KEYS
to
SOIL TAXONOMY

by

SOIL SURVEY STAFF

Agency for International Development
United States Department of Agriculture
Soil Management Support Services

SMSS Technical Monograph No. 19
Fourth Edition, 1990

Virginia Polytechnic Institute
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Prepared by Crop and Soil Environmental Sciences
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Blacksburg, Virginia

For

THE SOIL MANAGEMENT SUPPORT SERVICES

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FOREWORD

This publication, *Keys to Soil Taxonomy*, serves two purposes. It provides the taxonomic keys required for the classification of a soil in a form that can be used easily in the field, and it serves as a means of providing an up-to-date version of *Soil Taxonomy* that includes all revisions to the keys that have been approved. It replaces the keys in *Soil Taxonomy*, but it does not replace *Agriculture Handbook 436*, which contains descriptive material, laboratory data, and chapters on other subjects related to Soil Taxonomy. This is the third update of the *Keys to Soil Taxonomy*, which was originally printed in 1983, and we plan to continue reprinting the keys about every two years. *Agriculture Handbook 436* will be revised and reissued in the future, after most of the current ongoing International Soil Classification Committees (ICOMs) have completed their mandates, but probably not before about 1995.

This publication incorporates all amendments approved to date and published in *National Soil Taxonomy Handbook* (NSTH) Issues 1 through 13. It includes the recommendations of the International Committee on Low Activity Clays (NSTH Issue # 8), the International Committee on Oxisols (NSTH Issue # 11), and the International Committee on Andisols (NSTH Issue # 13). This edition of the *Keys to Soil Taxonomy* contains a revised format to the Keys to Subgroups which is also published in NSTH Issue # 13.

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

RICHARD W. ARNOLD
Director, Soil Survey Division
Soil Conservation Service
1990

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Chapter 1

The Soil That We Classify and Horizons and Properties Diagnostic for the Higher Categories: Mineral Soils

THE SOIL THAT WE CLASSIFY

Soil, as used in this text, is the collection of natural bodies on the earth's surface, in places modified or even made by man of earthy materials, containing living matter and supporting or capable of supporting plants out-of-doors. Its upper limit is air or shallow water. At its margins it grades to deep water or to barren areas of rock or ice. Its lower limit to the not-soil beneath is perhaps the most difficult to define. Soil includes the horizons near the surface that differ from the underlying rock material as a result of interactions, through time, of climate, living organisms, parent materials, and relief. In the few places where it contains thin cemented horizons that are impermeable to roots, soil is as deep as the deepest horizon. More commonly soil grades at its lower margin to hard rock or to earthy materials virtually devoid of roots, animals, or marks of other biologic activity. The lower limit of soil, therefore, is normally the lower limit of biologic activity, which generally coincides with the common rooting depth of native perennial plants. If 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. Yet in defining mapping units for detailed soil surveys, lower layers that influence the movement and content of water and air in the soil of the root zone must also be considered.

BURIED SOILS

A soil is considered to be a buried soil if there is a surface mantle of new material that is 50 cm or more thick or if there is a surface mantle between 30 and 50 cm thick and the thickness of the mantle is at least half that of the named diagnostic horizons that are preserved in the buried soil. A mantle that is less than 30 cm thick is not considered in the taxonomy but, if important to the use of the soil, is considered in establishing a phase. The soil that we classify in places where a mantle is present, therefore, has its upper boundary at the 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 the pedon, as defined in the following chapter. The recognition of a surface mantle should not be based solely on studies of associated soils.

MINERAL SOIL MATERIAL

Mineral soil material *either*

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

2. Is saturated with water for long periods or has been artificially drained, and has

   a. Less than 18 percent organic carbon by weight if 60 percent or more of the mineral fraction is clay; *or*

   b. Less than 12 percent organic carbon by weight if the mineral fraction has no clay; *or*

   c. A proportional content of organic carbon between 12 and 18 percent if the clay content of the mineral fraction is between zero and 60 percent.

Soil material that has more organic carbon than the amounts just given is considered to be organic material.

DEFINITION OF MINERAL SOILS

Mineral soils, in this taxonomy, are soils that meet one of the following requirements:

1. Mineral soil material less than 2.0 mm in diameter (the fine-earth fraction) makes up more than half the thickness of the upper 80 cm (31 in.); *or*

2. The depth to bedrock is less than 40 cm and the layer or layers of mineral soil directly above the rock either are 10 cm or more thick or have half or more of the thickness of the overlying organic soil material; *or*

3. The depth to bedrock is 40 cm or more, the mineral soil material immediately above the bedrock is 10 cm or more thick, and *either*

   a. Organic soil material is less than 40 cm thick and is decomposed (consisting of hemic or sapric materials as defined later) or has a bulk density of 0.1 or more; *or*

   b. Organic soil material is less than 60 cm thick and either is undecomposed sphagnum or moss fibers or has a bulk density that is less than 0.1.

DIAGNOSTIC SURFACE HORIZONS; THE EPIPEDON

Seven diagnostic horizons that form at the surface are defined. Any horizon, however, may be at the surface of a truncated soil. A horizon that forms at the surface is called an epipedon (Gr. *epi*, over or upon, and *pedon*, soil). The epipedon not only has formed at the surface but it also has been either appreciably darkened by organic matter or eluviated or, as a minimum, rock structure has been destroyed. Such a horizon may become covered by thin deposits of fresh alluvium or by thin 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 below. Generally a buried horizon lies below a depth of 50 cm or more, usually more.

There can be only one epipedon formed in the mineral surface horizon(s) of a soil. This epipedon may be overlain by organic materials that may meet the definition of a histic epipedon (defined later). Otherwise one soil may contain only one epipedon.

A recent alluvial or eolian deposit that retains fine stratifications or an Ap horizon that is directly underlain by material that retains fine stratifications 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.

The epipedon is not a synonym for the A horizon because it may include part or all of the illuvial B horizon if the darkening by organic matter extends from the surface into or through the B horizon. To avoid changes in classification of a soil as the result of plowing, the properties of the epipedon, except for structure, should be determined after the surface soil to a depth of 18 cm has been mixed or, if the depth to bedrock is less than 18 cm, after the whole soil down to rock has been mixed.

Anthropic epipedon

In summary, the anthropic epipedon conforms to all the requirements of the mollic epipedon except (1) the limits on acid-soluble P_2O_5, with or without the base saturation, or (2) the length of the period during which it has available moisture. Additional data on anthropic epipedons from several parts of the world may permit improvements in this definition.

Histic epipedon (Gr. *histos*, tissue)

The histic epipedon normally is at the surface, although it may be buried at a shallow depth. It normally is a thin horizon of peat or muck if the soil has not been plowed. If the soil has been plowed, the histic epipedon has the very high content of organic matter that results from mixing peat with some mineral material. Since peaty deposits occur in wet places, the histic epipedon either is saturated with water for 30 consecutive days or more during the year or has been artificially drained.

The histic epipedon, therefore, can be defined as a layer (one horizon or more) at or near the surface that is saturated with water for 30 consecutive days or more at some time in most years, or is artificially drained, and that meets one of the following requirements:

1. The surface horizon consists of organic soil material that *either*

   a. Is 75 percent or more, by volume, sphagnum fibers or has a bulk density, when moist, of less than 0.1 and is less than 60 cm (24 in.) but more than 20 cm thick; *or*

   b. Is less than 40 cm but more than 20 cm thick and meets one of the following requirements with respect to organic-carbon content and thickness:

      (1) Has 18 percent or more organic carbon if the mineral fraction is 60 percent or more clay; *or*

      (2) Has 12 percent or more organic carbon if the mineral fraction has no clay; *or*

      (3) Has an intermediate proportional content of organic carbon if part but less than 60 percent of the mineral fraction is clay.

2. The plow layer is 25 cm or more thick and has 8 percent or more organic carbon if it has no clay, or 16 percent or more organic carbon if 60 percent or more of the mineral fraction is clay, or an intermediate proportional content of organic carbon if part but less than 60 percent of the mineral fraction is clay.

3. A layer of organic material that has enough organic carbon and is thick enough to satisfy one of the requirements under item 1 lies beneath a surface layer of mineral materials that is less than 40 cm (16 in.) thick. In such a soil, the histic epipedon has been buried but the mineral materials at the surface are too thin to be considered diagnostic in the classification.

4. A surface layer of organic material less than 25 cm thick that has enough organic carbon to satisfy the minimum requirements under item 2 after the soil has been mixed to a depth of 25 cm.

Mollic epipedon (L. *mollis*, soft)

The mollic epipedon is defined in terms of its morphology rather than its genesis. It consists of mineral soil material. It is a surface horizon or horizons unless (a) it underlies a recent deposit that is less than 50 cm thick and that has fine stratifications if not plowed or (b) it underlies a thin layer of organic material in a wet soil (see histic epipedon). If the layer of organic material is thick enough that the soil is organic, the mineral soil is considered to be buried.

The mollic epipedon has the following properties:

1. Soil structure is strong enough that the major part of the horizon is not both massive and hard or very hard when dry. Very coarse prisms, more than 30 cm in diameter, are included in the meaning of massive if there is no secondary structure within the prisms.

2. Unless there is more than 40 percent finely divided lime, both broken and crushed samples have Munsell color value of 3 or darker when moist and 5 or darker when dry, and chroma of 3 or less when moist;[1] the color value normally is at least 1 Munsell unit darker or the chroma is at least 2 units less (both moist and dry) than that of the 1C horizon if a 1C horizon is 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 shales also can 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 have lower 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 (horizons) 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 (either a lithic or paralithic contact as defined later).

The mollic epipedon is expected to have dark color and low chroma throughout the major part of its matrix. If the structure is fine granular or fine blocky, the color when broken may be only the color of the coatings. The color of the matrix in such situations can be determined only by 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 only enough to break and mix the coatings. The color value when dry should be determined after the crushed sample has been smoothed to eliminate shadows.

If there is more than 40 percent finely divided lime, the limits of color value, dry, are waived; the color value, moist, then should be 5 or less. This waiver is necessary because finely divided lime acts as a white pigment.

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[1] The chroma is permitted to range up to but not to include 4.0 soils that have a hyperthermic or isohyperthermic temperature regime. The color when moist is that of a specimen that is moist enough that an additional drop of water produces no change in the color. The color when dry is that of a specimen dry enough that continued drying produces no further change.

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

4. The organic-carbon content is 2.5 percent or more in the upper 18 cm if the color requirement is waived because of finely divided lime. Otherwise, the organic-carbon content is at least 0.6 percent (1 percent organic matter) throughout the thickness of soil specified in item 5.

The mollic epipedon consists of mineral rather than organic soil material. Its organic-carbon content, therefore, has an upper as well as a lower limit. The upper limit of organic carbon in a mollic epipedon is the same as that of mineral soil material; in part it is the lower limit for the histic epipedon, defined later in this chapter. Because an organic horizon can form above a mollic epipedon in a wet soil, the mollic epipedon is not necessarily the surface horizon but is the uppermost horizon composed of mineral soil material.

5. The thickness is one of the following after mixing the upper 18 cm of soil or the whole soil if the depth to rock, petrocalcic horizon, or duripan is less than 18 cm:

a. Ten cm or more if the epipedon is underlain directly by a lithic contact; 10 cm or more in soils of shallow families in which the epipedon is underlain directly by a paralithic contact, a petrocalcic horizon, or a duripan, all defined later in this chapter; *or*

b. In other soils the epipedon must be more than 25 cm thick if its texture if finer than loamy fine sand *and*

(1) The upper boundary of pedogenic lime that is present as filaments, soft coatings, or soft nodules is deeper than 75 cm; *and*

(2) The base of any argillic, natric, spodic, cambic, or oxic horizon is deeper than 75 cm; *and*

(3) The upper boundary of any petrocalcic horizon, fragipan, or duripan is deeper than 75 cm; *or*

c. In other soils that have a loamy or clayey epipedon, the thickness of the epipedon must be 18 cm or more and it must be more than one-third of the depth from the top of the epipedon to the shallowest of one of the features listed in (b) if that is less than 75 cm; *or*

d. In other soils the epipedon must be more than 25 cm thick if *either*

(1) The texture of the epipedon is as coarse as or coarser than loamy fine sand throughout its thickness; *or*

(2) If there are no underlying diagnostic horizons and the organic-carbon content of the underlying materials decreases irregularly with increasing depth (as in recent alluvium that is not finely stratified); *or*

e. In other soils, the epipedon must be 18 cm (7 in.) or more thick if none of the conditions that are listed in *b*, *c*, and *d* exist.

6. The epipedon has less than 250 parts per million (ppm) of P_2O_5 soluble in 1 percent citric acid, or it either has increasing amounts of P_2O_5 soluble in citric acid below the epipedon or the amounts of P_2O_5 soluble in citric acid decrease or increase irregularly with 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 that have acquired, under use, the properties of the mollic epipedon, but to include the epipedon of a soil developed in highly phosphatic parent material.

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

8. The *n* value (defined later in this chapter) is less than 0.7. Although many soils that have a mollic epipedon are very poorly drained, a mollic epipedon does not have the very high water content of sediments that have been continuously under water since deposition.

Ochric epipedon (Gr. *ochros*, pale)

An ochric epipedon is one that is too high in value or chroma, is too dry, has too little organic matter, has an *n* value too high, or is too thin to be mollic, umbric, anthropic, plaggen or histic, or it is both hard and massive when dry. An epipedon is ochric if the Munsell color value after rubbing is 6 or higher when dry or 4 or higher when moist, if the chroma is 4 or more[2], or if the A or Ap horizon that has both low value and low chroma is too thin to be a mollic or an umbric epipedon. Epipedons that have a color value after rubbing of 5 or less, dry, and 3 or less, moist, are also ochric provided they are no darker than the 1C horizon and do not have as much as 0.6 percent more organic carbon than the 1C horizon. The ochric epipedon includes eluvial horizons that are at or near the surface (the E horizon and an albic horizon, which is defined later) and extends to the first underlying diagnostic illuvial horizon (defined later as an argillic,

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[2] The chroma is permitted to range up to but not to include 4.0 soils that have a hyperthermic or isohyperthermic temperature regime. The color when moist is that of a specimen that is moist enough that an additional drop of water produces no change in the color. The color when dry is that of a specimen dry enough that continued drying produces no further change.

natric, or spodic horizon). If the underlying horizon is a B horizon of alteration (defined later as a cambic or oxic horizon) and there is no surface horizon that is appreciably darkened by humus, the most convenient lower limit of the ochric epipedon is the base of the plow layer or an equivalent depth in a soil that has not been plowed. Actually, the same subhorizon in an unplowed soil may be both a part of the epipedon and a part of the cambic horizon. The epipedon and the subsurface diagnostic horizons are not mutually exclusive. The ochric epipedon does not have rock structure. It does not include fresh sediments that are finely stratified.

Melanic epipedon (Gr. melas-anos, black)

The melanic epipedon is a thick black horizon occurring at or near the surface, containing high concentrations of organic carbon, usually associated with short-range-order minerals or aluminum-humus complexes. The intense black color is ascribed in Japan to the accumulation of organic matter from which "Type A" humic acids are extracted. This organic matter is thought to result from the supply of large amounts of root residues from a graminaceous vegetation, and can be distinguished from organic matter formed under forest by the melanic index (Honna et al., 1988).[3]

The melanic epipedon meets the following requirements:

1. It has an upper boundary at or within 30 cm of the mineral soil surface or upper boundary of an organic layer that meets andic soil properties, defined later, whichever is shallower; *and*

2. It has, in a cumulative thickness of 30 cm or more within a total thickness of 40 cm:

   a. Moist Munsell value and chroma of 2 or less throughout and a melanic index of 1.70 or less throughout, *and*

   b. Six percent or more organic carbon as a weighted average, and no less than 4 percent organic carbon in any subhorizon; *and*

3. It has andic soil properties in all parts that meet 1 and 2 above.

Plaggen epipedon (Ger. *plaggen*, sod)

The plaggen epipedon is a manmade surface layer 50 cm (20 in.) or more thick that has been produced by long-continued manuring.

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[3] Honna, T.; Yamamoto, S.; Matsui, K. 1988. A simple procedure to determine Melanic Index. See ICOMAND Circular Letter No. 10, p. 76-77.

The color of a plaggen epipedon and its organic-carbon content depend on sources of the materials used for bedding.

The plaggen epipedon can be identified by several means. Commonly it contains artifacts, such as bits of brick and pottery, throughout its depth. Chunks of diverse materials, such as black sand and light gray sand, as large as the size held by a spade may be present. The plaggen epipedon normally shows spade marks throughout its depth and also remnants of thin stratified beds of sand that probably were produced on the surface by beating rains and later were buried by spading.

Umbric epipedon (L. *umbra*, shade, hence dark)

Requirements of the umbric epipedon are comparable to those of the mollic epipedon in color, organic-carbon and phosphorus content, consistence, structure, *n* value, and thickness. The umbric epipedon includes those thick, dark-colored surface horizons that have base saturation of less than 50 percent (by NH_4OAc). It should be noted that the restriction against a hard or very hard and massive epipedon 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 have evidences of slow addition of materials under cultivation. The umbric epipedon does not have the artifacts, spade marks, and raised surfaces that are evidences of slow additions in the plaggen epipedon.

DIAGNOSTIC SUBSURFACE HORIZONS

The horizons discussed in this section form below the surface of the soil, although in some places they form immediately below a layer of leaf litter. They may be exposed at the surface by truncation of the soil. Some of these horizons are generally considered to be B horizons; some are considered B horizons by many but not all pedologists; others are generally considered to be parts of the A horizon.

Agric horizon

The agric horizon (L. *ager*, field) is an illuvial horizon formed under cultivation that contains significant amounts of illuvial silt, clay, and humus. After long-continued cultivation, changes in the horizon immediately 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 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, or ped surfaces become coated with a dark-colored mixture of organic matter, silt, and clay. The accumulation on the sides of wormholes becomes thick and eventually can fill them. If worms are scarce, the accumulation may take the form of thick lamellae that may range in thickness from a few millimeters to about 1 cm. The coatings on the sides of wormholes and lamellae always have lower color value and chroma than the soil matrix.

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

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

Albic horizon

The albic (L. *albus*, white) horizon is one from which clay and free iron oxides have been removed or in which the oxides have been segregated to the extent that the color of the horizon is determined by the color of the primary sand and silt particles rather than by the coatings on these particles. An albic horizon may be at the surface of the mineral soil; it may lie just above an argillic or a spodic horizon; it may lie between a spodic horizon and either a fragipan or an argillic horizon; or it may lie between an argillic horizon and a fragipan or between a cambic horizon and an argillic horizon, natric horizon, or fragipan. It is usually underlain by a spodic, natric, or argillic horizon, a fragipan, or a relatively impervious layer that can produce a perched water table and either stagnant or moving water.

Deep deposits of pure white sand can be formed by wind or wave action. Although these deposits have the apparent morphology of an albic horizon, they are in fact a parent material. The white sand in such a deposit does not overlie a B horizon or any other soil horizon except, in some places, a buried soil.

An albic horizon, therefore, is defined as a surface or a lower horizon that has such thin or discontinuous coatings on the sand or silt particles that the hue and chroma of the horizon are determined chiefly by the color of the sand and silt particles.

The color value, moist, of an albic horizon is 4 or more, or the value, dry, is 5 or more, or both. If the value, dry, is 7 or more, or the value, moist, is 6 or more, the chroma is 3 or less either dry or moist. If the value, dry, is 5 or 6, or the value, moist, is 4 or 5, the chroma is closer to 2 than to 3 either dry or moist. If parent materials have a hue of 5YR or redder, a chroma, moist, of 3 is permitted in the albic horizon if the chroma is due to the color of uncoated silt or sand grains. Under an albic horizon there is usually a B horizon that is an argillic or a spodic horizon, but in some few sandy soils the underlying horizon is too weakly developed to meet the levels of accumulation required for those horizons.

Argillic horizon

An argillic horizon is an illuvial horizon in which layer-lattice silicate clays have accumulated by illuviation to a significant extent. The process of illuviation, of course, does not preclude concurrent formation of clay in the illuvial horizon. If the horizon is illuvial, it must have formed below the surface of the mineral soil though later it may have been exposed at the surface by erosion.

In summary, we can say that an argillic horizon is one that contains illuvial layer-lattice clays. This horizon forms below an eluvial horizon, but it may be at the surface if a soil has been partially truncated. It has the following properties that can be used for identification:

1. If an eluvial horizon remains and if there is no lithologic discontinuity between it and the argillic horizon, the argillic horizon contains more total clay and more fine clay than the eluvial horizon, as follows. The increases in clay are reached within a vertical distance of 30 cm or less.

   a. If any part of the eluvial horizon has less than 15 percent total clay in the fine-earth fraction (less than 2.0 mm), the argillic horizon must contain at least 3 percent more clay (13 percent versus 10 percent, for example). The ratio of fine clay to total clay normally is greater in the argillic horizon than in the overlying eluvial horizons or the underlying horizon by about one-third or more.

   b. If the eluvial horizon has more than 15 percent and less than 40 percent total clay in the fine-earth fraction, the ratio of clay in the argillic horizon to that in the eluvial horizon must be 1.2 or more. The ratio of fine clay to total clay in the argillic horizon is normally greater than in the eluvial horizon by about one-third or more.

c. If the eluvial horizon has more than 40 percent total clay in the fine-earth fraction, the argillic horizon must contain at least 8 percent more clay or, if the total clay content exceeds 60 percent, 8 percent more fine clay (50 percent versus 42 percent, for example).

2. An argillic horizon should be at least one-tenth as thick as the sum of the thickness of all overlying horizons, or it should be 15 cm or more thick if the eluvial and illuvial horizons together are more than 150 cm thick. If the argillic horizon is sand or loamy sand, it should be at least 15 cm thick. If it is composed entirely of lamellae, lamellae 1 cm or more thick should have a combined thickness of at least 15 cm. If the argillic horizon is loamy or clayey, it should be at least 7.5 cm thick.

