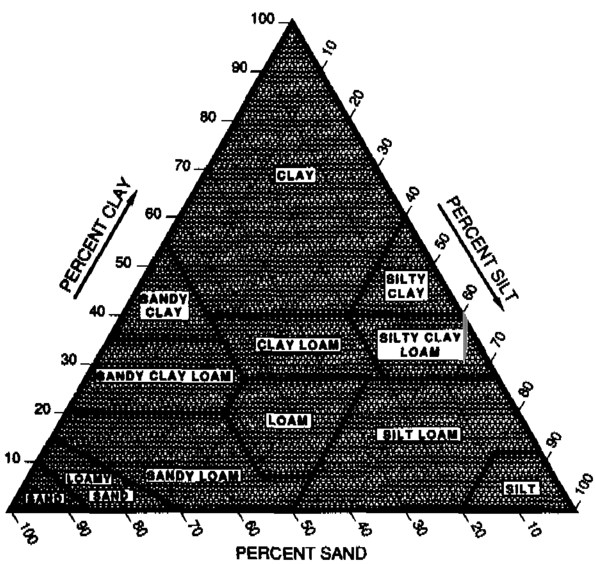


*Figure 2. Chart showing the percentages of clay (below 0.002 mm), silt (0.002 to 0.05 mm), and sand (0.05 to 2.0 mm) in the basic soil textural classes.*

# Index

## A



## B



## C

## H



## I



## J-K



## L



## M



## N

## O



## P



## Q-R



## S

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