3. In structureless soils, the argillic horizon has oriented clay bridging the sand grains and also in some pores.

4. If peds are present, an argillic horizon should meet one of the following requirements:

a. Have clay skins on some of both the vertical and horizontal ped surfaces and in the fine pores or have oriented clay in 1 percent or more of the cross section; *or*

b. Meet requirements 1 and 2 and also have a broken or irregular upper boundary and some clay skins in the lowest part of the horizon; *or*

c. If the horizon is clayey, if the clay is kaolinitic, and if the surface horizon has more than 40 percent clay, have some clay skins on peds and in pores in the lower part of the horizon that has blocky or prismatic structure; *or*

d. If the illuvial horizon is clayey with 2-to-1 lattice clays, an argillic horizon does not need to have clay skins if there are uncoated grains of sand or silt in the overlying horizon and evidences of pressure caused by swelling, or if the ratio of fine to total clay in the horizon is greater by at least one-third than the ratio in the overlying or the underlying horizon, or if it has more than 8 percent more fine clay. The evidences of pressure may be occasional slickensides or wavy horizon boundaries in the illuvial horizon.

5. If a soil has a lithologic discontinuity between the eluvial horizon and the argillic horizon or if only a plow layer overlies the argillic horizon, the argillic horizon

needs to have clay skins in only some part, either in some fine pores or, if peds exist, on some vertical and horizontal ped surfaces. Either thin sections should show that some part of the horizon has about 1 percent or more of oriented clay bodies, or the ratio of fine clay to total clay should be greater than in the overlying or the underlying horizon.

Calcic horizon

The calcic horizon is a horizon of accumulation of calcium carbonate or of calcium and magnesium carbonate. The accumulation may be in the C horizon, but it may also be in a variety of other horizons such as a mollic epipedon, an argillic or a natric horizon, or a duripan.

The calcic horizon has two forms. In one, the underlying materials have less carbonate than the calcic horizon. This form of calcic horizon includes horizons of secondary carbonate enrichment that are 15 cm (6 in.) or more thick, have a carbonate content equivalent to 15 percent or more $CaCO_3$, and have a $CaCO_3$ equivalent at least 5 percent greater than the C horizon. In the other form, the calcic horizon is 15 cm or more thick, has a $CaCO_3$ equivalent of 15 percent or more, and contains 5 percent or more, by volume, of identifiable secondary carbonates as pendants on pebbles, as concretions, or as soft powdery forms. If this calcic horizon rests on limestone, marl, or other very highly calcareous materials (40 percent or more $CaCO_3$ equivalent), the percentage of carbonates need not decrease with depth.

If the particle-size class is sandy, sandy-skeletal, coarse-loamy, or loamy-skeletal with less than 18 percent clay, the 15 percent requirement for $CaCO_3$ equivalent is waived. But to qualify as a calcic horizon, the horizon must have at least 5 percent (by volume) more soft powdery secondary $CaCO_3$ than an underlying horizon, and the calcic horizon must be at least 15 cm thick.

If a horizon enriched with secondary carbonate is indurated or cemented to the degree that dry fragments do not slake in water, it is considered to be a petrocalcic horizon, which is discussed later. Air-dry fragments of a calcic horizon will slake in water. Pendants below rocks and concretions normally do not slake, but these are not connected, and the soil material between the concretions will slake.

Cambic horizon

In summary, the cambic horizon is an altered horizon that does not have the dark color, organic-matter content, and structure that are definitive of a histic, a mollic, or an umbric epipedon, and it has

1. Texture that is very fine sand, loamy very fine sand, or finer in the fine-earth (less than 2.0 mm) fraction; *and*

2. Soil structure or absence of rock structure in at least half the volume; *and*

3. Minerals that consist of (a) enough amorphous or 2:1 lattice clay to give a cation-exchange capacity (by NH_4OAc) of more than 16 cmol(+) per kg clay or (b) 10 percent or more weatherable minerals; *and*

4. Evidence of alteration in one of the following forms:

a. Have an aquic moisture regime or artificial drainage and, beginning at a depth of less than 50 cm, colors with a hue no bluer than 10Y if the hue changes on exposure to air, and dominant chroma on faces of peds if peds are present or in the matrix if peds are absent as follows:

(1) If there is mottling, the chroma is 2 or less; *or*

(2) If there is no mottling and the value is less than 4, the chroma is less than 1; if the value is 4 or more, the chroma is 1 or less; *and*

(3) One or more of the following properties:

(a) A regular decrease in the amount of organic carbon with depth and a content of less than 0.2 percent organic carbon at a depth of 125 cm below the surface or immediately above a sandy-skeletal substratum that is 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 50 cm below the surface; *or*

(c) Permafrost at some depth; *or*

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

b. Do not have an aquic moisture regime or artificial drainage and colors as defined in "a." and have one or more of the following properties:

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

(2) Evidences of removal of carbonates. Particularly, the cambic horizon has less carbonate than 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 under side, those in the cambic horizon should be free of coatings; *or*

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

5. Properties that do not meet the requirements of an argillic, kandic, or spodic horizon; *and*

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

7. Enough thickness that its base is at least 25 cm (10 in.) below the soil surface unless the soil temperature regime is cryic or pergelic.

Duripan

The duripan (L. *durus*, hard, plus pan; meaning hardpan) is a subsurface horizon that is cemented by silica to the degree that fragments from the air-dry horizon do not slake during prolonged soaking in water or in HCl. In summary, the duripan is a silica-cemented subsurface horizon in which

1. Cementation is strong enough that dry fragments from some subhorizon do not slake in water, even during prolonged wetting; *and*

2. Coatings of silica, insoluble in 1N HCl even during prolonged soaking but soluble in hot concentrated KOH or in alternating acid and alkali, are present in some pores and on some structural faces; or some durinodes are present; *and*

3. Cementation is not destroyed by soaking in acid in more than half of any laminar capping that may be present or in some other continuous or imbricated subhorizon. Cementation in such layers is completely destroyed by hot concentrated KOH, either by a single treatment or by alternating with acid; *and*

4. If fractured, the average lateral distance between fracture points is 10 cm or more.

Fragipan

A fragipan (modified from L. *fragilis*, brittle, and pan; meaning brittle pan) is a loamy or uncommonly a sandy subsurface horizon that may but does not necessarily underlie a cambic, spodic, argillic, or albic horizon. It has a very low content of organic matter, has high bulk density relative to the horizons above it, and is seemingly cemented when dry, having then hard or very hard consistence. When moist, a fragipan has moderate or weak brittleness, which is the tendency for a ped or clod to rupture suddenly when pressure is applied rather than to undergo slow deformation. A dry fragment slakes or fractures when placed in water. A fragipan is usually mottled, is slowly or very slowly permeable to water, and has few or many bleached, roughly vertical planes that are faces of coarse or very coarse polyhedrons or prisms.

<u>Identification</u>

There is no known laboratory procedure for identifying a sample of a fragipan. Identification is primarily a field problem. A combination of clues must be used because there is no single unique property of fragipans. First, position is important. A fragipan lies below an eluvial horizon unless the soil has been truncated, but it is not necessarily immediately below. If the soil has been truncated, the pan can be traced up slope until it lies under an eluvial horizon.

Second, if there is an argillic or a cambic horizon above a fragipan, there is commonly an E' horizon between the fragipan and the overlying horizon. The E' horizon is marked by uncoated grains of sand and silt. This horizon seems related to water that either stands above the pan or moves laterally along its surface.

Third, if the pan is not saturated for long periods, some or all pedons normally have bleached vertical streaks that form a roughly polygonal pattern on a horizontal plane. The bleached streaks are bounded by strong brown or reddish brown streaks where iron and manganese have accumulated. If the pan is saturated for long periods or if the texture is sandy, the polygonal color pattern may be absent.

Fourth, if the moisture content is near the wilting point, the matrix between the streaks is very firm. If it is near field capacity, the matrix is brittle. The brittle matrix should constitute 60 percent or more of the volume of some subhorizon.

Fifth, fine feeder roots are virtually absent in the brittle parts of a fragipan. If brittleness is so weakly expressed that fine feeder roots are present throughout the horizon, the horizon should not be considered a fragipan. It should be noted, however, that some trees have tap roots that extend through a well-expressed fragipan, but this is the exception rather than the rule. It is characteristic of fragipans that few or many roots may be present in the bleached vertical streaks and that few or no fine roots are present in the brittle matrix between the bleached streaks. The fine roots should not be present at intervals of less than 10 cm except within bleached vertical streaks, and the mean horizontal dimensions of the brittle matrix should be at least 10 cm.

Sixth, texture of the fine-earth fraction of a fragipan is finer than fine sand, and the percentage of clay is generally less than 35; in most soils appreciably less. The texture normally is loamy, that is, silt loam, loam, or sandy loam.

Seventh, an air-dry fragment about the size of a fist slakes or fractures when placed in water.

Gypsic horizon

The gypsic horizon is a noncemented or weakly cemented horizon of enrichment with secondary sulfates that is 15 cm or more thick, has at least 5 percent more gypsum than the C horizon or the underlying stratum, and in which the product of the thickness in centimeters and the percentage of gypsum is 150 or more. Thus, a horizon 30 cm thick that has 5 percent gypsum qualifies if gypsum is absent in the underlying horizon. A layer 30 cm thick that has 6 percent gypsum qualifies if the gypsum content of the underlying horizon is not more than 1 percent. Cementation is weak enough that a dry fragment slakes in water.

The percentage of gypsum can be calculated by multiplying the milliequivalents of gypsum per 100 g soil by the milliequivalent weight of gypsum, which is 0.086.

Kandic horizon[4]

The kandic horizon:

1. Is a vertically continuous subsurface horizon and has, starting at the point where the clay increase requirements are met, a CEC of 16 cmol(+) or less per kg clay (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 at least the major part of the horizon.

2. Has a thickness of at least 30 cm, or if a lithic, paralithic, or petroferric contact occurs within 50 cm of the soil surface, then the thickness of the kandic horizon is at least 60 percent of the vertical distance between 18 cm and the contact but at least 15 cm thick.

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

4. 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 if there is no lithic, paralithic, or petroferric contact within 50 cm.

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[4] The kandic horizon, and the *kandi* and *kanhapli* great groups in following chapters, represent the work of the International Committee on the Classification of Low Activity Clays (ICOMLAC), chaired by F.R. Moormann.

5. Has more total clay than the overlying coarser textured surface horizon and the increased clay content is reached within a vertical distance of 15 cm or less as follows:

a. If the surface horizon as defined above has less than 20 percent total clay, the kandic horizon begins where some subhorizon contains at least 4 percent more clay absolute than the overlying horizon.

b. If the surface horizon as defined above has 20 to 40 percent total clay the kandic horizon begins where some subhorizon has at least 1.2 times more clay than the overlying horizon.

c. If the surface horizon as defined above has more than 40 percent total clay, the kandic horizon begins where some subhorizon has at least 8 percent more clay absolute than the overlying horizon.

Natric horizon

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

1. *Either*

a. Prisms or, more commonly, columns in some part, usually the upper part, that may or may not break to blocks; *or*

b. Rarely, blocky structure and tongues of an eluvial horizon, in which there are uncoated silt or sand grains, extending more than 2.5 cm into the horizon; *and*

2. *Either*

a. The SAR[5] is 13 or more (or 15 percent or more saturation with exchangeable sodium) in some subhorizon within 40 cm of the upper boundary; *or*

b. More exchangeable magnesium plus sodium than calcium plus exchange acidity (at pH 8.2) in some subhorizon within 40 cm of the upper boundary if the

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[5] The percentage of exchangeable sodium (ESP) is used in the definition of the natric horizon and in a number of the taxa. Since this text was written, the U.S. Salinity Laboratory (personal communication from C. A. Bower) has revised its definition of sodic (alkali) soils and the method for measuring the sodium adsorption ratio (SAR) as follows: SAR is measured by the normal method if the conductivity (EC) of the saturation extract is less than 20 dS per m at 25°C. If the conductivity is 20 dS or more and SAR is more than 10, SAR is determined on a sample that has been leached with distilled water until EC of the leachate decreases to about 4 dS per meter but not to less than 4. ESP of 15 or more is replaced by SAR of 13 or more if EC is large enough to require a correction for soluble salts in calculating ESP. If EC is low enough (4 or less) that no correction is needed for soluble salts, ESP is determined directly from the replaced cations.

SAR is 13 or more (or ESP is 15 or more) in some horizon within 200 cm of the surface.

Oxic horizon

The oxic horizon is intended to characterize a mineral subsurface horizon of sandy loam or finer particle size with low cation exchange capacity and low weatherable mineral content. The upper boundary of the oxic horizon is at 18 cm below the soil surface or the base of the Ap horizon, whichever is deeper, or at a deeper depth where the mineralogical and charge characteristics meet the requirements of the oxic horizon.

In summary, the oxic horizon is a subsurface horizon that:

1. Is at least 30 cm thick; *and*

2. Has a particle size of sandy loam or finer in the fine earth fraction; *and*

3. Has a fine-earth fraction (less than 2.0 mm) that has an apparent ECEC (NH_4OAc bases plus 1N KCl-extractable Al) equal to or less than 12 cmol(+) per kg clay and an apparent CEC pH 7 (NH_4OAc CEC) equal to or less than 16 cmol(+) per kg clay (measured clay or 3 x 1500 kPa water retention, whichever is greater but less than 100); *and*

4. Does not have as much as 10 percent weatherable minerals in the 50-200 micron fraction; *and*

5. Has a diffuse upper particle-size boundary (i.e., less than 1.2 times clay content increase within a vertical distance of 15 cm if the surface horizon contains 20-40 percent clay; less than 4 percent absolute clay content increase if the surface contains 20 percent or less clay; less than 8 percent absolute if the surface contains 40 percent or more clay); *and*

6. Does not have andic soil properties; *and*

7. Has less than 5 percent by volume that shows rock structure unless the lithorelicts containing weatherable minerals are coated with sesquioxides.

Petrocalcic horizon

The petrocalcic horizon is a continuous, cemented or indurated calcic horizon that is cemented by calcium carbonate or in some places by calcium and some magnesium carbonate. Accessory silica may be present. The petrocalcic horizon is continuously cemented throughout the pedon to the degree that dry fragments do not slake in water. It cannot be penetrated by spade or auger when dry. It is massive or platy, very hard or extremely hard when dry, and very firm or extremely firm when moist. Noncapillary pores are filled, and the petrocalcic horizon is a barrier to roots. Hydraulic conductivity is moderately slow to very slow. The horizon is usually much more than 10 cm (4 in.) thick.

A laminar capping commonly is present but is not required.

If a laminar horizon rests on bedrock, it is considered a petrocalcic horizon if it is 2.5 cm or more thick and the product of the thickness in centimeters multiplied by the percentage of $CaCO_3$ equivalent is 200 or more.

Petrogypsic horizon

The petrogypsic horizon is a gypsic horizon that is strongly enough cemented with gypsum that dry fragments do not slake in water and that roots cannot enter. The gypsum content commonly is far greater than the minimum requirements for the gypsic horizon and usually exceeds 60 percent. Petrogypsic horizons are restricted to arid climates and to parent materials that are rich in gypsum.

Placic horizon

The placic horizon (Gr. base of *plax*, flat stone; meaning a thin cemented pan) is a thin, black to dark reddish pan cemented by iron, by iron and manganese, or by an iron-organic matter complex. Its thickness ranges generally from 2 to 10 mm. Rarely, it is as thin as 1 mm or as thick as 20 to 40 mm in spots. It may be, but is not necessarily, associated with stratification in parent materials. It is in the solum, roughly parallel to the soil surface, and is commonly within the upper 50 cm of the mineral soil. It has a pronounced wavy or even convolute form. It normally occurs as a single pan, not as multiple sheets one underlying another, but in places it may be bifurcated. It is a barrier to water and roots.

An iron-cemented pan is strong brown to dark reddish brown. A pan cemented by iron and manganese or by iron-organic matter complexes is black or reddish black. A single pan may contain two or more layers cemented by different agents. Iron-organic matter cements commonly are present in the upper part of the pan.

Identification is seldom difficult. The hard brittle pan differs so much from the material in which it occurs and is so close to the surface of the mineral soil material that it is obvious unless its thickness is minimal. A few analyses of placic horizons show that organic carbon is present in amounts ranging from 1 percent to 10 percent or more. The presence of organic carbon as well as the shape and position of the pan distinguish the placic horizon from the ironstone sheet that may form where water hangs or moves laterally at a lithologic discontinuity.

Salic horizon

A salic horizon is a horizon 15 cm or more thick that contains a secondary enrichment of salts more soluble in cold water than gypsum. It contains at least 2 percent salt, and the product of its thickness in centimeters and salt percentage by weight is 60 or more. Thus, a horizon 20 cm thick would need to contain 3 percent salt to qualify as a salic horizon and a horizon 30 cm thick would need 2 percent.

Sombric horizon

The sombric horizon is a subsurface horizon of mineral soils 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 of a spodic horizon relative to clay, and it does not have the high base saturation of a natric horizon. The sombric horizon does not underlie an albic horizon.

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

The sombric horizon has lower color value or chroma, or both, than the overlying horizon and commonly, but not necessarily, contains more organic matter than the overlying horizon. It may have formed in an argillic, a cambic, or, possibly, an oxic horizon. If peds are present, the dark colors are most pronounced on ped surfaces.

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

Spodic horizon

A spodic horizon is normally a subsurface horizon that underlies an O, A, Ap, or E horizon. It may, however, meet the definition of an umbric epipedon. A spodic horizon has the morphological or the chemical and physical characteristics that are listed next, and its hue and chroma remain constant with increasing depth or the subhorizon that has the reddest hue or the highest chroma is near the top of the horizon. The color changes within 50 cm from the top of the horizon.[6] If the soil temperature regime is frigid or warmer, some part of the spodic horizon must meet one or more of the following requirements below a depth of 12.5 cm or below any Ap horizon that is present. If the soil temperature regime is cryic or pergelic, there is no requirement for depth. In addition, the spodic horizon must meet one or more of the following requirements:

1. Have a subhorizon more than 2.5 cm thick that is continuously cemented by some combination of organic matter with iron or aluminum or with both; *or*

2. Have a particle-size class that is sandy or coarse-loamy, and sand grains are covered with cracked coatings or there are distinct dark pellets of coarse-silt size or larger, or both; *or*

3. Have one or more subhorizons in which

   a. If there is 0.1 percent or more extractable iron, the ratio of iron plus aluminum (elemental) extractable by pyrophosphate at pH 10 to percentage of clay is 0.2 or more (percentage of pyrophosphate-extractable Fe + Al at pH 10/clay percentage of 0.2 or more) or if there is less than 0.1 percent extractable iron, the ratio of aluminum plus carbon extractable by pyrophosphate at pH 10 to percentage clay is 0.2 or more; *and*

   b. The sum of pyrophosphate-extractable iron plus aluminum is half or more of the extractable sum of dithionite-citrate extractable iron plus aluminum (percentage of pyrophosphate-extractable Fe + Al/percentage of dithionite-citrate extractable Fe + Al of 0.5 or more); *and*

   c. The combined index of accumulation of amorphous material must be 65 or more. The index for each subhorizon is calculated by subtracting half of the clay percentage from CEC at pH 8.2 and multiplying the remainder by the thickness of the subhorizon in centimeters. The results for all subhorizons are then added and the total must be 65 or more.

Sulfuric horizon

The sulfuric (L. *sulfur*) horizon is composed either of mineral or organic soil material that has both a pH less than 3.5 (1:1 in water) and jarosite mottles (the color of fresh straw that has a hue of 2.5Y or yellower and chroma of 6 or more).

A sulfuric horizon forms as a result of artificial drainage and oxidation of sulfide-rich mineral or organic

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[6] A thin black horizon that has color value of 2 or less may overlie this horizon.

materials. Such a horizon is highly toxic to plants and virtually free of living roots.

OTHER DIAGNOSTIC SOIL CHARACTERISTICS

Abrupt textural change

An abrupt textural change is a change from an ochric epipedon or an albic horizon to an argillic horizon. There is, in the zone of contact, a very appreciable increase in clay content within a very short distance in depth. If the clay content of the ochric epipedon or the albic horizon is less than 20 percent, the clay content should double within a distance in depth of 7.5 cm or less. If the clay content exceeds 20 percent, the increase in clay content should be at least 20 percent of the fine-earth fraction, for example, from 22 percent to 42 percent, within a distance of 7.5 cm in depth, and the clay content in some part of the argillic horizon should be at least double that of the horizon above. A transitional horizon normally is not present or is too thin to be sampled. In some soils, however, there may be tonguing or interfingering of albic materials, which are defined later, in parts of the argillic horizon. The horizon boundary in such a soil is irregular or even discontinuous. The sampling of such a mixture as a single horizon might create the impression of a relatively thick transitional horizon, even though the thickness of the actual transition at the contact may be only 1 mm or so.

Andic soil properties

To have andic soil properties, the soil material must have less than 25 percent organic carbon and meet one or both of the following two requirements:

1. *Either*

   a. Acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron is 2.0 percent or more in the less than 2.0 mm fraction, *and*

   b. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, is 0.90 g cm^{-3} or less, *and*

   c. Phosphate retention[7] of the less than 2.0 mm fraction is 85 percent or more; *or*

2. The less than 2.0 mm fraction has phosphate retention of more than 25 percent and the 0.02 - 2.0 mm fraction is at least 30 percent of the less than 2.0 mm fraction; and meets one of the following three requirements:

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

a. The less than 2.0 mm fraction has acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more, and there is at least 30 percent volcanic glass in the 0.02 - 2.0 mm fraction, *or*

b. The less than 2.0 mm fraction has acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 2.0 percent or more, and there is at least 5 percent volcanic glass in the 0.02 - 2.0 mm fraction, *or*

c. The less than 2.0 mm fraction has acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of between 0.40 percent and 2.0 percent, and there is enough volcanic glass in the 0.02 - 2.0 mm fraction that the percentage of glass, when plotted against the percentage of acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron, gives a point within the shaded area of Figure 1.

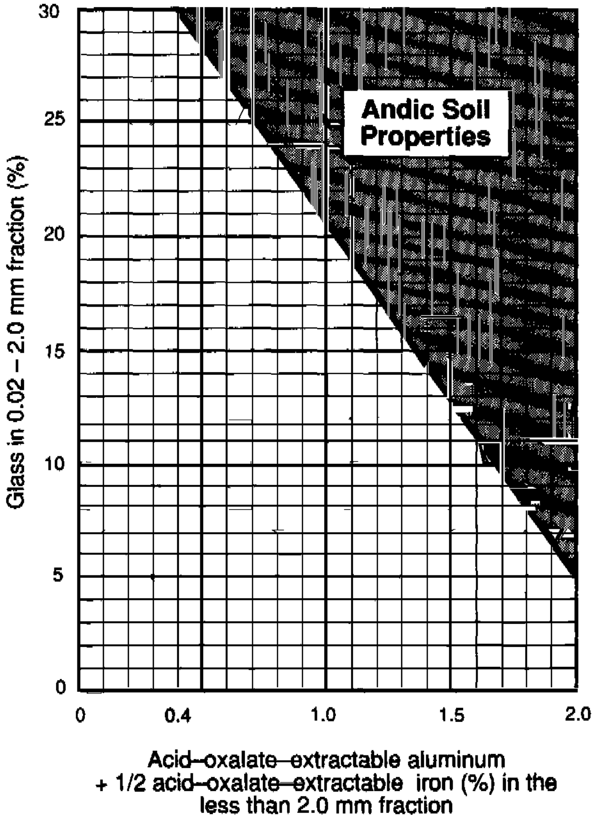

Figure 1 — *Soils that plot in the shaded area have Andic soil properties if the less than 2.0 mm fraction has phosphate retention of more than 25 percent and the 0.02 to 2.0 mm fraction is at least 30 percent of the less than 2.0 mm fraction.*

Coefficient of linear extensibility, COLE

This coefficient is the ratio of the difference between the moist length and the 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. It can be calculated from the difference in bulk density of the clod when moist and when dry. COLE can be estimated from shrinkage of a sample that has been packed at field capacity into a mold and then dried.

Durinodes

Durinodes (L. *durus*, hard; *nodus*, knot) 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 some slaking. The durinodes are firm or very firm; they are brittle when wet, both before and after treatment with acid; and they are disconnected and range upward in size from a diameter of about 1 cm. Most durinodes are roughly concentric when viewed in cross section, and concentric stringers of opal may be visible under a hand lens.

Gilgai

Gilgai is the microrelief that is typical of clayey soils that have a high coefficient of expansion with changes in moisture content and that also have distinct seasonal changes in moisture content. The microrelief consists of either a succession of enclosed microbasins and microknolls in nearly level areas, or of microvalleys and microridges that run up and down the slope. The height of the microridges commonly ranges from a few centimeters to 1 m. Rarely does the height approach 2 m.

Lithic contact

A lithic contact is a boundary between soil and coherent underlying material. Except in Ruptic-Lithic subgroups the underlying material must be continuous within the limits of a pedon except for cracks produced in place without significant displacement of the pieces. Cracks should be few, and their average horizontal spacing should be 10 cm or more. The underlying material must be sufficiently coherent when moist to make hand digging with a spade impractical, although it may be chipped or scraped with a spade. If it is a single mineral, it must have a hardness by Mohs scale of 3 or more. If it is not a single mineral, chunks of gravel size that can be broken out must not disperse during shaking for 15 hours in water or in 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 soil surface of Oxisols and within 50 cm of the soil surface of all other mineral soils.

Mottles that have chroma of 2 or less

It refers to colors in a horizon in which parts have chroma of 2 or less, moist, and value, moist, of 4 or more, whether or not that part is dominant in volume or whether or not it is a continuous phase surrounding spots of higher chroma. If either the minor or major part of a horizon has chroma of 1 to 2 and value, moist, of 4 or more and there are spots of higher chroma, the part that has the lower chroma is included in the meaning of "mottles that have chroma of 2 or less." The part is excluded from the meaning if all the horizon has chroma of 2 or less or if no part of the horizon has chroma as low as 2.

The phrase also means that the horizon that has such mottles is saturated with water at some period of the year or the soil is artificially drained. It is also implicit in the meaning that the temperature of the horizon is above the biologic zero, which is about 5°C (41°F), during at least a part of the time that the horizon is saturated.

***n* value**

The *n* value (Pons and Zonneveld 1965) refers to the relation between the percentage of water under field conditions and the percentages of inorganic clay and of humus. The *n* value is helpful in predicting whether the soil may be grazed by livestock or will support other loads, and the degree of subsidence that would occur after drainage. The *n* value can be calculated for mineral soil materials that are not thixotropic 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 (organic carbon x 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 the soil in the hand. If the soil flows with difficulty between the fingers, 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 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 is not a single mineral, chunks of gravel size that can be broken out disperse more or less completely during 15 hours of end-over-end shaking in water or in sodium hexametaphosphate solution and, when moist, the material can be dug with difficulty with a spade. The material underlying a paralithic contact is normally 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 the horizontal spacing between cracks should be 10 cm or more.

Permafrost

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

Petroferric contact

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

Several features can aid in making the distinction between a lithic and a petroferric contact. First, a petroferric contact is roughly horizontal. Second, the amount of iron in the material immediately below a petroferric contact is high. The content of Fe_2O_3 normally ranges upward from 30 percent. Third, the ironstone sheets below a petroferric contact are thin. Their thickness ranges from a few centimeters to a very few meters. Sandstone, on the other hand, may be thin or very thick, may be level bedded or tilted, and may have only a small percentage of Fe_2O_3. In the tropics the ironstone commonly is more or less vesicular.

Plinthite

Plinthite (Gr. *plinthos*, brick) is an iron-rich, humus-poor mixture of clay with quartz and other dilutents. It commonly occurs as dark red mottles, which usually are in 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 exposed also to heat from the sun. The lower boundary of a zone in which plinthite occurs usually is diffuse or gradual, but it may be abrupt at a lithologic discontinuity.

Generally, plinthite forms in a horizon that is saturated with water at some season. The original segregation of the iron normally is in the form of soft, more or less clayey, red or dark red mottles. The mottles are not considered plinthite unless there has been enough segregation of iron to permit irreversible hardening on exposure to wetting and drying. Plinthite in the soil usually is firm or very firm when the soil moisture content is near field capacity and hard when the moisture content is below the wilting point. Plinthite does not harden irreversibly as a result of a single cycle of drying and rewetting. After a single drying, it will remoisten, and then it can be dispersed in large part by shaking in water with a dispersing agent.

In a moist soil, plinthite is soft enough 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.

Potential linear extensibility

This characteristic is the sum of the products, for each horizon, of the thickness of the horizon in centimeters and the COLE of the horizon.

Sequum: number and kind

A sequence of an eluvial horizon and its subjacent B horizon, if one is present, is called a sequum. An albic horizon and a spodic horizon immediately underlying it, for example, constitute a sequum. Similarly, a mollic epipedon over a cambic horizon or an argillic horizon over a k horizon also constitute a sequum. Two sequa may be present in vertical sequence in a single soil, and that sequence is called a bisequum.

Slickensides

Slickensides are polished and grooved surfaces that are produced by one mass sliding past another. Some of them occur at the base of a slip surface where a mass of soil moves downward on a relatively steep slope. Slickensides are very common in swelling clays in which there are marked changes in moisture content.

Soft powdery lime

Soft powdery lime is a phrase that is used in the definitions of a number of taxa. It refers to translocated authigenic lime, soft enough to be cut readily with a fingernail, that was precipitated in place from the soil solution rather than inherited from a soil parent material such as a calcareous loess or till. It should be present in a significant enough accumulation to constitute a k horizon.

To be identifiable, soft powdery lime must have some relation to the soil structure or fabric. It may disrupt the fabric to form spheroidal aggregates, or white eyes, that are soft and powdery when dry. Or the lime may be present as soft coatings in pores or on structural faces. If present as coatings, it covers a significant part of the surface. Commonly, it coats the whole surface to a thickness of 1 to 5 mm or more. But only part of a surface may be coated if little lime is present in the soil. The coatings should be thick enough to be visible when moist and should cover a continuous area large enough to be more than filaments. The pseudomycelia commonly seen in a dry calcareous horizon do not come within the meaning of soft powdery lime. Pseudomycelia are soft powdery filaments on structural faces, commonly branching, but they may come and go with the seasons and may be only lime that was precipitated in a single season by the withdrawal of stored soil moisture rather than a k horizon.

Soft coatings on hard lime concretions are also excluded from the meaning of soft powdery lime. These may be thin or thick, and they may be the result of either current accumulation or removal of lime. That is, the concretion may be growing or may be undergoing dissolution, and either process can produce a soft coating.

Soil moisture regimes

The soil moisture regime, as the term is used here, refers to the presence or absence either of ground water or of water held at a tension 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 also is affected by dissolved salts. A soil may be saturated with water that is too salty to be available to most plants, but it would seem better to call such a soil salty rather than dry. Consequently, we consider a horizon to be dry when the moisture tension is 1500 kPa or more. If water is held at a tension of less than 1500 kPa but more than zero, we consider the horizon to be moist. A soil may be continuously moist in some or all horizons throughout the year or for some part of the year. It may be 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. A soil or a horizon is considered to be saturated with water when water stands in an unlined borehole close enough to the soil surface or to the horizon in question that the capillary fringe[8] reaches the surface or the top of the horizon.

Soil moisture control section

The intent in defining the soil moisture control section is to facilitate estimation of soil moisture regimes from climatic data. The upper boundary of this control section is the depth to which a dry (tension of more than 1500 kPa but not air dry) soil will be moistened by 2.5 cm (1 in.) of water within 24 hours. The lower boundary is the depth to which a dry soil will be moistened by 7.5 cm (3 in.) of water within 48 hours. These depths are exclusive of 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, petroferric, or paralithic contact or to a petrocalcic horizon or a duripan, the upper boundary of the rock or of the cemented horizon is the lower boundary of the soil moisture control section. If 2.5 cm of water moistens the soil to one of these contacts or horizons, 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 the latter soil is moist if the upper boundary of the rock or the cemented horizon has a thin film of water. If the upper boundary is dry, the control section is dry.

As a rough guide to the limits, the soil moisture control section lies approximately between 10 and 30 cm (4 and 12 in.) if the particle-size class is fine-loamy, coarse-silty, fine-silty, or clayey. The control section extends approximately from a depth of 20 cm to a depth of 60 cm (8 to 24 in.) if the particle-size class is coarse-loamy, and from 30 to 90 cm (12 to 35 in.) if the particle-size class is sandy.

Classes of soil moisture regimes

The moisture regimes are defined in terms of the ground-water level and in terms of the presence or absence of water held at a tension less than 1500 kPa in the moisture control section by periods of the year. It is assumed in the definitions that the soil supports whatever vegetation it is capable of supporting. In other words, it is in crops, grass, or native vegetation; it is not being fallowed to increase the amount of stored moisture, nor is it being irrigated by man. These cultural practices affect the soil moisture condition as long as they are continued.

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[8] The capillary fringe is the zone just above the water table (zero gauge pressure) that remains almost saturated (Soil Sci. Soc. Amer. Glossary, 1965, p. 332).

Aquic moisture regime.--The aquic (L. *aqua*, water) moisture regime implies a reducing regime that is virtually free of dissolved oxygen because the soil is saturated by ground water or by water of the capillary fringe. An aquic regime must be a reducing one. Some soil horizons, 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; for example, if the temperature is less than 1°C such a regime is not considered aquic.

For differentiation in the highest categories of soils that have an aquic regime, the whole soil must be saturated. In the subgroups, only the lower horizons are saturated. The soil is considered to be saturated if water stands in an unlined borehole at such a shallow depth that the capillary fringe (see footnote 8) reaches the soil surface except in noncapillary pores. The water in the borehole is stagnant and remains colored if a dye is placed in the water. In a sandy soil, the thickness of the capillary fringe may be only 10 to 15 cm. In a loamy or clayey soil that does not shrink or swell appreciably, the thickness may be 30 cm or more, depending on the size distribution of the pores.

The duration of the period that the soil must be saturated to have an aquic regime is not known. 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) at some time while the soil or the horizon is saturated.

Very commonly, the level of ground water fluctuates with the seasons. The level 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 term is not used as a formative element for names of taxa, it is used in their descriptions as an aid in understanding genesis.

Aridic and torric (L. *aridus*, dry, and L. *torridus*,[9] 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 in most years is

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[9] *Torridus* is not the ideal root, but a better one could not be found. Although soils may not be hot throughout the year, soils that have a torric moisture regime are hot and dry in summer.

1. Dry in all parts more than half the time (cumulative) that the soil temperature at a depth of 50 cm is above 5°C; *and*

2. Never moist in some or all parts for as long as 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 are normally 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 of soil temperature exclude from these moisture regimes the very cold and dry regions of Greenland and adjacent islands. Such fragmentary data are available on the soils of those regions 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 most years the soil moisture control section is not dry in any part for as long as 90 days (cumulative). 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 differ by 5°C or more, the soil moisture control section is not dry in all parts for as long as 45 consecutive days in the 4 months that follow the summer solstice in 6 or more years out of 10. In addition, the udic moisture regime requires, except for short periods, a three-phase system, solid-liquid-gas, in part, but not necessarily in all, of the soil when the soil temperature is above 5°C.

The udic moisture regime is common to the soils of humid climates that have well-distributed rainfall or that have enough rain in summer 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.

If precipitation exceeds evapotranspiration in all months of most years, there are occasional brief periods when some stored moisture is used, but the moisture tension rarely becomes as great as 100 kPa in the soil moisture control section. The water moves through the soil in all months that it is not frozen. This extremely wet moisture regime is called "perudic" (L. *per*, throughout in time, L. *udus*, moist). The formative element *ud* is used in the names of most taxa 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. The concept is one of limited moisture, but the moisture is present at a time when conditions are suitable for plant growth. The ustic moisture regime is not applied to soils that have cryic or pergelic temperature regimes, which are defined later.

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, the soil moisture control section in the ustic moisture regime is dry in some or all parts for 90 or more cumulative days in most years. But the moisture control section is moist in some part for more than 180 cumulative days, or it is continuously moist in some part for at least 90 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, the soil moisture control section in the ustic regime is dry in some or all parts for 90 or more cumulative days in most years. But it is not dry in all parts for more than half the time that the soil temperature is higher than 5°C at a depth of 50 cm (the aridic and torric regimes). Also, it is not dry in all parts for as long as 45 consecutive days in the 4 months that follow the summer solstice in 6 or more years out of 10 if the moisture control section is moist in all parts for 45 or more consecutive days in the 4 months that follow the winter solstice in 6 or more years out of 10 (xeric regime).

In tropical and subtropical regions that have either one or two dry seasons, summer and winter have little meaning. In those regions, the ustic regime is that typified in a monsoon climate that has 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 they have a dormant period while the soil is dry.

Xeric moisture regime.--The xeric moisture regime (Gr. *xeros*, dry) is that typified in Mediterranean climates, where winters are moist and cool and summers are warm and dry. The moisture, coming in winter when potential evapotranspiration is at a minimum, is particularly effective for leaching. In a xeric moisture regime, the soil moisture control section is dry in all parts for 45 or more consecutive days within the 4 months that follow the summer solstice in 6 or more years out of 10. It is moist in all parts for 45 or more consecutive days within the 4 months that follow the winter solstice in 6 or more years out of 10. The moisture control section is moist in some part more than half the time, cumulative, that the soil temperature at a depth of 50 cm is higher than 5°C, or in 6 or more years out of 10 it is moist in some part for at least

90 consecutive days when the soil temperature at a depth of 50 cm is continuously higher than 8°C. In addition, the mean annual soil temperature is lower than 22°C, and mean summer and mean winter soil temperatures differ by 5°C or more at a depth of 50 cm or at a lithic or paralithic contact, whichever is 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; connoting 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 excess water is not present. 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.

Cryic (Gr. *kryos*, coldness; connoting very cold soils).-- In this regime soils have a mean annual temperature higher than 0°C (32°F) but lower than 8°C (47°F).

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) at a depth of 50 cm 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) There is no O horizon, lower than 15°C (59°F); *or*

(2) There is an O horizon, lower than 8°C (47°F);

b. If the soil is saturated with water during some part of the summer, *and*

(1) There is no O horizon, lower than 13°C (55°F); *or*

(2) There is an O horizon or a histic epipedon, lower than 6°C (43°F).

2. In organic soils, *either*

a. The soil is frozen in some layer within the control section in most years about 2 months after the summer solstice; that is, the soil is very cold in winter but warms up slightly in summer; *or*

b. The soil is not frozen in most years below a depth of 5 cm; that is, 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.

Most isofrigid soils with a mean annual soil temperature above 0°C have a cryic temperature regime. A few with organic materials in the upper part are exceptions. Throughout this text all isofrigid soils without permafrost are considered to have a cryic temperature regime.

Frigid.--The frigid regime and some of the others that follow are used chiefly in defining classes of soils in the low categories. In the frigid regime the soil is warmer in summer than in the cryic regime, but its mean annual temperature is lower than 8°C (47°F), and the difference between mean winter and mean summer soil temperature is more than 5°C (9°F) at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Mesic.--The mean annual soil temperature is 8°C or higher but lower than 15°C (59°F) and the difference between mean summer and mean winter soil temperature is more than 5°C at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Thermic.--The mean annual soil temperature is 15°C (59°F) or higher but lower than 22°C (72°F), and the difference between mean summer and mean winter soil temperature is more than 5°C at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Hyperthermic.--The mean annual soil temperature is 22°C (72°F) or higher, and the difference between mean summer and mean winter soil temperature is more than 5°C at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

If the name of a soil temperature regime has the prefix iso, the mean summer and winter soil temperature 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 (47°F).

Isomesic.--The mean annual soil temperature is 8°C or higher but lower than 15°C (59°F).

Isothermic.--The mean annual soil temperature is 15°C or higher but lower than 22°C (72°F).

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

Sulfidic materials

Sulfidic materials are waterlogged mineral or organic soil materials that contain 0.75 percent or more sulfur (dry weight), mostly in the form of sulfides, and that have less than three times as much carbonate ($CaCO_3$ equivalent) as sulfur. Sulfidic materials accumulate in a soil that is permanently saturated, generally with brackish water. The sulfates in the water are biologically reduced to sulfides as the soil materials accumulate. Sulfidic materials are most common 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. If the soil is drained, the sulfides oxidize and form sulfuric acid. The pH, which normally is near neutrality before drainage, may drop below 2. The acid reacts with the soil to form iron and aluminum sulfates. The iron sulfate, jarosite, segregates and forms the bright-yellow mottles that characterize a sulfuric horizon. The transition from sulfidic materials to a sulfuric horizon normally requires a very few years. A sample of sulfidic materials, if air dried slowly in shade for about 2 months with occasional remoistening, becomes extremely acid. For quick identification in the field, a sample can be oxidized by boiling in concentrated H_2O_2 and measuring the drop in pH.[10]

Tonguing and interfingering

<u>Tonguing of albic materials</u>

Tongues of albic materials consist of penetrations of bleached material that has the color of an albic horizon in an argillic or a natric horizon, along ped surfaces if peds are present. No continuous albic horizon need be present above the tongues. The penetrations have a vertical dimension of more than 5 cm in any argillic or natric horizon. Their horizontal dimension is 5 mm or more in a fine-textured argillic or natric horizon (clay, silty clay, or sandy clay), 10 mm or more in a moderately fine textured argillic or natric horizon (clay loam, sandy clay loam, or silty clay loam), and 15 mm or more in a medium or coarser textured argillic or natric horizon (silt loam, loam, very fine sandy loam, or coarser). The penetrations must occupy more than 15 percent of the matrix of some part of the argillic or natric horizon before they are considered tongues.

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[10] Concentrated H_2O_2 can cause serious burns and is dangerous. Gloves should be worn, and precautions should be taken against spilling, leakage, or spattering.

Interfingering of albic materials

Interfingering of albic materials consists of penetrations of albic materials into an underlying argillic or natric horizon along faces of peds, primarily along vertical faces but to a lesser degree along horizontal faces. No continuous albic horizon need be present. The penetrations are not wide enough to constitute tonguing, but they form continuous skeletans (ped coatings of clean silt or sand defined by Brewer, 1964) more than 1 mm thick on the vertical ped faces, which means a total width of more than 2 mm between abutting peds. Because quartz is such a common constituent of soils, the skeletans usually appear to be nearly white when dry and light gray when moist, but their color is determined in large part by the color of the sand or silt fraction.

To be recognized as interfingering, all the following requirements must be met in a horizon that is 5 cm or more thick:

1. Half or more of the matrix consists of peds of the argillic or natric horizon; *and*

2. Albic materials are thicker than 2 mm on vertical faces between abutting peds but are too thin to be tongues; *and*

3. Clay skins are present in the peds, at least in pores.

Albic materials meet the following requirements for color: If the value, dry, is 7 or more, or the value, moist, is 6 or more, the chroma is 3 or less either dry or moist. If the value, dry, is 5 or 6 and the value, moist, is 4 or 5, the chroma is closer to 2 than to 3 either dry or moist.

Weatherable minerals

Several references are made to weatherable minerals in the text of this chapter and later chapters. Obviously, the stability of a mineral in a soil is a partial function of the soil moisture regime. In the context of the references in the definitions of diagnostic horizons and of various taxa, a humid climate is always assumed, either present or past. Minerals that are included in the meaning of weatherable minerals are:

1. Clay minerals: All 2:1 lattice clays except one that is currently considered to be an aluminum-interlayered chlorite. Sepiolite, talc, and glauconite are also included in the meaning of 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.

It should be noted that this is a restricted meaning of weatherable minerals. Calcite, for example, is readily soluble in a humid environment. If it is dissolved, it leaves no trace or residue. Soils that have been intensely and deeply weathered in a humid environment of the past are, in some places, preserved today in an arid environment. Calcite could reappear in one of these soils if it were brought in as dust. The intent is to include, in the context of the meaning of weatherable minerals for this purpose, only those minerals that are unstable in a humid climate relative to other minerals, such as quartz and 1:1 lattice clays, and that are more resistant to weathering than calcite.

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Chapter 2

Horizons and Properties Diagnostic for the Higher Categories: Organic Soils

ORGANIC SOIL MATERIALS

Organic soil materials and organic soils:

1. Are saturated with water for long periods or are artificially drained and, excluding live roots, (a) have 18 percent or more organic carbon if the mineral fraction is 60 percent or more clay, (b) have 12 percent or more organic carbon if the mineral fraction has no clay, or (c) have a proportional content of organic carbon between 12 and 18 percent if the clay content of the mineral fraction is between zero and 60 percent; *or*

2. Are never saturated with water for more than a few days and have 20 percent or more organic carbon.

DEFINITION OF ORGANIC SOILS

Organic soils (Histosols) are soils that

1. Have organic soil materials that extend from the surface to one of the following:

   a. A depth within 10 cm or less of a lithic or paralithic contact, provided the thickness of the organic soil materials is more than twice that of the mineral soil above the contact; *or*

   b. Any depth if the organic soil material rests on fragmental material (gravel, stones, cobbles) and the interstices are filled with organic materials, or rests on a lithic or paralithic contact; *or*

2. Have organic materials that have an upper boundary within 40 cm of the surface *and*

   a. Have one of the following thicknesses:

      (1) 60 cm or more if three-fourths or more of the volume is moss fibers or the moist bulk density is less than 0.1 g per cubic centimeter (6.25 lbs per cubic foot); *or*

      (2) 40 cm or more if

         (a) The organic soil material is saturated with water for long periods (more than 6 months) or is artificially drained; *and*

(b) The organic material consists of sapric or hemic materials, or consists of fibric materials that are less than three-fourths moss fibers by volume and have a moist bulk density of 0.1 or more; *and*

b. Have organic soil materials that

(1) Do not have a mineral layer as much as 40 cm thick either at the surface or whose upper boundary is within a depth of 40 cm from the surface; *and*

(2) Do not have mineral layers, taken cumulatively, as thick as 40 cm within the upper 80 cm; *and*

3. Do not have andic soil properties in layers 35 cm or more thick within a depth of 60 cm from the surface.

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

KINDS OF ORGANIC SOIL MATERIALS

Three basic kinds of organic soil materials are distinguished, fibric, hemic, and sapric, according to the degree of decomposition of the original plant materials.

Fibers

A fiber is a fragment or piece of plant tissue, excluding live roots, that is large enough to be retained on a 100-mesh sieve (openings 0.15 mm in diameter) and that retains recognizable cellular structure of the plant from which it came. The material is screened after dispersion in sodium hexametaphosphate. Fragments larger than 2 cm in cross section or in their smallest dimension, to be called fibers, must be decomposed enough that they can be crushed and shredded with the fingers. Fragments of wood that are larger than 2 cm in cross section and that are so undecomposed that they cannot be crushed and shredded with the fingers are not considered fibers. Such fragments of undecomposed wood in the form of large branches, logs, and stumps are considered to be coarse fragments, comparable to gravel, stones, and boulders in mineral soils.

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

Fibric soil materials have the following characteristics:

1. The fiber content after rubbing is three-fourths[1] or more of the soil volume, excluding coarse fragments and mineral layers; *or*

2. The fiber content after rubbing is two-fifths or more of the soil volume, excluding coarse fragments and mineral layers, and the material yields a sodium pyrophosphate extract color on white chromatographic paper that has value and chroma of 7/1, 7/2, 8/1, 8/2, or 8/3 (Munsell designations).

Hemic soil materials

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

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

These are the most highly decomposed of the organic materials. They normally have the smallest amount of plant fiber, the highest bulk density, and the lowest water content on a dry-weight basis at saturation. They 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 the others.

Sapric materials have the following characteristics:

1. The fiber content after rubbing is less than one-sixth of the soil volume, excluding coarse fragments and mineral layers; *and*

2. The sodium pyrophosphate extract color on chromatographic paper is below or to the right of a line drawn to exclude blocks 5/1, 6/2, and 7/3.

Humilluvic materials

Illuvial humus accumulates in the lower parts of some organic soils if they are acid and have been drained and cultivated. The illuvial humus 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 illuvial humus should constitute at least half the volume of a layer at least 2 cm thick.

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

Limnic materials

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.

Coprogenous earth

A coprogenous earth (sedimentary peat) layer is a limnic layer that

1. Contains many fecal pellets a few hundredths to a few tenths of a millimeter in diameter; *and*

2. Has a color value, moist, of less than 5; *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 that often tend to crack along horizontal planes; *and*

4. Is normally, but not necessarily, nearly devoid of fragments of plants that can be recognized with the eye; *and*

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

Diatomaceous earth

A diatomaceous earth layer is a limnic layer that

1. Has a matrix color value of 3 through 5 if not previously dried, and the value changes irreversibly on drying. The color change results from irreversible shrinkage of organic matter coatings on diatoms, which can be identified by microscopic (440X) examination of dry samples; *and*

2. Yields a color higher in value and lower in chroma than 10 YR 7/3 on white filter paper that is inserted into a paste made of the material in a saturated sodium pyrophosphate solution, or the cation-exchange capacity is less than 240 cmol(+) per kg of organic matter (by loss on ignition), or both.

Marl

A marl layer is a limnic layer that

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 color irreversibly on drying. A layer of marl contains too little organic matter to coat the carbonate, even before it has been shrunk by drying.

THICKNESS OF ORGANIC MATERIALS (CONTROL SECTION)

For practical reasons an arbitrary control section has been established for taxonomy of Histosols. It is either 130 cm (51 in.) or 160 cm (63 in.) thick, depending on the kind of material, provided that no lithic or paralithic contact, thick layer of water, or frozen soil occurs within those limits. The thicker control section is used if the surface layer to a depth of 60 cm (24 in.) has three-fourths or more fibers derived from *Sphagnum* or from *Hypnum* or other mosses or has a bulk density less than 0.1. Layers of water may be thin or thick, from a few centimeters to many meters. Water is taken as the base of the control section only if the water extends below a depth of 130 cm or 160 cm, depending on the kind of material above it. A lithic or a paralithic contact shallower than 130 cm (51 in.) or 160 cm (63 in.), depending on the kind of material above it, is taken as the base of the control section, or the base is placed 25 cm (10 in.) below the depth at which the soil is frozen about 2 months after the summer solstice. An unconsolidated mineral substratum shallower than those limits does not change the base of the control section.

The control section has been divided somewhat arbitrarily into three tiers, the surface, subsurface, and bottom tiers.

Surface tier

The surface tier is the upper 60 cm (24 in.) if (1) the material is fibric and three-fourths or more of the fiber volume is derived from *Sphagnum* or mosses, or (2) the material has a bulk density less than 0.1; otherwise, the surface tier is the top 30 cm (12 in.) exclusive of loose surface litter or living mosses.

A surface mineral layer less than 40 cm (16 in.) thick is present on some organic soils as a result of flooding, additions by men to increase soil strength or reduce frost hazard, volcanic eruptions, or other causes. If present, it is considered a part of the surface tier, even though it may be more than 30 cm thick, and the depth then is measured from the top of the mineral layer.

Subsurface tier

The subsurface tier is 60 cm (24 in.) thick unless the control section ends at a lithic or paralithic contact or at water within this depth or unless the soil is frozen at too shallow a depth. In any of these situations the subsurface tier extends from the base of the surface tier to the base 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 (16 in.) thick unless the control section stops within the maximum span.

The control section is terminated at a shallower depth by water or by a lithic or a paralithic contact, or at a depth 25 cm (10 in.) below a layer that is frozen 2 months after the summer solstice.

Chapter 3

Family Differentiae

MINERAL SOILS

The differentiae used to distinguish families of mineral soils within a subgroup are listed next in the order in which the descriptive terms appear in the family name and in which the terms are defined in this chapter.

Particle-size classes
Mineralogy classes
Calcareous and reaction classes
Soil temperature classes
Soil depth classes
Soil slopes classes
Soil consistence classes
Classes of coatings (on sand)
Classes of cracks

Particle-size classes

Particle size refers to grain-size distribution of the whole soil and is not the same as texture, which refers to the fine-earth fraction. The fine-earth fraction consists of the particles that have a diameter of less than 2.0 mm. Particle-size classes are a kind of compromise between engineering and pedologic classifications. The limit between sand and silt is a diameter of 74 microns in the engineering classification and of either 50 or 20 microns in pedologic classifications. The engineering classifications are based on percentages by weight in the fraction less than 74 mm in diameter, and textural classes are based on percentages by weight in the fraction less than 2.0 mm in diameter.

The very fine sand separate (diameter between 0.05 mm and 0.1 mm) is split in engineering classifications. In defining particle-size classes, much the same split is made but in a different manner. A fine sand or loamy fine sand normally has an appreciable content of very fine sand, but the very fine sand fraction is mostly coarser than 74 microns. A silty sediment, such as loess, may also have an appreciable component of very fine sand, but most of the very fine sand is finer than 74 microns. So, in particle-size classes, the very fine sand is allowed to "float." It is treated as sand if the texture is fine sand, loamy fine sand, or a coarser class. It is treated as silt if the texture is very fine sand, loamy very fine sand, sandy loam, silt loam, or a finer class.

No single set of particle-size classes seems appropriate as family differentiae for all kinds of soils. The classes that follow provide for a choice of either 7 or 11 particle-size classes. This choice permits relatively fine distinctions in soils if the particle size is important and broader groupings if the particle size is not susceptible to precise measurement or if the use of narrowly defined classes produces undesirable groupings. Thus in some families the term "clayey" indicates that there is 35 percent or more clay in defined horizons, but in other families the term "fine" indicates that the clay fraction constitutes 35 through 59 percent of the fine earth of the horizons, and the term "very-fine" indicates 60 percent or more clay. The term "rock fragments" refers to particles 2.0 mm in diameter or larger and includes all sizes that have horizontal dimensions less than the size of a pedon. It is not the same as coarse fragments, which excludes stones and boulders larger than about 25 cm. The term "fine earth" refers to particles smaller than 2.0 mm in diameter.

Definition of classes

Fragmental.--Stones, cobbles, gravel, and very coarse sand particles; too little fine earth to fill some of the interstices larger than 1 mm in diameter.

Sandy-skeletal.--Rock fragments 2.0 mm in diameter or larger make up 35 percent or more by volume; enough earth to fill interstices larger than 1 mm; the fraction finer than 2.0 mm is sandy as defined for the sandy particle-size class.

Loamy-skeletal.--Rock fragments make up 35 percent or more by volume; enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2.0 mm is loamy as defined for the loamy particle-size class.

Clayey-skeletal.--Rock fragments make up 35 percent or more by volume; enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2.0 mm is clayey as defined for the clayey particle-size class.

Sandy.--The texture of the fine earth is sand or loamy sand that contains less than 50 percent very fine sand; rock fragments make up less than 35 percent by volume.

Loamy.[1]--The texture of the fine earth is loamy very fine sand, very fine sand, or finer, but the amount of clay is less than 35 percent; rock fragments are less than 35 percent by volume.

Coarse-loamy. By weight, 15 percent or more of the particles are fine sand (diameter 0.25-0.1 mm) or coarser, including fragments up to 7.5 cm in diameter; less than 18 percent clay in the fine-earth fraction.

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[1] If the ratio of 1500 kPa water retention to clay is 0.6 or more in half or more of the control section, the percentage of clay is considered to be 2.5 times the percentage of 1500 kPa water retention. Carbonates of clay size are not considered to be clay but are treated as silt in all particle-size classes.

Fine-loamy. By weight, 15 percent or more of the particles are fine sand (diameter 0.25-0.1 mm) or coarser, including fragments up to 7.5 cm in diameter; 18 through 34 percent clay in the fine-earth fraction (less than 30 percent in Vertisols).

Coarse-silty. By weight, less than 15 percent of the particles are fine sand (diameter 0.25-0.1 mm) or coarser, including fragments up to 7.5 cm in diameter; less than 18 percent clay in the fine-earth fraction.

Fine-silty. By weight, less than 15 percent of the particles are fine sand (diameter 0.25-0.1 mm) or coarser, including fragments up to 7.5 cm in diameter; 18 through 34 percent clay in the fine-earth fraction (less than 30 percent in Vertisols).

Clayey.[2]-- The fine earth contains 35 percent or more clay by weight, and rock fragments are less than 35 percent by volume.

Fine. A clayey particle-size class that has 35 through 59 percent clay in the fine-earth fraction (30 through 59 percent in Vertisols).

Very-fine. A clayey particle-size class that has 60 percent or more clay in the fine-earth fraction.

Modifiers that replace names of particle-size classes[3]

There are three situations in which particle-size class names are not used. In one, the name is redundant. Psamments and Psammaquents, by definition, are sandy, and no particle-size class name is needed or used in the family name.

In the second situation, soil materials derived from volcanic ejecta, particle-size analysis is difficult to apply because the soil material commonly consists of aggregates containing volcanic glass and allophane.

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[2] If the ratio of 1500 kPa water retention to clay is 0.6 or more in half or more of the control section, the percentage of clay is considered to be 2.5 times the percentege of 1500 kPa water retention. Carbonates of clay size are not considered to be clay but are treated as silt in all particle-size classes.

[3] The definition of the geologic terms used in the substitute particle-size classes are the same as those in: Bates, R.L.; Jackson, J.A. (Eds.). 1980. Glossary of Geology (Second Edition). American Geological Institute. Falls Church, VA. 751 p., with the following exceptions:

Cinders: Uncemented juvenile vitric vesicular pyroclastic material, 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.

Lapilli: Non- or slightly vesicular pyroclastics, 2.0 to 76 mm in at least one dimension, with an apparent specific gravity of 2.0 or more.

Pumice-like: Vesicular pyroclastic materials other than pumice but having an apparent specific gravity (including vesicles) of less than 1.0.

These components are not adequately described by normal particle-size classes, 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 that part of the soil that has andic soil properties or that is high in volcanic glass, as is the situation with Andisols by definition. In families of Andisols and in most andic and vitrandic subgroups of other soil orders the following substitutes for particle-size class names are used for the part of the soil that does not disperse.

In the third situation, the content of allophane and organic matter is also high and particle size has only limited relation to the physical and chemical properties of the soils. This seems to be normal in soils that have both a cryic temperature regime and a spodic horizon. Therefore, particle-size class names are not used for the spodic horizons of most Cryaquods, Cryohumods, Cryorthods, or Cryic Placohumods and for some other Spodosols[4].

The following terms are substituted for the particle-size class names in the taxa that have been listed unless the particle-size modifier is redundant. They reflect a combination of particle size and mineralogy, and they take the place of both.

A. Substitutes for the fragmental class:

These classes have insufficient fine earth to fill 10 percent of interstices coarser than 1 mm.

<u>Pumiceous</u> - More than 60 percent by weight of the whole soil is composed of volcanic ash, cinders, lapilli, pumice and pumice-like[5] fragments more than 1 mm in diameter; pumice or pumice-like fragments form two-thirds or more by volume of the fraction coarser than 2.0 mm.

<u>Cindery</u> - More than 60 percent by weight of the whole soil is composed of volcanic ash, cinders, lapilli, pumice and pumice-like fragments more than 1 mm in diameter; pumice or pumice-like fragments form less than two-thirds by volume of the fraction coarser than 2.0 mm.

B. Substitutes for the non-fragmental classes:

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[4] Particle-size class names are applied to other spodic horizons but with reservations. Somewhat different classes probably should be used for most families of Spodosols, but data are too few to permit the testing of alternatives. Some series that would otherwise be reasonably homogeneous are split at the family level by the particle-size classes. These soils have appreciable but not very large amounts of organic matter in the spodic horizon.

[5] Pumice-like: Vesicular pyroclastic materials other than pumice but having an apparent specific gravity (including vesicles) of less than 1.0 g/cc.

These classes have sufficient fine earth to fill 10 percent or more of the interstices coarser than 1 mm.

Ashy - Rock fragments make up less than 35 percent by volume and the fine earth is *either*:

a. Thirty percent or more by weight volcanic glass, glass aggregates, glass coated grains or other vitric volcaniclastics; *or*

b. Thirty percent or more by weight is between 0.02 and 2.0 mm in diameter and 5 percent or more of the 0.02 to 2.0 mm fraction is volcanic glass, glass aggregates, glass coated grains, or other vitric volcaniclastics, and the $Al_o + Fe_o/2$ is 0.4 percent or more, and the water at 1500 kPa is less than 30 percent on undried samples and less than 12 percent on dried samples of the fine earth.

Ashy-pumiceous - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are two-thirds or more by volume of the rock fragments; fine earth is ashy.

Ashy-skeletal - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are less than two-thirds by volume of the rock fragments; fine earth is ashy.

Medial - The fine earth has andic soil properties; water at 1500 kPa is 12 percent or more on air-dried samples of the fine earth, or is 30 percent or more on undried samples, but is less than 100 percent on undried samples; rock fragments make up less than 35 percent by volume.

Medial-pumiceous - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are two-thirds or more by volume of the rock fragments; fine earth is medial.

Medial-skeletal- Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are less than two-thirds by volume of the rock fragments; fine earth is medial.

Hydrous - The fine earth has andic soil properties; water at 1500 kPa is 100 percent or more on undried samples of the fine earth; rock fragments make up less than 35 percent by volume.

Hydrous-pumiceous - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are two-thirds or more by volume of the rock fragments; fine earth is hydrous.

Hydrous-skeletal - Rock fragments make up 35 percent or more by volume; pumice or pumice-like fragments are less than two-thirds by volume of the rock fragments; fine earth is hydrous.

Control section for particle-size classes or their substitutes

Names of particle-size classes or their substitutes as defined are applied to specific horizons or to the materials between given limits of depth that are defined in terms of either the distance below the surface of the mineral soil or the upper boundary of a specified horizon or root-limiting layer. The vertical section so defined is called the control section. Root-limiting layers include fragipans, duripans, continuous ortstein, petrocalcic and petrogypsic horizons, and lithic, paralithic, and petroferric contacts. Definitions of the control section for determination of the particle-size classes are arranged as a key.

A. Particle-size modifiers or substitutes are used to describe material from the surface to a root-limiting layer if any of these come within a depth of 36 cm (14 in.) or less; or to a depth of 36 cm if the soil temperature is 0°C or lower within this depth about 2 months after the summer solstice.

B. In Andisols particle-size modifiers or substitutes are used to describe material from the mineral soil surface or upper boundary of an organic layer that meets andic soil properties, whichever is shallower, to 100 cm or to a lithic, paralithic, or petroferric contact, to a duripan, or to a petrocalcic or placic horizon if the depth to any of these is less than 100 cm; or to a depth 25 cm below the level at which the soil temperature is 0°C about 2 months after the summer solstice; whichever is shallower.

C. In great groups of Spodosols, Alfisols, and Ultisols that have a spodic horizon or a fragipan in or above an argillic or kandic horizon; in Oxisols; and in other soils that do not have an argillic, kandic, or natric horizon:

1. Particle-size modifiers or substitutes are used to describe material from the base of the Ap horizon or from a depth of 25 cm, whichever is greater, to a root-limiting layer if the depth is less than 100 cm; or to a depth 25 cm below the level at which the soil temperature is 0°C about 2 months after the summer solstice; whichever is shallower.

2. Otherwise, particle-size modifiers or substitutes are used to describe material from a depth of 25 cm to a depth of 100 cm.

D. In other soils of the orders Alfisols and Ultisols and in great groups of Aridisols and Mollisols that have an argillic or kandic horizon that has (a) a lower boundary deeper than 25 cm (see E) and (b) an upper boundary shallower than 100 cm, or the soil is in a grossarenic subgroup:

1. If there are no strongly contrasting particle-size classes, as defined later, and there is no root-limiting layer between the top of the argillic, kandic, or natric horizon and a depth of 100 cm, particle-size modifiers or substitutes are used to describe the whole argillic, kandic, or natric horizon if it is less than 50 cm thick[6] or the upper 50 cm of the argillic, kandic, or natric horizon if it is more than 50 cm thick.

2. If there are horizons or layers of strongly contrasting particle-size classes, as defined later, within or below the argillic, kandic, or natric horizon and within a depth of 100 cm, particle-size modifiers or substitutes are used to describe material from the top of the argillic, kandic, or natric horizon to a depth of 100 cm or to a root limiting layer, whichever is shallower.

3. If there is a root-limiting layer below an argillic, kandic, or natric horizon, particle-size modifiers or substitutes are used to describe material from the top of the argillic, kandic, or natric horizon, excluding any part incorporated in an Ap horizon, to the top of the root-limiting layer, or are used to describe the upper 50 cm of the argillic, kandic, or natric horizon, whichever of these is less.

E. In other soils in the orders Alfisols and Ultisols and in great groups of Aridisols and Mollisols that have an argillic, kandic, or natric horizon that has its upper boundary at a depth of more than 100 cm and that are not in a grossarenic subgroup, particle-size modifiers or substitutes are applied to describe material from a depth of 25 cm to a depth of 100 cm below the mineral surface.

F. In other soils in which the lower boundary of the argillic or natric horizon is shallower than 25 cm, that is, they have a *k* horizon in which there is soft powdery lime, or have a calcic or other named diagnostic horizon that has its upper boundary within 25 cm of the surface, or have rock structure dominant within that depth, particle-size classes are used to describe material from the top of the argillic horizon or the base of an Ap horizon, whichever is shallower, to a root-limiting layer or to a depth of 100 cm, whichever is shallowest.

<u>Strongly contrasting particle-size classes</u>

In applying names of particle-size classes, the weighted average particle-size class of the control section or of the horizon listed is named unless there are strongly contrasting particle-size classes within the control

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[6] The upper boundary of the argillic or kandic horizon is not always obvious. If properties of an argillic horizon are present but the upper boundary is gradual, use the depth at which the percentage of clay exceeds that of a higher lying horizon by the appropriate amount after fitting to a smooth curve. If the boundary is irregular or broken, as in A&B or B&A horizons, use the depth at which half or more of the volume has the fabric of an argillic horizon.

section or the horizons. If there are strongly contrasting particle-size classes, both particle-size classes are named. Thus, if the weighted average of the upper part of the control section is loamy fine sand and the lower part is clay, the family differentia is sandy over clayey. If there are more than two contrasting particle-size classes within the control section, the classes differing most in median particle size are named. Sandy includes fine sand as well as coarser sands. Substitute names for particle-size class names are applied only if the materials extend at least 10 cm into the upper part of the control section.

The following particle-size classes are strongly contrasting if the transition between them is less than 12.5 cm thick:

1. Ashy over loamy-skeletal.
2. Ashy over loamy.
3. Ashy over medial-skeletal.
4. Ashy over medial.
5. Ashy over pumiceous or cindery if there is an absolute difference of 20 percent or more in volume of rock fragments.
6. Ashy over sandy or sandy-skeletal.
7. Cindery over loamy.
8. Cindery over medial-skeletal.
9. Cindery over medial.
10. Clayey over fine-silty if there is an absolute difference of more than 25 percent in the percentage of clay.
12. Clayey over fragmental.
13. Clayey over loamy if there is an absolute difference of more than 25 percent in the percentage of clay.
14. Clayey over loamy-skeletal if there is an absolute difference of more than 25 percent in the percentage of clay in the fine-earth fraction.
15. Clayey over sandy or sandy-skeletal.
16. Clayey-skeletal over sandy.
17. Coarse-loamy over clayey.
18. Coarse-loamy over fragmental.
19. Coarse-loamy over sandy or sandy-skeletal if the coarse-loamy material has less than 50 percent fine or coarser sand.
20. Coarse-silty over clayey.
21. Coarse-silty over sandy or sandy-skeletal.
22. Fine-loamy over clayey if there is an absolute difference of more than 25 percent in the percentage of clay.
23. Fine-loamy over fragmental.
24. Fine-loamy over pumiceous or cindery.
25. Fine-loamy over sandy or sandy-skeletal.
26. Fine-silty over clayey if there is an absolute difference of more than 25 percent in the percentage of clay.
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 has less than 50 percent fine or coarser sand.
36. Loamy-skeletal over clayey if there is an absolute difference of more than 25 percent in the percentage of clay in the fine-earth fraction.
37. Loamy-skeletal over fragmental.
38. Loamy-skeletal over sandy.
39. Medial over ashy.
40. Medial over clayey-skeletal.
41. Medial over clayey.
42. Medial over fragmental.
43. Medial over hydrous.
44. Medial over loamy-skeletal.
45. Medial over loamy.
46. Medial over pumiceous or cindery.
47. Medial over sandy or sandy-skeletal.
48. Pumiceous or ashy-pumiceous over loamy.
49. Pumiceous or ashy-pumiceous over medial-skeletal.
50. Pumiceous or ashy-pumiceous over medial.
51. Pumiceous or ashy-pumiceous over sandy or sandy-skeletal.
52. Sandy over clayey.
53. Sandy over loamy if the loamy material has less than 50 percent fine or coarser sand.
54. Sandy-skeletal over loamy if the loamy material has less than 50 percent fine or coarser sand.

The intent in setting up classes of strongly contrasting particle sizes is to identify changes in pore-size distribution that seriously affect movement and retention of water and that have not been identified in higher categories. The list given is intended for use in grouping the soil series of the United States into families. It is not intended as a complete list. For example, fine sand over coarse sand is common in the Udipsamments of western Europe but is not known to be important in the United States.

Choice of 7 or 11 particle-size classes

Only the seven particle-size classes are used in lithic, arenic, and grossarenic subgroups and in shallow families.

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

Contrasting families are recognized if substitute terms are used to characterize the materials in a part of the particle-size control section. If the substitute terms are used only for the upper part then only the seven particle-size classes are used. For example, we might use cindery over loamy but not cindery over fine-loamy.

Only two particle-size classes are used to separate families in Vertisols, 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.

Mineralogy classes

<u>The control section</u>

Mineralogy classes are based on the approximate mineralogical composition of selected size fractions of the same segment of the soil (control section) that is used for application of particle-size classes.

<u>Contrasting mineralogy modifiers</u>

Contrasting mineralogy modifiers are not recognized except where substitutes for particle-size class modifiers have been used. In identifying and naming the contrasting mineralogy modifiers in families of those soils, the seven particle-size classes are used to describe the lower part of the section. For example, a pair of contrasting layers is named as medial over loamy, mixed, not medial over coarse-loamy, mixed.

If there are layers of contrasting particle size in the control section, the mineralogy class of the upper part of the control section is definitive of the family mineralogy. For example, if there is fine-loamy material of mixed mineralogy over sandy material that is siliceous, the proper modifiers to describe the family are fine-loamy over sandy, mixed, not fine-loamy, mixed, over sandy, siliceous.

<u>Key to mineralogy classes</u>

All mineral soils, except Oxisols, are placed in the first mineralogy class of the key (Table 1) that accommodates them although they may appear also to meet the requirements of other mineralogy classes. The correct mineralogy class for Oxisols is determined by using the key in Table 2. These are keys, not complete definitions. Substitute terms connoting both particle size and mineralogy are based on combined texture, consistence, and mineralogy classes and are used to indicate important variations in Andisols, in many intergrades to Andisols, and in many cryic great groups and cryic subgroups of Spodosols. Mineralogy classes are not named in Calciaquolls because the effect of the carbonates overshadows other differences in mineralogy, and they are not named in Quartzipsamments, which, by definition, are siliceous.

It is recognized that it is normally impossible to be certain of the percentages of the various kinds of clay minerals. Quantitative methods of identification are still subject to change. Although much progress has been made in the past few decades, an element of judgment enters into the estimation. All the evidence does not need to come from X-ray, surface, and DTA determinations. Other physical and chemical properties suggest the mineralogy of many clayey soils. Changes in volume, cation-exchange capacity, and the consistence are useful in estimating the nature of clay.

The description of clay mineralogy in naming families of clayey soils is based on the weighted average of the control section.

Calcareous and reaction classes

The presence or absence of carbonates and the reaction are treated together because they are so intimately related. A calcareous horizon cannot be strongly acid. Calcareous classes are applied to the section between a depth of 25 and 50 cm or between a depth of 25 cm and a lithic or paralithic contact that is below a depth of 25 but not 50 cm, or to some part of the soil above a lithic or paralithic contact that is shallower than 25 cm. Two classes, calcareous and noncalcareous, are used in selected taxa. The definitions follow.

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 a part of a family name.

It should be noted that a soil that contains dolomite is calcareous and that effervescence of dolomite, when treated with cold dilute HCl, is slow.

Reaction classes are applied to the control section that is defined for particle-size classes. Three classes (acid, nonacid, and allic) are used in selected taxa. The definitions follow.

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 at least some part of the control section. The term nonacid is not used in the family name of calcareous soils.

Allic.--There is more than 2 cmol(+) of KCl-extractable Al per kg soil (less than 2.0 mm fraction) in some 30 cm layer in the control section.

Acid and nonacid classes are used only in names of families of Entisols and Aquepts; they are not used in sandy, sandy-skeletal, and fragmental families of these taxa, nor are they used in Sulfaquepts and Fragiaquepts, or in families that have carbonatic or gypsic mineralogy. The allic class is used only in names of families of Oxisols.

Calcareous classes are used if appropriate in the same taxa as reaction classes and, in addition, are used in families of Aquolls except for Calciaquolls and for Aquolls that have an argillic horizon. Calcareous and reaction classes are not used in soils that have carbonatic or gypsic mineralogy. A soil that is calcareous is never acid. Calcareous therefore implies nonacid, and both names are not used because nonacid would be redundant. Similarly, noncalcareous would be redundant in acid families, and it is not used as part of the family name. If calcareous is used in a family name, calcareous is considered to be a subclass of mineralogy. It follows the mineralogy class name and is shown in parenthesis, for example: 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 name of a higher taxon carries the same limitation. Thus, frigid is implied in all boric suborders and cryic great groups, and is redundant if used in the name of a family.

The Celsius (centigrade) scale is the standard. Approximate Fahrenheit equivalents are indicated parenthetically. It is assumed that the temperature is that of a soil that is not being irrigated.

For soils in which the difference is 5°C (9°F) 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 temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, the classes, defined in terms of the mean annual soil temperature, are as follows:

Frigid.--Below 8°C (47°F).

Mesic.--From 8° to 15°C (47° to 59°F).

Thermic.--From 15° to 22° C (59° to 72°F).

Hyperthermic.--22°C (72°F) or higher.

For soils in which the difference is less than 5°C (9°F) between mean summer and mean winter soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, the classes, defined in terms of the mean annual soil temperature, are as follows:

Isofrigid.--Below 8°C (47°F).

Isomesic.--From 8° to 15°C (47° to 59°F).

Isothermic.--From 15° to 22°C (59° to 72°F).

Isohyperthermic.--22°C (72°F) or higher.

The appropriate limit between isofrigid and isomesic cannot be tested in the United States and probably will need to be revised.

Other characteristics

Several soil characteristics other than those already mentioned are needed in particular taxa to provide reasonable groupings of series into families. Some of these seem to be logical family criteria. Others probably should have been used in higher categories, but the lack of information about them makes it much safer to use them as family differentiae at this time. These characteristics include depth of soil, consistence, moisture equivalent, slope of soil, and permanent cracks.

<u>Depth of soil</u>

Classes of shallow and deep soils may be needed at the family level in all the orders of mineral soils. Some distinctions in depth are made in great groups and in arenic, paralithic, and lithic subgroups, but some other soils should also be grouped in families according to depth. Some soils have a paralithic contact over soft rock such as clay shale that is too compact for penetration by roots. The soil depth classes follow:

Micro.--Less than 18 cm through diagnostic horizons. Used in cryic great groups but not in pergelic subgroups or in Entisols.

Shallow.--Two depths are considered shallow:

a. Less than 50 cm to the upper boundary of a duripan or petrocalcic horizon or to a lithic, paralithic or petroferric contact. Used in lithic and petroferric subgroups of Oxisols and all great groups of Alfisols, Aridisols, Entisols, Inceptisols, Mollisols, Spodosols, and Ultisols, except pergelic subgroups of the cryic great groups and lithic subgroups. It is emphasized that the adjective "shallow" is not used in the family name of lithic subgroups of orders, other than Oxisols, because it would be redundant.

b. Less than 100 cm to a lithic or paralithic or a petroferric contact. Used in families of Oxisols.

Slope or shape of soil

Soils of aquic great groups normally have level or concave surfaces. They are mainly in places where ground water saturates the soil during some period of the year. A few, however, are on the sides of slopes where water cannot stand and are kept wet by more or less continuous precipitation and by seepage of water from higher areas. In a very few, the hydrostatic pressure keeps the soil wet. No consistent internal morphological clues have yet been found that distinguish these sloping aquic soils if the dissolved oxygen content is low, but their recognition in the field from the position of the soil in the landscape is generally easy. In aquic great groups, particularly in Aquolls, Aquox, and Aquults, use the shape of the soil as a family differentia. For Aquolls and Aquults use classes of level and sloping as these classes are defined in the Soil Survey Manual. For Aquox use sloping in the names of families if slope is more than 8 percent. It may be necessary to use slope classes as family differentiae in other orders, but they should not be used in families of Aquods or Albaqualfs. Level is assumed in families of aquic soils if no slope modifier is used in the family name.

Consistence

Some cemented horizons, for example, a duripan, are differentiae in the classification in categories above the family. Others such as a cemented spodic horizon (ortstein) are not, but no single family should include soils that have a continuous, shallow, cemented horizon and soils that do not. In Spodosols, in particular, a cemented spodic horizon needs to be used as a family differentia. The following classes of consistence are defined for Spodosols.

Ortstein.--All or part of the spodic horizon is at least weakly cemented, when moist, 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 as much as half of each pedon.

Cementation of a small volume into shot or concretions does not constitute cementation to form a massive horizon. The name of a family of noncemented Spodosols normally does not have a modifier to imply 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 a petrocalcic or petrogypsic horizon is expected to meet most, if not all, the needs for recognition of cementation in those horizons. Taxa of these cemented soils are not named in the family category.

Classes of coatings (on sands)

Despite the emphasis given to particle-size classes in the taxonomy, variability remains in the sandy particle-size class, which takes in sands and loamy sands. Some sands are very clean, almost completely free of silt and clay. Others are mixed with appreciable amounts of finer grains. A moisture equivalent of 2 percent makes a reasonable division of the sands at the family level. Two classes of Quartzipsamments are defined in terms of their moisture equivalent.

Coated.--The moisture equivalent is 2 percent or more.

Uncoated.--The moisture equivalent is less than 2 percent. The moisture retained at tension of 50 kPa may be substituted for the moisture equivalent. Or, if moisture tension data are not available, the silt plus clay is 5 percent or less.

Classes of permanent cracks

Hydraquents consolidate[7] after drainage and become Fluvaquents. In the process, they form polyhedrons, roughly 12 to 50 cm in diameter, depending on the *n*-value and particle size. The 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 moisture content of the soil, but the cracks are permanent and can persist for some hundreds of years even though the soils are cultivated. The cracks permit rapid movement of water through the soil either vertically or laterally. Yet the soils may have the same particle size, mineralogy, and other family properties as soils that are not cracked or that have cracks that open and close with the seasons. The soils that have permanent cracks are so rare in the United States that only a provisional definition of their characteristics can be presented.

The modifier "cracked" is used only to designate families of Fluvaquents. It means that there are continuous, permanent, lateral and vertical cracks, at least 2 mm wide, spaced at average lateral intervals of 50 cm or less. If this modifier is not in the family name, permanent cracks are assumed to be absent.

[7] The process is designated by a Dutch word that means "to ripen" because the change resembles the change in consistence of cheese as water is removed.

FAMILY DIFFERENTIAE FOR HISTOSOLS

Most of the differentiae used to distinguish families of Histosols have been defined earlier, either because they are differentiae in mineral soils as well as in Histosols; or because their definitions are essential for the classification of some Histosols in categories higher than the family. The differentiae that are not defined elsewhere are defined in this section and the taxa in which they are used are enumerated.

The order in which family modifiers are placed in the technical family names of Histosols follows. The modifiers chosen are those appropriate to the particular family.

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

The differentiae are discussed in the remainder of this section.

Particle-size classes

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

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

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

Mineralogy classes

Mineralogy classes of Histosols are of three kinds, according to the nature of the subgroup or great group.

Ferrihumic.--Containing ferrihumic materials within the control section (applied to Fibrists, Hemists, and Saprists, except Sphagnofibrists and sphagnic subgroups of other great groups). Bog iron is present in some Histosols or in organic soil materials. It is called ferrihumic material. It consists of authigenic deposits (formed in place) of hydrated iron oxides mixed with varying kinds or amounts of organic materials. The iron in some places is present in large cemented aggregates. In others it may be mostly dispersed and soft. The colors normally are shades of dark reddish brown, commonly mixed with black, and the colors change little on drying. The content of iron oxide ranges from 10 percent to more than 20 percent.

Ferrihumic material either is saturated with water for long periods (more than 6 months) or is in an artificially drained soil. The content of free iron oxide should exceed 10 percent (7 percent Fe), but the horizon may be either organic or mineral provided there is at least 1 percent organic matter. The materials should have more than 2 percent (by weight) concretions of iron, which may range in size from fine (less than 5 mm) to 1 m or more in the largest lateral dimension. Colors should be dark reddish brown or reddish brown, or should be close to those colors. The presence of ferrihumic material within the control section is one of the family differentiae.

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

Modifiers applied only to terric subgroups.–The mineralogy modifiers used for mineral soils are applied to the mineral parts of the soil for which a particle-size modifier has been used if the mineralogy is not ferrihumic.

Modifiers applied to limnic subgroups.–If limnic materials are present in the control section, if they are 5 cm or more thick, and if the materials do not have ferrihumic mineralogy, the following modifiers are used.

Coprogenous. Limnic materials that consist of coprogenous earth are present.

Diatomaceous. Limnic materials that consist of diatomaceous earth are present.

Marly. Limnic materials that consist of marl are present.

Reaction classes

Modifiers to indicate reaction are used in all subgroups. The meanings follow.

Euic.–The pH of undried samples is 4.5 or more (0.01 M $CaCl_2$) in at least some part of the organic materials in the control section.

Dysic.–The pH is less than 4.5 (in 0.01 M $CaCl_2$) in all parts of the organic materials in the control section.

Soil temperature classes

Names and definitions of classes follow the rules given for soil temperature classes of mineral soils. Frigid, however, is redundant in boric and cryic great groups and is not used. No temperature modifier is used in pergelic subgroups.

Soil depth classes

Soil depth modifiers are used in all lithic subgroups of Histosols except in the suborder of Folists. It is assumed that lithic Folists have a shallow lithic contact. Other lithic Histosols have a lithic contact within the control section but it may be as much as 160 cm deep.

Shallow families.--Used in lithic subgroups to indicate a lithic contact between a depth of 18 cm and 50 cm.

Micro families.--Used to indicate a lithic contact shallower than 18 cm without regard to soil temperature. (In mineral soils, micro families are restricted to cryic great groups.)

LITERATURE CITED

Soil Survey Staff. 1951. Soil survey manual. U.S. Dept. Agr. Handb. 18. U.S. Govt. Printing Office, Washington, DC.

TABLE 1 - KEY TO MINERALOGY CLASSES
(except for Oxisols - see Table 2)

CLASSES APPLIED TO SOILS OF ANY PARTICLE-SIZE CLASS

Carbonatic
Definition: More than 40% by weight carbonates (expressed as $CaCO_3$) plus gypsum, and the carbonates are more than 65% of the sum of carbonates and gypsum.

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter or whole soil less than 20 mm, whichever has highest percentage of carbonates plus gypsum.

Ferritic
Definition: More than 40 % by weight iron oxide extractable by citrate-dithionite, reported as Fe_2O_3 (or 28% reported as Fe).

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter.

Gibbsitic
Definition: More than 40% by weight hydrated aluminum oxides, reported as gibbsite and bohemite.

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter.

Oxidic
Definition: Less than 90% quartz; less than 40% any other single mineral listed subsequently; and the ratio, percent extractable iron oxide plus percent gibbsite to percent clay[8] is 0.20 or more. That is,

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

Determinant size fraction: For quartz and other minerals, fraction 0.02 to 2.0 mm in diameter; for ratio of iron oxide and gibbsite to clay, whole soil less than 2.0 mm.

Serpentinitic
Definition: More than 40% by weight serpentine minerals (antigorite, chrysotile, fibrolite, and talc).

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter.

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8 Percentage of clay or percentage of 1500 kPa water retention times 2.5, whichever is greater, provided the ratio of 1500 kPa water retention to clay is 0.6 or more in half or more of the control section.

Gypsic
Definition: More than 40% by weight of carbonates (expressed as $CaCO_3$) plus gypsum, and the gypsum is more than 35% of the sum of carbonates and gypsum.

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter, or whole soil less than 20 mm, whichever has higher percentage of carbonates plus gypsum.

Glauconitic
Definition: More than 40% glauconite by weight.

Determinant size fraction: Whole soil, particles less than 2.0 mm in diameter.

CLASSES APPLIED TO SOILS THAT HAVE A FRAGMENTAL, SANDY, SANDY-SKELETAL, LOAMY, OR LOAMY-SKELETAL PARTICLE SIZE CLASS

Micaceous
Definition: More than 40% mica by weight[9]

Determinant size fraction: 0.02 to 20 mm.

Siliceous
Definition: More than 90% by weight[10] of silica minerals (quartz, chalcedony, or opal) and other extremely durable minerals that are resistant to weathering.

Determinant size fraction: 0.02 to 2.0 mm.

Mixed
Definition: All others that have less than 40% of any one mineral other than quartz or feldspars.

Determinant size fraction: 0.02 to 2.0 mm.

CLASSES APPLIED TO SOILS THAT HAVE A CLAYEY OR CLAYEY-SKELETAL PARTICLE-SIZE CLASS

Halloysitic
Definition: More than half halloysite[11] by weight and smaller amounts of allophane or kaolinite or both.

Determinant size fraction: Less than 0.002 mm.

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

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

[11] Halloysite as used here includes only the tubular forms. What has been called tabular halloysite is grouped here with kaolinite.

Kaolinitic
Definition: More than half kaolinite, tabular halloysite' dickite, and nacrite by weight, smaller amounts of other 1:1 or non-expanding 2:1 layer minerals or gibbsite, and less than 10% montmorillonite.

Determinant size fraction: Less than 0.002 mm.

Montmorillonitic
Definition: More than half montmorillonite and nontronite by weight or a mixture that has more montmorillonite than any other one clay mineral.

Determinant size fraction: Less than 0.002 mm.

Illitic
Definition: More than half illite (hydrous mica) by weight and commonly more than 4% K_2O.

Determinant size fraction: Less than 0.002 mm.

Vermiculitic
Definition: More than half vermiculite by weight or more vermiculite than any other one clay mineral.

Determinant size fraction: Less than 0.002 mm.

Chloritic
Definition: More than half chlorite by weight or more chlorite than any other clay mineral.

Determinant size fraction: Less than 0.002 mm.

Mixed
Definition: Other soils[12].

Determinant size fraction: Less than 0.002 mm.

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[12] Sepiolitic, defined as containing more than half by weight of sepiolite, attapulgite, and palygorskite, should be named if found.

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 citrate-dithionite in the less than 2.0 mm fractions?

2. More than 40 percent gibbsite in the less than 2.0 mm fractions?

3. 18-40 percent iron oxide (12.6- 28 percent Fe) by citrate-dithionite in the less than 2.0 mm fractions?

4. 18-40 percent gibbsite in the less than 2.0 mm fractions?

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?

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 4

Identification of the Taxonomic Class of a Soil

KEY TO SOIL ORDERS

In this key and the other keys that follow, the diagnostic horizons and the properties mentioned do not include the properties of buried soils except their organic carbon if of Holocene age, andic soil properties, and base saturation. Properties of buried soils are considered in the categories of subgroups, families, 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 that *either*

1. Have organic soil materials that extend from the surface to one of the following:

a. A depth within 10 cm or less of a lithic or paralithic contact, provided the thickness of the organic soil materials is more than twice that of the mineral soil above the contact; *or*

b. Any depth if the organic soil material rests on fragmental material (gravel, stones, cobbles) and the interstices are filled with organic materials, or rests on a lithic or paralithic contact; *or*

2. Have organic materials that have an upper boundary within 40 cm of the surface, *and*

a. Have one of the following thicknesses:

(1) 60 cm or more if three-fourths or more of the volume is moss fibers or the moist bulk density is less than 0.1 g per cubic centimeter (6.25 lbs per cubic foot); *or*

(2) 40 cm or more if

(a) The organic soil material is saturated with water for long periods (more than 6 months) or is artificially drained; *and* `

(b) The organic material consists of sapric or hemic materials or consists of fibric materials that are less than three-fourths moss fibers by volume and have a moist bulk density of 0.1 or more; *and*

b. Have organic soil materials that

(1) Do not have a mineral layer as much as 40 cm thick either at the surface or whose upper boundary is within a depth of 40 cm from the surface; *and*

(2) Do not have mineral layers, taken cumulatively, as thick as 40 cm within the upper 80 cm; *and*

c. Do not have andic soil properties in layers 35 cm or more thick within a depth of 60 cm from the surface.

Histosols, p. 225

B. Other soils that have andic soil properties throughout subhorizons, whether buried or not, which have a cumulative thickness of 35 cm or more within 60 cm of the mineral soil surface or upper boundary of an organic layer that meets andic soil properties, whichever is shallower.

Andisols, p. 129

C. Other soils that do not have a plaggen epipedon but that have *either*:

1. A spodic horizon whose upper boundary is within 200 cm of the surface; *or*

2. A placic horizon that meets all the requirements of a spodic horizon except thickness and index of accumulation and rests on a fragipan, on a spodic horizon, or on an albic horizon that rests on a fragipan.

Spodosols, p. 357

D. Other soils that have *either*:

1. An oxic horizon with its upper boundary within 150 cm of the soil surface, and do not have a clay content increase necessary to define the upper boundary of a kandic horizon within a depth of 150 cm of the soil surface, *or*

2. 40 percent or more clay in the surface 18 cm, after mixing, and, with its upper boundary within 150 cm of the soil surface, either an oxic horizon, or a kandic horizon that meets the weatherable mineral requirements of an oxic horizon.

Oxisols, p. 335

E. Other soils that

1. Do not have a lithic or paralithic contact, petrocalcic horizon, or duripan within 50 cm of the surface; *and*

2. After the soil to a depth of 18 cm has been mixed, as by plowing, have 30 percent or more clay in all subhorizons to a depth of 50 cm or more; *and*

3. Have, at some time in most years unless irrigated or cultivated, open cracks[1] at a depth of 50 cm that are at least 1 cm wide and extend upward to the surface or to the base of the plow layer or surface crust; *and*

4. Have one or more of the following:

   a. Gilgai; *or*

   b. At some depth between 25 and 100 cm, slickensides close enough to intersect; or

   c. At some depth between 25 and 100 cm, wedge-shaped natural structural aggregates that have their long axes tilted 10 to 60° from the horizontal.

Vertisols, p. 407

F. Other soils that have an ochric or anthropic epipedon and *either*:

1. Do *not* have an argillic or a natric horizon *but*

   a. Are saturated with water within 100 cm of the surface for 1 month or more in some years and have a salic horizon whose upper boundary is within 75 cm of the surface; *or*

   b. Have one or more of the following horizons whose upper boundary is within 100 cm of the soil surface: a petrocalcic, calcic, gypsic, petrogypsic, or cambic horizon or a duripan; and have an aridic moisture regime; *or*

2. Have an argillic or a natric horizon and have

   a. An aridic moisture regime; *and*

   b. An epipedon that is not both massive and hard or very hard when dry.

Aridisols, p. 159

G. Other soils that have a mesic, isomesic, or warmer temperature regime, do not have tongues of albic materials in the argillic horizon that have vertical dimensions of as much as 50 cm if there are more than 10 percent weatherable minerals in the 20- to 200-micron fraction, but have one of the following combinations of characteristics: *either*

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[1] An open crack is interpreted to be a separation between gross polyhedrons. If the surface horizons are strongly self-mulching, that is, if the soil is a mass of loose granules, or if the soil is cultivated while the cracks are open, the cracks may be largely filled with granular materials from the surface. But they are considered to be open in the sense that the polyhedrons are separated.

1. Have an argillic or kandic horizon but not a fragipan and have base saturation (by sum of cations) of less than 35 percent at the following depths: *either*

a. If the argillic or kandic horizon has in some part a hue of 5YR or yellower, or a color value, moist, of 4 or more, or a color value, dry, that is more than 1 unit higher than the value, moist, the shallowest of the following:

(1) 125 cm below the upper boundary of the argillic or kandic horizon; *or*

(2) 180 cm below the surface of the soil; *or*

(3) Immediately above a lithic or paralithic contact; *or*

b. If the argillic or kandic horizon has some other color or if the epipedon has a sandy or sandy-skeletal particle-size class throughout, the deepest of 125 cm below the upper boundary of the argillic horizon, 180 cm below the surface of the soil, or immediately above a lithic or a paralithic contact if it is shallower; *or*

2. Have a fragipan that

a. Meets all the requirements of an argillic or kandic horizon or has clay skins more than 1 mm thick in some part, or underlies an argillic or kandic horizon; *and*

b. Has base saturation (by sum of cations) of less than 35 percent at a depth of 75 cm below the upper boundary of the fragipan or immediately above a lithic or paralithic contact, whichever is shallower.
Ultisols, p. 373

H. Other soils that

1. Have *either*:

a. A mollic epipedon; *or*

b. A surface horizon that, after the soil to a depth of 18 cm is mixed, meets all requirements of a mollic epipedon except thickness, and, in addition, an upper subhorizon more than 7.5 cm thick that is in an argillic, kandic or a natric horizon, that meets the requirements of a mollic epipedon with respect to color, content of organic carbon, base saturation, and structure but is separated from the surface horizon by an albic horizon; *and, in addition,*

2. Have base saturation of 50 percent or more (by NH_4OAc) as follows: *either*

a. If there is an argillic, kandic or natric horizon, from its upper boundary to a depth of 125 cm below that boundary, or to a depth 180 cm below the soil surface or to a lithic or paralithic contact, whichever is least; *or*

b. If there is no argillic, kandic, or natric horizon, in all subhorizons to a depth 180 cm below the soil surface or to a lithic or paralithic contact, whichever is least.

Mollisols, p. 275

I. Other soils that *either*

1. Have an argillic, kandic or natric horizon but no fragipan; *or*

2. Have a fragipan that

a. Is in or underlies an argillic or kandic horizon; *or*

b. Meets all requirements of an argillic or kandic horizon; *or*

c. Has clay skins more than 1 mm thick in some part.

Alfisols, p. 73

J. Other soils that have no sulfidic material within 50 cm of the mineral soil surface; and have between 20 and 50 cm below the mineral soil surface an *n* value of 0.7 or less in one or more subhorizons or less than 8 percent clay in one or more subhorizons; and have *one or more* of the following:

1. An umbric, mollic, histic (either mineral or organic) or plaggen epipedon; *or*

2. A cambic horizon or both an aquic moisture regime and permafrost; *or*

3. Within 100 cm of the surface, a calcic, petrocalcic, gypsic, petrogypsic, or placic horizon or a duripan; *or*

4. A fragipan or an oxic horizon with its upper boundary between a depth of 150 and 200 cm; *or*

5. A sulfuric horizon whose upper boundary is within 50 cm of the soil surface; *or*

6. In half or more of the upper 50 cm, an SAR of 13[2] or more (or sodium saturation that is 15 percent or more) that decreases with depth below 50 cm and, within a depth of 100 cm, have ground water at some period during the year when the soil is not frozen in any part.
Inceptisols, p. 241

K. Other soils.
Entisols, p. 195

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[2] The percentage of exchangeable sodium (ESP) is used in the definition of the natric horizon and in a number of the taxa. Since this text was written, the U.S. Salinity Laboratory (personal communication from C. A. Bower) has revised its definition of sodic (alkali) soils and the method for measuring the sodium adsorption ratio (SAR) as follows: SAR is measured by the normal method if the conductivity (EC) of the saturation extract is less than 20 dS per m at 25°C. If the conductivity is 20 mmhos or more and SAR is more than 10, SAR is determined on a sample that has been leached with distilled water until EC of the leachate decreases to about 4 mmhos per centimeter but not to less than 4. ESP of 15 or more is replaced by SAR of 13 or more if EC is large enough to require a correction for soluble salts in calculating ESP. If EC is low enough (4 or less) that no correction is needed for soluble salts, ESP is determined directly from the replaced cations.

Chapter 5

Alfisols

KEY TO SUBORDERS

IA. Alfisols that have an aquic moisture regime or are artificially drained and that have characteristics associated with wetness, namely, mottles, or iron-manganese concretions more than 2 mm in diameter, or chroma of 2 or less immediately below any Ap horizon or below any dark A horizon in which the moist color value is 3 or less after the material is rubbed, and one of the following:

1. Dominant chroma of 2 or less[1] in coatings on the surface of peds and mottles within peds of the argillic or kandic horizon, or a dominant chroma of 2 or less in the matrix of the argillic or kandic horizon and mottles of higher chroma; *or*

2. If there are no mottles in the argillic or kandic horizon, a dominant chroma of 1 or less.

Aqualfs, p. 74

IB. Other Alfisols that have

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

2. A cryic temperature regime.

Boralfs, p. 84

IC. Other Alfisols that have one of the following:

1. An ustic moisture regime; *or*

2. An epipedon that is both massive and hard or very hard when dry, and a moisture regime that is aridic but marginal to ustic.

Ustalfs, p. 106

ID. Other Alfisols that have one of the following:

1. A xeric moisture regime; *or*

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1 If the hue is redder than 10YR because of red parent materials that remain red after citrate-dithionite extraction, the requirement for low chroma is waived. Where the soil temperature regime is hyperthermic, isothermic, or isohyperthermic, chroma up to 4 is tentatively permitted if the hue is 2.5Y or 5Y and if mottles are distinct or prominent. Such soils are too few in the United States to permit testing these limits.

2. An epipedon that is both massive and hard or very hard when dry, and a moisture regime that is aridic but marginal to xeric.

Xeralfs, p.119

IE. Other Alfisols that have a udic moisture regime.

Udalfs, p. 91

AQUALFS

Key to great groups

IAA. Aqualfs that have plinthite that forms a continuous phase or constitutes half or more of the matrix within some subhorizon between 30 and 150 cm below the surface of the soil.

Plinthaqualfs, p. 83

IAB. Other Aqualfs that have a natric horizon and do not have a duripan.

Natraqualfs, p. 80

IAC. Other Aqualfs that have a duripan.

Duraqualfs, p. 77

IAD. Other Aqualfs that have a fragipan.

Fragiaqualfs, p. 77

IAE. Other Aqualfs that have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kandiaqualfs, p.78

IAF. Other Aqualfs that have an albic horizon tonguing into an argillic horizon.

Glossaqualfs, p. 77

IAG. Other Aqualfs that have an abrupt textural change between an ochric epipedon or an albic horizon and an argillic horizon and have slow or very slow hydraulic conductivity in the argillic horizon.[2]

Albaqualfs, p. 75

IAH. Other Aqualfs that have an umbric epipedon.

Umbraqualfs, p. 83

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[2] Hydraulic conductivity is defined as the rate of internal water movement under a unit potential gradient. In this text the term refers to vertical saturated hydraulic conductivity. Slow and very slow rates refer to 4 to 10 and less than 4 cm water per day, respectively.

IAI. Other Aqualfs.

Ochraqualfs, p. 80

Albaqualfs

Key to subgroups

IAGA. Albaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Albaqualfs

IAGB. Other Albaqualfs that:

1. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap or an albic horizon; *and*

   b. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the soil to a depth of 100 cm or in the whole soil if the depth to a lithic or paralithic contact is more than 50 cm but less than 100 cm; *and*

   c. More than 35 percent clay in horizons that have a total thickness of more than 50 cm; *and*

2. Have a surface horizon that, after the soil to a depth of 18 cm has been mixed, has 30 percent or more clay and is discontinuous throughout each pedon.

Ruptic-Vertic Albaqualfs

IAGC. Other Albaqualfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap or an albic horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the soil to a depth of 100 cm or in the whole soil if the depth to a lithic or paralithic contact is more than 50 cm but less than 100 cm; *and*

3. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.

Vertic Albaqualfs

IAGD. Other Albaqualfs that:

1. Have chroma of 3 or more in more than 40 percent of the mass between the bottom of the A or the Ap horizon and a depth of 75 cm; *and*

2. Have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed and smoothed, or have, after the soil to a depth of 18 cm has been mixed, an upper layer that has these colors.

Udollic Albaqualfs

IAGE. Other Albaqualfs that have chroma of 3 or more in more than 40 percent of the mass between the bottom of the A or the Ap horizon and a depth of 75 cm.

Aeric Albaqualfs

IAGF. Other Albaqualfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less, and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil, and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Albaqualfs

IAGG. Other Albaqualfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed and smoothed, or have, after the soil to a depth of 18 cm has been mixed, an upper layer that has these colors.

Mollic Albaqualfs

IAGH. Other Albaqualfs that have a horizon within a depth of 100 cm from the surface that is brittle, is 15 cm or more thick, and contains some opal coatings or 20 percent or more durinodes.

Durorthidic Albaqualfs

IAGI. Other Albaqualfs.

Typic Albaqualfs

Duraqualfs

Duraqualfs are the Aqualfs that have a duripan below the argillic horizon. They are not known to occur in the United States. The group has been proposed for other countries, but definitions of subgroups have not been suggested.

Fragiaqualfs

Key to subgroups

IADA. Fragiaqualfs that have a mottled horizon between the A or Ap horizon and a fragipan that has dominant chroma more than 2 if the hue is 10YR or redder or more than 3 if the hue is 2.5Y or yellower.

Aeric Fragiaqualfs

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

Plinthic Fragiaqualfs

IADC. Other Fragiaqualfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed and smoothed; or the upper soil to a depth of 18 cm, after mixing, has these color values.

Umbric Fragiaqualfs

IADD. Other Fragiaqualfs.

Typic Fragiaqualfs

Glossaqualfs

Key to subgroups

IAFA. Glossaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Glossaqualfs

IAFB. Other Glossaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Glossaqualfs

IAFC. Other Glossaqualfs that have in more than 40 percent of the matrix[3] in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one* of the following:

1. If mottled, the value, moist, is 4 or more and the chroma, moist, is 3 or more; *or*

2. If not mottled, the chroma, moist, is 2 or more.

Aeric Glossaqualfs

IAFD. Other Glossaqualfs that have an Ap horizon that has a color value, moist, of 3 or less, and a color value, dry, of 5 or less after the soil has been crushed and smoothed; or the soil to a depth of 18 cm, after mixing, has these colors.

Mollic Glossaqualfs

IAFE. Other Glossaqualfs.

Typic Glossaqualfs

Kandiaqualfs

Key to subgroups

IAEA. Kandiaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiaqualfs

IAEB. Other Kandiaqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface.

Grossarenic Kandiaqualfs

IAEC. Other Kandiaqualfs that have a horizon within 150 cm of the soil surface that has 5 percent or more plinthite by volume.

Plinthic Kandiaqualfs

IAED. Other Kandiaqualfs that:

1. Have in more than 40 percent of the matrix in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one or more* of the following:

   a. If mottled and the mean annual soil temperature is lower than 15°C, chroma, moist, of 3 or more; *or*

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[3] If the hue is 7.5YR or redder and if peds are present, ped exteriors in the argillic horizon should have dominant chroma, moist, of 1 or less and ped interiors should have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, should be 1 or less immediately below any surface horizon that has color value, moist, of 3 or less.

b. If mottled and the mean annual soil temperature is 15°C or more:

(1) If the hue is 2.5Y or redder and the value, moist, is more than 5, the chroma, moist, is 3 or more; *or*

(2) If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

(3) If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

c. If not mottled, the chroma, moist, is 2 or more; *and*

2. Have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed; or the upper soil to a depth of 18 cm, after mixing, has these color values.

Aeric Umbric Kandiaqualfs

IAEE. Other Kandiaqualfs that have in more than 40 percent of the matrix in one or more subhorizons between the A or Ap horizon and a depth of 75 cm one or more of the following:

1. If mottled and the mean annual soil temperature is lower than 15°C, chroma, moist, of 3 or more; *or*

2. If mottled and the mean annual soil temperature is 15°C or more:

a. If the hue is 2.5Y or redder and the value, moist, is more than 5, the chroma, moist, is 3 or more; *or*

b. If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

c. If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

3. If not mottled, the chroma, moist, is 2 or more.

Aeric Kandiaqualfs

IAEF. Other Kandiaqualfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed; or the upper soil to a depth of 18 cm, after mixing, has these color values.

Umbric Kandiaqualfs

IAEG. Other Kandiaqualfs.

Typic Kandiaqualfs

Natraqualfs

Key to subgroups

IABA. Natraqualfs that

1. Have tonguing *or* interfingering of albic materials more than 2.5 cm into the natric horizon; *and*

2. Have, in all horizons within 40 cm of the soil surface, less than 15 percent saturation with sodium and less magnesium and sodium than calcium and extractable acidity.

Albic Glossic Natraqualfs

IABB. Other Natraqualfs that have less than 15 percent saturation with sodium, and have less magnesium and sodium than calcium and extractable acidity, throughout the upper 15 cm of the natric horizon or in all horizons within 40 cm of the soil surface, whichever is deeper.

Albic Natraqualfs

IABC. Other Natraqualfs that have tonguing or interfingering of albic materials more than 2.5 cm into the natric horizon.

Glossic Natraqualfs

IABD. Other Natraqualfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed and smoothed; or the soil to a depth of 18 cm, after mixing, has these colors.

Mollic Natraqualfs

IABE. Other Natraqualfs.

Typic Natraqualfs

Ochraqualfs

Key to subgroups

IAIA. Ochraqualfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Ochraqualfs

IAIB. Other Ochraqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Ochraqualfs

IAIC. Other Ochraqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Ochraqualfs

IAID. Other Ochraqualfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap or an albic horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper soil to a depth of 100 cm or in the whole soil if a lithic, paralithic, or petroferric contact is deeper than 50 cm but not deeper than 100 cm; *and*

3. More than 35 percent clay in horizons that have total thickness of more than 50 cm.

Vertic Ochraqualfs

IAIE. Other Ochraqualfs that:

1. Have in more than 40 percent of the matrix[4] in one or more subhorizons between the A or Ap horizon and a depth of 75 cm one or more of the following:

a. If mottled and the mean annual soil temperature is lower than 15° C, chroma, moist, of 3 or more; *or*

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[4] If the hue is 7.5YR or redder and if peds are present, ped exteriors in the argillic horizon should have dominant chroma, moist, of 1 or less and ped interiors should have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, should be 1 or less immediately below any surface horizon that has color value, moist, of 3 or less.

b. If mottled and the mean annual soil temperature is 15°C or more:

(1) If the hue is 2.5Y or redder and the value, moist, is more than 5, the chroma is 3 or more; *or*

(2) If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

(3) If the hue is yellower than 2.5Y, the chroma, *moist is 3 or more; or*

c. If *not* mottled, the chroma, moist, is 2 or more; *and*

2. Have an Ap horizon that meets all the requirements of an umbric epipedon except thickness; or the upper *soil to a depth of* 18 cm, *after mixing*, meets these requirements.

Aeric Umbric Ochraqualfs

IAIF. Other Ochraqualfs that:

1. Have in more than 40 percent of the matrix[5] in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one or more* of the following:

a. If mottled and the mean annual soil temperature is lower than 15°C, chroma, moist, of 3 or more; *or*

b. If mottled and the mean annual soil temperature is 15°C or more:

(1) If the hue is 2.5Y or redder and the value, moist, is more than 5, the chroma is 3 or more; *or*

(2) If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

(3) If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

c. If not mottled, the chroma, moist, is 2 or more; *and*

2. Have an Ap horizon that meets all the requirements of a mollic epipedon except thickness; or the upper soil *to a depth of 18 cm*, after mixing, meets these requirements.

Udollic Ochraqualfs

[5] If the hue is 7.5YR or redder and if peds are present, ped exteriors in the argillic horizon should have dominant chroma, moist, of 1 or less and ped interiors should have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, should be 1 or less immediately below any surface horizon that has color value, moist, of 3 or less.

IAIG. Other Ochraqualfs that have in more than 40 percent of the matrix[6] in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one or more* of the following:

1. If mottled and the mean annual soil temperature is lower than 15°C, chroma, moist, of 3 or more; *or*

2. If mottled and the mean annual soil temperature is 15°C or more:

   a. If the hue is 2.5Y or redder and the value, moist, is more than 5, the chroma is 3 or more; *or*

   b. If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

   c. If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

3. If not mottled, the chroma, moist, is 2 or more.

Aeric Ochraqualfs

IAIH. Other Ochraqualfs that have an Ap horizon that meets all the requirements of a mollic epipedon except thickness; or the upper soil to a depth of 18 cm, after mixing, meets these requirements.

Mollic Ochraqualfs

IAII. Other Ochraqualfs that have an Ap horizon that meets all the requirements of an umbric epipedon except thickness; or the upper soil to a depth of 18 cm, after mixing, meets these requirements.

Umbric Ochraqualfs

IAIJ. Other Ochraqualfs.

Typic Ochraqualfs

Plinthaqualfs

Plinthaqualfs are the Aqualfs that have plinthite that forms a continuous phase or that constitutes half or more of the matrix of some subhorizon of the argillic horizon within 150 cm of the soil surface.

Umbraqualfs

Key to subgroups

IAHA. Umbraqualfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, one or more of the following:

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[6] If the hue is 7.5YR or redder and if peds are present, ped exteriors in the argillic horizon should have dominant chroma, moist, of 1 or less and ped interiors should have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, should be 1 or less immediately below any surface horizon that has color value, moist, of 3 or less.

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Umbraqualfs

IAHB. Other Umbraqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Umbraqualfs

IAHC. Other Umbraqualfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Umbraqualfs

IAHD. Other Umbraqualfs that have, *in* the umbric epipedon and in horizons above the argillic horizon, soft discrete nodules 2.5 to 30 cm in diameter that constitute more than 5 percent of the volume, that are cemented by iron, and that lie above and in an irregular or broken upper boundary of the argillic horizon.

Ferrudalfic Umbraqualfs

IAHE. Other Umbraqualfs.

Typic Umbraqualfs

BORALFS

Key to great groups

IBA. Boralfs that have an argillic horizon with its upper boundary deeper than 60 cm below the mineral surface,[7] that have texture finer than loamy fine sand in some subhorizon above the argillic horizon, and that have

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[7] If there is a surface mantle that has more than 60 percent vitric volcanic ash, cinders, or other vitric pyroclastic materials, the depth to the argillic horizon is measured from the base of this mantle rather than from the surface of the mineral soil.

albic materials tonguing or interfingering in the argillic horizon.

Paleboralfs, p. 90

IBB. Other Boralfs that have a fragipan.

Fragiboralfs, p. 88

IBC. Other Boralfs that have a natric horizon.

Natriboralfs, p. 90

IBD. Other Boralfs that have a cryic temperature regime.

Cryoboralfs, p. 85

IBE. Other Boralfs that have base saturation (by sum of cations) of 60 percent or more in all subhorizons of the argillic horizon and are dry in some horizon at some time in most years.

Eutroboralfs, p. 86

IBF. Other Boralfs that either are never dry in any horizon in most years or have base saturation (by sum of cations) of less than 60 percent in some subhorizon of the argillic horizon.

Glossoboralfs, p. 89

Cryoboralfs

Key to subgroups

IBDA. Cryoboralfs that:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Have an Ap horizon that has a color value, moist, of 3 or less, or the upper soil, to a depth of 15 cm after mixing, has a moist color value of 3 or less.

Lithic Mollic Cryoboralfs

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

Lithic Cryoboralfs

IBDC. Other Cryoboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryoboralfs

IBDD. Other Cryoboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and

pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either:*

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Cryoboralfs

IBDE. Other Cryoboralfs that have mottles that have chroma of 2 or less within 75 cm of the surface, or the soils are continuously saturated with water for 3 months or longer within 100 cm of the surface where undrained.

Aquic Cryoboralfs

IBDF. Other Cryoboralfs that have an argillic horizon that has a texture that is loamy fine sand or coarser or is discontinuous vertically in the upper 15 cm (in lamellae).

Psammentic Cryoboralfs

IBDG. Other Cryoboralfs that have an Ap horizon that has a color value, moist, of 3 or less, or the upper soil has a moist color value of 3 or less after mixing to a depth of 15 cm.

Mollic Cryoboralfs

IBDH. Other Cryoboralfs that have albic materials tonguing in an argillic horizon.

Glossic Cryoboralfs

IBDI. Other Cryoboralfs.

Typic Cryoboralfs

Eutroboralfs

Key to subgroups

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

Lithic Eutroboralfs

IBEB. Other Eutroboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable iron of more than 1.0 percent.

Andic Eutroboralfs

IBEC. Other Eutroboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, one or more of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil, and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either:*

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Eutroboralfs

IBED. Other Eutroboralfs that:

1. Have an argillic horizon that has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface ; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of the argillic horizon that is more than 50 cm below the soil surface.

Aquic Arenic Eutroboralfs

IBEE. Other Eutroboralfs that:

1. Have an argillic horizon that *either*

a. Has its upper boundary at less than 50 cm below the soil surface and has mottles that have chroma of 2 or less in the upper 25 cm if the mottled layer is saturated with water at some time when the soil temperature is 5°C or higher; *or*

b. Has an upper boundary at 50 cm or more, and the soil has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have tongues of albic materials in the argillic horizon (interfingering is permitted).

Glossaquic Eutroboralfs

IBEF. Other Eutroboralfs that have an argillic horizon that *either:*

1. Has its upper boundary at less than 50 cm below the soil surface, and has mottles that have chroma of 2 or less in the upper 25 cm if the mottled layer is saturated with water at some time when the soil temperature is 5°C or higher; *or*

2. Has an upper boundary at 50 cm or more, and the soil

has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface.

Aquic Eutroboralfs

IBEG. Other Eutroboralfs that have an argillic horizon that has a texture that is loamy fine sand or coarser or is discontinuous vertically in the upper 15 cm (in lamellae).

Psammentic Eutroboralfs

IBEH. Other Eutroboralfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Eutroboralfs

IBEI. Other Eutroboralfs that have 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 soil, after mixing to a depth of 18 cm, has these colors.

Mollic Eutroboralfs

IBEJ. Other Eutroboralfs that have tongues of albic materials in the argillic horizon (interfingering is permitted).

Glossic Eutroboralfs

IBEK. Other Eutroboralfs.

Typic Eutroboralfs

Fragiboralfs

Key to subgroups

IBBA. Fragiboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Fragiboralfs

IBBB. Other Fragiboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Fragiboralfs

IBBC. Other Fragiboralfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon, and are saturated with water at some time within that depth when the soil temperature at a depth of 50 cm is 5°C or more.

Aquic Fragiboralfs

IBBD. Other Fragiboralfs.

Typic Fragiboralfs

Glossoboralfs

Key to subgroups

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

Lithic Glossoboralfs

IBFB. Other Glossoboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Glossoboralfs

IBFC. Other Glossoboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Glossoboralfs

IBFD. Other Glossoboralfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon if the mottled horizons are saturated with water at a time when the soil temperature is 5°C or higher.

Aquic Glossoboralfs

IBFE. Other Glossoboralfs that have an argillic horizon that has a texture that is loamy fine sand or coarser or is discontinuous vertically in the upper 15 cm (in lamellae).

Psammentic Glossoboralfs

IBFF. Other Glossoboralfs that do not have tongues of albic materials in the argillic horizon.

Eutric Glossoboralfs

IBFG. Other Glossoboralfs.

Typic Glossoboralfs

Natriboralfs

Natriboralfs are the Boralfs that have a natric horizon. They are rare in the United States, and subgroups have not been developed.

Paleboralfs

Key to subgroups

IBAA. Paleboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Paleboralfs

IBAB. Other Paleboralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Paleboralfs

IBAC. Other Paleboralfs that have mottles that have chroma of 2 or less within 100 cm of the surface.

Aquic Paleboralfs

IBAD. Other Paleboralfs that have an argillic horizon that has an increase in clay content of 20 percent or more (absolute) within a vertical distance of 7.5 cm from its upper boundary.

Abruptic Paleboralfs

IBAE. Other Paleboralfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the soil to a depth of 18 cm has these colors after mixing.

Mollic Paleboralfs

IBAF. Other Paleboralfs.

Typic Paleboralfs

UDALFS

Key to great groups

IEA. Udalfs that have an agric horizon.

Agrudalfs, p. 93

IEB. Other Udalfs that have a natric horizon.

Natrudalfs, p. 102

IEC. Other Udalfs that

1. Do not have a continuous albic horizon above the argillic horizon; *and*

2. Have a broken upper boundary of the argillic horizon; *and*

3. Have discrete nodules in the argillic horizon that range from 2.5 to 30 cm in diameter; exteriors of nodules are enriched and weakly cemented or indurated with iron and have redder hue or stronger chroma than interiors of nodules.

Ferrudalfs, p. 93

IED. Other Udalfs that have tongues of albic materials in the argillic horizon and do not have a fragipan.

Glossudalfs, p. 95

IEE. Other Udalfs that have tongues of albic materials in the argillic horizon and have a fragipan.

Fraglossudalfs, p. 95

IEF. Other Udalfs that have a fragipan.

Fragiudalfs, p. 93

IEG. Other Udalfs that

1. Have a CEC of 16 cmol(+) or less per kg clay (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4 OAc pH 7 plus 1N KCl-extractable Al) in the major part of the argillic or kandic horizon, or the major part of the upper 100 cm

of the argillic or kandic horizon if these horizons are thicker than 100 cm; *and*

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

3. Have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Kandiudalfs, p. 101

IEH. Other Udalfs that have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhapludalfs, p. 102

IEI. Other Udalfs that

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

2. Have clay distribution such that the percentage of clay does not decrease by as much as 20 percent of the maximum within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer; *and*

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

a. Hue redder than 10YR and chroma more than 4 dominant in the matrix in at least the lower part; *or*

b. Hue of 2.5YR or redder and value, moist, of less than 4 and value, dry, of less than 5 throughout the major part; *or*

c. Many coarse mottles that have hue redder than 7.5YR or chroma more than 5, or both, in some subhorizon.

Paleudalfs, p. 103

IEJ. Other Udalfs that have an argillic horizon that has throughout its thickness a hue redder than 5YR, a color value, moist of less than 3.5, and a color value, dry, no more than 1 unit higher than the value, moist.

Rhodudalfs, p. 106

IEK. Other Udalfs.

Hapludalfs, p. 96

Agrudalfs

Agrudalfs are the Udalfs that have an agric horizon. Some but not all have an anthropic epipedon. They have been in farms for many hundreds of years and have received heavy applications of animal manure and other amendments. They are not known to occur in the United States. It seems probable that only the typic and anthropic subgroups are needed. The Agrudalfs of western Europe have been farmed for more than 1,000 years,[8] and the early farmers selected only the best soils for cultivation. All of them are well drained, and they seem quite similar in most properties. The Typic Agrudalfs do not have an anthropic epipedon.

Ferrudalfs

Key to subgroups

IECA. Ferrudalfs that have mottles that have chroma of 2 or less within the upper 60 cm, and the horizons that have mottles of low chroma are saturated with water at some time of year or the soil has artificial drainage. The mottles should be distinguished from skeletans that may also have low chroma.

Aquic Ferrudalfs

IECB. Other Ferrudalfs.

Typic Ferrudalfs

Fragiudalfs

Key to subgroups

IEFA. Fragiudalfs that:

1. Do not have an argillic horizon above the fragipan that has clay skins on at least some vertical and horizontal faces of primary or secondary peds, or both; *and*

2. Have, immediately above the fragipan, thick skeletans of clean sand and silt on primary ped faces or have an eluvial horizon (E) that has thick skeletans and as much as 3 percent (absolute) less clay than both the overlying and underlying horizons; *and*

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[8] Personal communication from R. Tavernier.

3. Have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the soil, after mixing to a depth of 18 cm, has those colors.

Umbreptic Fragiudalfs

IEFB. Other Fragiudalfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the soil, after mixing to a depth of 18 cm, has those colors.

Mollic Fragiudalfs

IEFC. Other Fragiudalfs that:

1. Have, immediately above the fragipan, thick skeletans of clean sand and silt on primary ped faces, or have an eluvial horizon (E') that has thick skeletans and as much as 3 percent (absolute) less clay than both the overlying and underlying horizons; *and*

2. Have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of year when the soil temperature is 5°C or higher in those horizons.

Glossaquic Fragiudalfs

IEFD. Other Fragiudalfs that:

1. Do not have an argillic horizon above the fragipan that has clay skins on at least some vertical and horizontal faces of primary or secondary peds, or both; *and*

2. Have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of year when the soil temperature is 5°C or higher in those horizons.

Aqueptic Fragiudalfs

IEFE. Other Fragiudalfs that:

1. Have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of year when the soil temperature is 5°C or higher in those horizons; *and*

2. Have, 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 mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of year when the soil temperature is 5°C or higher in those horizons.

Aquic Fragiudalfs

IEFG. Other Fragiudalfs that have, immediately above the fragipan, thick skeletans of clean sand and silt on primary ped faces, or have an eluvial horizon (E') that has thick skeletans and as much as 3 percent (absolute) less clay than both the overlying and underlying horizons.

Glossic Fragiudalfs

IEFH. Other Fragiudalfs that do not have an argillic horizon above the fragipan that has clay skins on at least some vertical and horizontal faces of primary or secondary peds.

Ochreptic Fragiudalfs

IEFI. Other Fragiudalfs.

Typic Fragiudalfs

Fraglossudalfs

Key to subgroups

IEEA. Fraglossudalfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon, and the mottled horizons are saturated with water at some season when the soil temperature is 5°C or higher.

Aquic Fraglossudalfs

IEEB. Other Fraglossudalfs.

Typic Fraglossudalfs

Glossudalfs

Key to subgroups

IEDA. Glossudalfs that have a brittle matrix in one-fourth or more of some subhorizon that is at least 10 cm thick and that has an upper boundary within 125 cm of the surface.

Fragic Glossudalfs

IEDB. Other Glossudalfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon, and the mottled horizons are saturated with water at some season when their temperature is 5°C or higher.

Aquic Glossudalfs

IEDC. Other Glossudalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Glossudalfs

IEDD. Other Glossudalfs that do not have tongues of albic materials that extend through at least the upper 50 cm of the argillic horizon.

Haplic Glossudalfs

IEDE. Other Glossudalfs.

Typic Glossudalfs

Hapludalfs

Key to subgroups

IEKA. Hapludalfs that:

1. Have mottles with chroma of 2 or less in the upper 25 cm of the argillic horizon, or throughout the argillic horizon if the argillic horizon is thinner than 25 cm, and are saturated with water within that depth at some time when the soil temperature is $5^{\circ}C$ or higher; *and*

2. Have a lithic contact within 50 cm of the soil surface.

Aquic Lithic Hapludalfs

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

Lithic Hapludalfs

IEKC. Other Hapludalfs that have the following combinations of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and at least 30 cm long in some part and that extend to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness within the control section.

Vertic Hapludalfs

IEKD. Other Hapludalfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Hapludalfs

IEKE. Other Hapludalfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Hapludalfs

IEKF. Other Hapludalfs that:

1. Have an argillic horizon that

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammaquentic Hapludalfs

IEKG. Other Hapludalfs that have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammentic Hapludalfs

IEKH. Other Hapludalfs that:

1. Have an argillic horizon that

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Aquic Arenic Hapludalfs

IEKI. Other Hapludalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Hapludalfs

IEKJ. Other Hapludalfs that:

1. Have an abrupt textural change and mottles in the upper 25 cm of the argillic horizon; *and*

2. Have an argillic horizon that:

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

3. Have base saturation (by sum of cations) of less than 60 percent at a depth 125 cm below the top of the argillic horizon, or 180 cm below the soil surface, or immediately above a lithic or paralithic contact, whichever is least.

Albaquultic Hapludalfs

IEKK. Other Hapludalfs that:

1. Have an abrupt textural change and mottles in the upper 25 cm of the argillic horizon; *and*

2. Have an argillic horizon that:

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface.
Albaquic Hapludalfs

IEKL. Other Hapludalfs that:

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

2. Have an argillic horizon that

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface.
Glossaquic Hapludalfs

IEKM. Other Hapludalfs that:

1. Have an argillic horizon that:

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have base saturation (by sum of cations) of less than 60 percent at a depth 125 cm below the top of the argillic horizon, or 180 cm below the soil surface, or immediately above a lithic or paralithic contact, whichever is least.
Aquultic Hapludalfs

IEKN. Other Hapludalfs that:

1. Have an argillic horizon that

a. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

b. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface; *and*

2. Have an Ap horizon that has a color value, moist, of 3 or less or a color value, dry, of 5 or less (crushed and smoothed), or the upper soil to a depth of 18 cm, after mixing, has these colors.

Aquollic Hapludalfs

IEKO. Other Hapludalfs that have an argillic horizon that *either*:

1. If its upper boundary is less than 50 cm below the soil surface, has mottles that have chroma of 2 or less in the upper 25 cm, and it is saturated with water within that depth at some time when the soil temperature is 5°C or higher; *or*

2. If the upper boundary of the argillic horizon is deeper than 50 cm, has mottles that have chroma of 2 or less within a depth of 75 cm below the soil surface.

Aquic Hapludalfs

IEKP. Other Hapludalfs that have albic materials that constitute 5 percent or more of the volume of one or more subhorizons of the argillic horizon, and the mean annual soil temperature is 10°C or higher.

Glossic Hapludalfs

IEKQ. Other Hapludalfs that have interfingering of albic materials and albic materials surrounding some peds in the upper part of the argillic horizon, and the mean annual soil temperature is lower than 10°C.

Glossoboric Hapludalfs

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

Ultic Hapludalfs

IEKS. Other Hapludalfs that have an Ap horizon that has a color value, moist, of 3 or less and has a color value, dry, of 5 or less (crushed and smoothed), or the upper soil to a depth of 18 cm, after mixing, has these colors.

Mollic Hapludalfs

IEKT. Other Hapludalfs.

Typic Hapludalfs

Kandiudalfs

Key to subgroups

IEGA. Kandiudalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Plinthaquic Kandiudalfs

IEGB. Other Kandiudalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage.

Aquic Kandiudalfs

IEGC. Other Kandiudalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthic Kandiudalfs

IEGD. Other Kandiudalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Grossarenic Plinthic Kandiudalfs

IEGE. Other Kandiudalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiudalfs

IEGF. Other Kandiudalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface.

Grossarenic Kandiudalfs

IEGG. Other Kandiudalfs that have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiudalfs

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

Rhodic Kandiudalfs

IEGI. Other Kandiudalfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less after the soil has been crushed, or the upper soil, after mixing to a depth of 18 cm, has these color values.

Mollic Kandiudalfs

IEGJ. Other Kandiudalfs.

Typic Kandiudalfs

Kanhapludalfs

Key to subgroups

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

Lithic Kanhapludalfs

IEHB. Other Kanhapludalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage.

Aquic Kanhapludalfs

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

Rhodic Kanhapludalfs

IEHD. Other Kanhapludalfs.

Typic Kanhapludalfs

Natrudalfs

Key to subgroups

IEBA. Natrudalfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part and that extend to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil, or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Natrudalfs

IEBB. Other Natrudalfs that have tonguing or interfingering of albic materials more than 2.5 cm into the natric horizon.

Glossic Natrudalfs

IEBC. Other Natrudalfs that have an Ap horizon that has a color value, moist, of 2 or less, or the soil to a depth of 18 cm, after mixing, has that color value.

Mollic Natrudalfs

IEBD. Other Natrudalfs that do not have mottles that have chroma of 2 or less within 25 cm of the upper boundary of the natric horizon.

Aeric Natrudalfs

IEBE. Other Natrudalfs.

Typic Natrudalfs

Paleudalfs

Key to subgroups

IEIA. Paleudalfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil, or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Paleudalfs

IEIB. Other Paleudalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil

temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthaquic Paleudalfs

IEIC. Other Paleudalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have subhorizons in the upper part of the argillic horizon that have skeletans that

a. Have moist chroma of 2 or less; *and*

b. Occupy 5 percent or more of the volume of the subhorizon.

Glossaquic Paleudalfs

IEID. Other Paleudalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have an increase of 15 percent clay or more (absolute) within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon.

Albaquic Paleudalfs

IEIE. Other Paleudalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizons are saturated with water at some time when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage.

Aquic Paleudalfs

IEIF. Other Paleudalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthic Paleudalfs

IEIG. Other Paleudalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Grossarenic Plinthic Paleudalfs

IEIH. Other Paleudalfs that have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammentic Paleudalfs

IEII. Other Paleudalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Paleudalfs

IEIJ. Other Paleudalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Paleudalfs

IEIK. Other Paleudalfs that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the surface.

Plinthic Paleudalfs

IEIL. Other Paleudalfs that *either:*

1. Have subhorizons in the upper part of the argillic horizon that have skeletans that

a. Have moist chroma of 2 or less; *and*

b. Occupy 5 percent or more of the volume of the subhorizon; *or*

2. Have albic materials that constitute as much as 5 percent of some subhorizon of the argillic horizon.

Glossic Paleudalfs

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

Rhodic Paleudalfs

IEIN. Other Paleudalfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, no more than 1 unit higher than the value, moist, or the soil, after mixing to a depth of 18 cm, has these color values.

Mollic Paleudalfs

IEIO. Other Paleudalfs.

Typic Paleudalfs

Rhodudalfs

Rhodudalfs are dark red Udalfs of midlatitudes that have a thinner solum than the Paleudalfs. The definition is parallel to that of other Rhodic great groups. Their parent materials are basic. These soils are rare in the United States. Definitions of subgroups have not been developed.

USTALFS

Key to great groups

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

Durustalfs, p. 108

ICB. Other Ustalfs that have plinthite that forms a continuous phase or constitutes more than half the matrix within some subhorizon of the argillic horizon within 150 cm of the surface.

Plinthustalfs, p. 118

ICC. Other Ustalfs that have a natric horizon.

Natrustalfs, p. 114

ICD. Other Ustalfs that

1. Have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm; *and*

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

3. Have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Kandiustalfs, p.111

ICE. Other Ustalfs that have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhaplustalfs, p. 113

ICF. Other Ustalfs that *either*

1. Have a petrocalcic horizon that has its upper boundary within 150 cm of the soil surface; *or*

2. Do *not* have a lithic or paralithic contact within 150 cm of the surface; and the argillic horizon

a. Has a clay distribution such that the percentage of clay does not decrease by as much as 20 percent of the maximum within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer; *and*

b. Has one or more of the following:

(1) Hues redder than 10YR and chroma of more than 4 in the matrix of at least the lower part of the horizon; *or*

(2) Hues of 7.5YR or redder and value, moist, that is less than 4 and value, dry, that is less than 5 throughout the major part of the horizon; *or*

(3) Common coarse mottles that have hue of 7.5YR or redder or chroma of more than 5 in the lower part of the horizon; *or*

3. Do *not* have a lithic or paralithic contact within 50 cm of the surface, and have an argillic horizon in which the upper part has a clayey particle-size class and there is an increase of at least 20 percent clay (absolute) within a vertical distance of 7.5 cm, or of at least 15 percent clay (absolute) within a vertical distance of 2.5 cm at the upper boundary.

Paleustalfs, p. 115

ICG. Other Ustalfs that have an argillic horizon that has throughout its thickness a hue redder than 5YR, a color value, moist, of 3 or less, and a color value, dry, no more than one unit higher than the value, moist.

Rhodustalfs, p. 119

ICH. Other Ustalfs.

Haplustalfs, p. 108

Durustalfs

Durustalfs are the Ustalfs that have a duripan whose upper boundary is within 100 cm of the surface. They are not known to occur in the United States, and subgroups have not been developed. They are provided for use in other countries.

Haplustalfs

Key to subgroups

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

Lithic Haplustalfs

ICHB. Other Haplustalfs that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Udertic Haplustalfs

ICHC. Other Haplustalfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm

long in some part, and that extend to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplustalfs

ICHD. Other Haplustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year or the soil has artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Aquic Arenic Haplustalfs

ICHE. Other Haplustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year or the soil has artificial drainage; *and*

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

Aquultic Haplustalfs

ICHF. Other Haplustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year or the soil has artificial drainage.

Aquic Haplustalfs

ICHG. Other Haplustalfs that have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammentic Haplustalfs

ICHH. Other Haplustalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface; *and*

2. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, or isomesic or a warmer iso-temperature regime, the soils are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Arenic Aridic Haplustalfs

ICHI. Other Haplustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Haplustalfs

ICHJ. Other Haplustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, or isomesic or a warmer iso-temperature regime, the soils are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Haplustalfs

ICHK. Other Haplustalfs that have CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in the major part of the argillic horizon or in the major part of the upper 100 cm if the argillic horizon is more than 100 cm thick.

Kanhaplic Haplustalfs

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

Ultic Haplustalfs

ICHM. Other Haplustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in

some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Haplustalfs

ICHN. Other Haplustalfs.

Typic Haplustalfs

Kandiustalfs

Key to subgroups

ICDA. Kandiustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface.

Grossarenic Kandiustalfs

ICDB. Other Kandiustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Aquic Arenic Kandiustalfs

ICDC. Other Kandiustalfs that have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiustalfs

ICDD. Other Kandiustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when the soil temperature at that depth is 5°C or higher or the soil has artificial drainage.

Aquic Kandiustalfs

ICDE. Other Kandiustalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are moist six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 180 days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Arenic Aridic Kandiustalfs

ICDF. Other Kandiustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiustalfs

ICDG. Other Kandiustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are moist six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 180 days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Kandiustalfs

ICDH. Other Kandiustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for 135 or less cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Kandiustalfs

ICDI. Other Kandiustalfs that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, and have a value, moist, of 3 or less and have a 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 soil surface.

Lithic Kanhaplustalfs

ICEB. Other Kanhaplustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time when the soil temperature at that depth is 5°C or higher *or* the soil has artificial drainage.

Aquic Kanhaplustalfs

ICEC. Other Kanhaplustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are moist less than six-tenths of the time in half or more years in some part of the moisture control section (not necessarily the same part) when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 180 days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Kanhaplustalfs

ICED. Other Kanhaplustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for 135 or less cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Kanhaplustalfs

ICEE. Other Kanhaplustalfs that have, throughout the argillic or kandic horizon, a hue of 2.5YR or redder, and have a value, moist, of 3 or less and have a 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 that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of a natric horizon that is more than 100 cm below the soil surface.

Grossarenic Natrustalfs

ICCB. Other Natrustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface and there is ground water in the mottled horizon at some time of year when the soil temperature is 5°C or higher; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Aquic Arenic Natrustalfs

ICCC. Other Natrustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface and there is ground water in the mottled horizon at some time of year when the soil temperature is 5°C or higher.

Aquic Natrustalfs

ICCD. Other Natrustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Natrustalfs

ICCE. Other Natrustalfs that have a petrocalcic horizon that has its upper boundary within 150 cm of the surface.

Petrocalcic Natrustalfs

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

Salorthidic Natrustalfs

ICCG. Other Natrustalfs that have an Ap horizon that has a color value, moist, of 3 or less, or the soil, after mixing to a depth of 18 cm, has a color value, moist, of 3 or less.

Mollic Natrustalfs

ICCH. Other Natrustalfs.

Typic Natrustalfs

Paleustalfs

Key to subgroups

ICFA. Paleustalfs that:

1. When neither irrigated nor fallowed to store moisture:

   a. If the soil temperature regime is mesic or thermic, are dry for less than four-tenths of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

   b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

   b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

   c. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Udertic Paleustalfs

ICFB. Other Paleustalfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or

paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Paleustalfs

ICFC. Other Paleustalfs that have an argillic horizon that is discontinuous horizontally, or is discontinuous vertically in the upper 20 cm of its thickness, or has a texture that is loamy fine sand or coarser.

Psammentic Paleustalfs

ICFD. Other Paleustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Paleustalfs

ICFE. Other Paleustalfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface and the mottled horizon is saturated with water at some time of the year when the temperature of the horizon is 5°C or higher; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Aquic Arenic Paleustalfs

ICFF. Other Paleustalfs that have 5 percent or more plinthite by volume in one or more subhorizons within 150 cm of the soil surface.

Plinthic Paleustalfs

ICFG. Other Paleustalfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when the temperature of the horizon is 5°C or higher.

Aquic Paleustalfs

ICFH. Other Paleustalfs that have a petrocalcic horizon that has its upper boundary within 150 cm of the soil surface.

Petrocalcic Paleustalfs

ICFI. Other Paleustalfs that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. When not irrigated and when not fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Arenic Aridic Paleustalfs

ICFJ. Other Paleustalfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Paleustalfs

ICFK. Other Paleustalfs that:

1. When not irrigated and when not fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have a calcic horizon within a depth of 100 cm if the weighted average particle-size class of the upper 50 cm of the argillic horizon is sandy, 60 cm if it is loamy, or 50 cm if it is clayey, and they have carbonates in all subhorizons above the calcic horizon.

Calciorthidic Paleustalfs

ICFL. Other Paleustalfs that, when not irrigated and when not fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Paleustalfs

ICFM. Other Paleustalfs that have a CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in the major part of the argillic horizon, or the major part of the upper 100 cm of the argillic horizon if thicker than 100 cm.

Kandic Paleustalfs

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

Rhodic Paleustalfs

ICFO. Other Paleustalfs that have an argillic horizon that has base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Paleustalfs

ICFP. Other Paleustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for less than four-tenths of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Paleustalfs

ICFQ. Other Paleustalfs.

Typic Paleustalfs

Plinthustalfs

Plinthustalfs are the Ustalfs that have plinthite that forms a continuous phase or that constitutes more than half the matrix of some subhorizon of the argillic horizon within 125 cm of the soil surface. There are no soil series in the United States that are presently classified in this great group, but the group is provided for other parts of the world. Subgroups have not been developed.

Rhodustalfs

Key to subgroups

Because these soils are rare in the United States, the classification that follows probably is incomplete, and it is provisional.

ICGA. Rhodustalfs that have a lithic contact within 50 cm of the 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 the major part of the argillic horizon, or the major part of the upper 100 cm of the argillic horizon if the argillic horizon is thicker than 100 cm.

Kanhaplic Rhodustalfs

ICGC. Other Rhodustalfs that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Rhodustalfs

ICGD. Other Rhodustalfs.

Typic Rhodustalfs

XERALFS

Key to great groups

IDA. Xeralfs that have a duripan whose upper boundary is within 100 cm of the soil surface but below an argillic or a natric horizon.

Durixeralfs, p. 120

IDB. Other Xeralfs that have a natric horizon.

Natrixeralfs, p. 125

IDC. Other Xeralfs that have a fragipan.

Fragixeralfs, p. 121

IDD. Other Xeralfs that have plinthite that forms a continuous phase in, or constitutes more than half the matrix of, some subhorizon of the argillic horizon within 150 cm of the soil surface.

Plinthoxeralfs, p. 127

IDE. Other Xeralfs that have an argillic horizon that, in all parts, has a color hue redder than 5YR and a value, moist, 3 or less and a value, dry, no more than one unit higher than the value, moist.

Rhodoxeralfs, p. 127

IDF. Other Xeralfs that have *either*:

1. A petrocalcic horizon whose upper boundary is within 150 cm of the soil surface; *or*

2. Do *not* have a lithic or paralithic contact within 150 cm of the soil surface; and the argillic horizon

   a. Has a vertical clay distribution such that the percentage of clay does not decrease from the maximum by as much as 20 percent throughout a depth of 150 cm from the soil surface, or the horizon in which the clay decreases either has greater than 5 percent plinthite by volume or has skeletans or other evidences of clay eluviation; *and*

   b. Has *one or both* of the following:

      (1) A hue redder than 10YR and chroma, moist or dry, of more than 4 in the matrix of at least the lower part of the argillic horizon; *or*

      (2) Common coarse mottles that have a hue of 7.5YR or redder or chroma, moist or dry, greater than 5, or both, in at least the lower part of the argillic horizon; *or*

3. Have an argillic horizon that has a clayey particle-size class in the upper part and an increase of at least 20 percent clay (absolute) within a vertical distance of 7.5 cm or of at least 15 percent clay (absolute) within a vertical distance of 2.5 cm at the upper boundary; and there is no lithic or paralithic contact within 50 cm of the surface of the soil.

Palexeralfs, p. 125

IDG. Other Xeralfs.

Haploxeralfs, p. 122

Durixeralfs

<u>Key to subgroups</u>

IDAA. Durixeralfs that have a natric horizon.

Natric Durixeralfs

IDAB. Other Durixeralfs that have mottles in the argillic horizon that have chroma of 2 or less.

Aquic Durixeralfs

IDAC. Other Durixeralfs that:

1. Have an argillic horizon that:

   a. Has 35 percent or more clay in some subhorizon at least 7.5 cm thick; *and*

   b. Has an increase in clay content that is 15 percent or more (absolute) within a vertical distance of 2.5 cm, or is 20 percent or more (absolute) within a vertical distance of 7.5 cm, at the upper boundary or within some part; *and*

2. Have a duripan that is *not* both massive, platy, or prismatic and more than half of its upper boundary indurated and coated with opal or with opal and sesquioxides, or indurated in some subhorizon below the upper boundary.

Abruptic Haplic Durixeralfs

IDAD. Other Durixeralfs that have an argillic horizon that:

1. Has 35 percent or more clay in some subhorizon at least 7.5 cm thick; *and*

2. Has an increase in clay content that is 15 percent or more (absolute) within a vertical distance of 2.5 cm, or is 20 percent or more (absolute) within a vertical distance of 7.5 cm, at the upper boundary or within some part.

Abruptic Durixeralfs

IDAE. Other Durixeralfs that have a duripan that is *not* both massive, platy, or prismatic and more than half of its upper boundary indurated and coated with opal or with opal and sesquioxides, or indurated in some subhorizon below the upper boundary.

Haplic Durixeralfs

IDAF. Other Durixeralfs.

Typic Durixeralfs

Fragixeralfs

Key to subgroups

IDCA. Fragixeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Fragixeralfs

IDCB. Other Fragixeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Fragixeralfs

IDCC. Other Fragixeralfs that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the soil to a depth of 18 cm, after mixing, has those colors.

Mollic Fragixeralfs

IDCD. Other Fragixeralfs that have mottles that have chroma of 2 or less in the upper 25 cm of the argillic horizon, or have mottles that have chroma of 2 or less within 40 cm of the surface, and the horizons that have mottles of low chroma are saturated with water at some time of the year when the soil temperature is 5°C or higher in those horizons. Mottles are not the same as skeletans that may also have low chroma.

Aquic Fragixeralfs

IDCE. Other Fragixeralfs that do *not* have an argillic horizon above the fragipan that has clay skins on at least some vertical and horizontal faces of primary or secondary peds, or both.

Ochreptic Fragixeralfs

IDCF. Other Fragixeralfs.

Typic Fragixeralfs

Haploxeralfs

Key to subgroups

IDGA. Haploxeralfs that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an A horizon that throughout its upper 10 cm has a color value, moist, of 3 or less and contains 0.7 percent or more organic carbon, or have an Ap horizon that has a color value, moist, of 3 or less and contains 0.7 percent or more organic carbon.

Lithic Mollic Haploxeralfs

IDGB. Other Haploxeralfs that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an argillic horizon that is discontinuous horizontally throughout the area of each pedon.

Lithic Ruptic-Xerochreptic Haploxeralfs

IDGC. Other Haploxeralfs that have a lithic contact within 50 cm of the soil surface.

Lithic Haploxeralfs

IDGD. Other Haploxeralfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haploxeralfs

IDGE. Other Haploxeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haploxeralfs

IDGF. Other Haploxeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Haploxeralfs

IDGG. Other Haploxeralfs that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface and the mottled horizon is saturated with water at some time when the temperature of that horizon is 5°C or higher or there is artificial drainage; *and*

2. Have an argillic horizon that has base saturation (by sum of cations) of less than 75 percent in one or more subhorizons of the upper 75 cm or to a lithic or paralithic contact, whichever is shallower.

Aquultic Haploxeralfs

IDGH. Other Haploxeralfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface and the mottled horizon is saturated with water at some time when the temperature of that horizon is 5°C or higher or there is artificial drainage.

Aquic Haploxeralfs

IDGI. Other Haploxeralfs that have exchangeable sodium that is 15 percent or more of the CEC (at pH 8.2) in one or more subhorizons in the argillic horizon.

Natric Haploxeralfs

IDGJ. Other Haploxeralfs that have an argillic horizon that is discontinuous vertically within the upper 20 cm or has a sandy particle-size class.

Psammentic Haploxeralfs

IDGK. Other Haploxeralfs that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Haploxeralfs

IDGL. Other Haploxeralfs that have a calcic horizon that has its upper boundary within the upper 100 cm of soil.

Calcic Haploxeralfs

IDGM. Other Haploxeralfs that have an argillic horizon that has base saturation (by sum of cations) of less than 75 percent in one or more subhorizons of the upper 75 cm or to a lithic or paralithic contact, whichever is shallower.

Ultic Haploxeralfs

IDGN. Other Haploxeralfs that have an A horizon that has throughout its upper 10 cm a color value, moist, of 3 or less and 0.7 percent or more organic carbon, or have an Ap horizon that has a color value, moist, of 3 or less and contains 0.7 percent or more organic carbon.

Mollic Haploxeralfs

IDGO. Other Haploxeralfs.

Typic Haploxeralfs

Natrixeralfs

Key to subgroups

IDBA. Natrixeralfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface and there is ground water in the mottled horizon at some time when the temperature of that horizon is 5°C or higher.

Aquic Natrixeralfs

IDBB. Other Natrixeralfs.

Typic Natrixeralfs

Palexeralfs

Key to subgroups

IDFA. Palexeralfs that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap horizon if the soil is not irrigated; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm, *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Palexeralfs

IDFB. Other Palexeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Palexeralfs

IDFC. Other Palexeralfs that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Palexeralfs

IDFD. Other Palexeralfs that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when its temperature is 5°C or higher or there is artificial drainage.

Aquic Palexeralfs

IDFE. Other Palexeralfs that have a petrocalcic horizon whose upper boundary is within 150 cm of the soil surface.

Petrocalcic Palexeralfs

IDFF. Other Palexeralfs that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 50 cm below the soil surface.

Arenic Palexeralfs

IDFG. Other Palexeralfs that have 15 percent or more saturation with sodium in one or more subhorizons within 100 cm of the soil surface.

Natric Palexeralfs

IDFH. Other Palexeralfs that have a calcic horizon within 150 cm of the soil surface.

Calcic Palexeralfs

IDFI. Other Palexeralfs that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Palexeralfs

IDFJ. Other Palexeralfs that have an argillic horizon that has less than 75 percent base saturation (by sum of cations) throughout.

Ultic Palexeralfs

IDFK. Other Palexeralfs that have an argillic horizon in which the upper part does not have a clayey particle-size class, or there is an increase of less than 20 percent clay (absolute) within a vertical distance of 7.5 cm or less than 15 percent clay (absolute) within 2.5 cm at the upper boundary.

Haplic Palexeralfs

IDFL. Other Palexeralfs that have an A horizon that, throughout its upper 10 cm, has a color value, moist, of 3 or less and contains 0.7 percent or more organic carbon, or have an Ap horizon that has a color value, moist, of 3 or less and contains 0.7 percent or more organic carbon.

Mollic Palexeralfs

IDFM. Other Palexeralfs.

Typic Palexeralfs

Plinthoxeralfs

Plinthoxeralfs are the Xeralfs that have plinthite that forms a continuous phase or that constitutes more than half the matrix of some subhorizon within 150 cm of the soil surface. Few of these soils are in the United States, but the soils are moderately extensive in some parts of the world. Subgroups have not been developed.

Rhodoxeralfs

Key to subgroups

The list of subgroups that follows is incomplete because the soils are of such limited extent in the United States.

IDEA. Rhodoxeralfs that have a lithic contact within 50 cm of the soil surface.

Lithic Rhodoxeralfs

IDEB. Other Rhodoxeralfs that have a petrocalcic horizon whose upper boundary is within 150 cm of the soil surface.

Petrocalcic Rhodoxeralfs

IDEC. Other Rhodoxeralfs that have a calcic horizon whose upper boundary is within 150 cm of the soil surface.

Calcic Rhodoxeralfs

IDED. Other Rhodoxeralfs that have an argillic horizon that is 15 cm or less thick or is discontinuous in each pedon.

Ochreptic Rhodoxeralfs

IDEE. Other Rhodoxeralfs.

Typic Rhodoxeralfs

Chapter 6

Andisols[1]

KEY TO SUBORDERS

BA. Andisols that have a histic epipedon or experienced periods of saturation and reduction, as evidenced by one or more of the following within 50 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, unless irrigated and evidence occurs above a depth of 40 cm and not below:

1. Two percent or more redox segregations[2]; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl[3] at some time of the year when not being irrigated.

Aquands, p. 130

BB. Other Andisols that have a cryic or pergelic soil temperature regime.

Cryands, p 134

BC. Other Andisols that have an aridic moisture regime.

Torrands, p.138

BD. Other Andisols that have a xeric moisture regime.

Xerands, p.154

BE. Other Andisols that have 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples, throughout a thickness of 35 cm or more within 60 cm of the mineral soil surface or

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[1] This chapter builds on the preliminary Andisol Proposal (1978) by G. D. Smith (NZ Soil Bureau Record 96) and represents the work of the International Committee on the Classification of Andisols (ICOMAND), chaired by M.L. Leamy, New Zealand Soil Bureau.

[2] Redox segregations, e.g., mottles and concretions, are formed as a result of the reduction and solubilisation of iron and/or manganese, their translocation, concentration, and their re-oxidation and precipitation in the form of oxides.

[3] A positive reaction to the 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 necessarily, or always, absent; this may merely 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.

upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitrands, p. 153

BF. Other Andisols that have an ustic soil moisture regime.

Ustands, p.150

BG. Other Andisols.

Udands, p. 139

AQUANDS

Key to great groups

BAA. Aquands that have a cryic or pergelic soil temperature regime.

Cryaquands, p.130

BAB. Other Aquands that have a placic horizon within 100 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower, in half or more of each pedon.

Placaquands, p. 133

BAC. Other Aquands that have a cemented layer in 75 percent or more of each pedon which does not slake in water after drying, with its upper boundary within 100 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower.

Duraquands, p. 131

BAD. Other Aquands that have 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples, throughout a thickness of 35 cm or more within 60 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitraquands, p. 133

BAE. Other Aquands that have a melanic epipedon.

Melanaquands, p.132

BAF. Other Aquands.

Haplaquands, p. 131

Cryaquands

Key to subgroups

BAAA. Cryaquands that have a lithic contact within 50 cm of the soil surface.

Lithic Cryaquands

BAAB. Other Cryaquands that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryaquands

BAAC. Other Cryaquands that have a histic epipedon.

Histic Cryaquands

BAAD. Other Cryaquands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Cryaquands

BAAE. Other Cryaquands.

Typic Cryaquands

Duraquands

Key to subgroups

BACA. Duraquands that have a histic epipedon.

Histic Duraquands

BACB. Other Duraquands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm.

Acraquoxic Duraquands

BACC. Other Duraquands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Duraquands

BACD. Other Duraquands.

Typic Duraquands

Haplaquands

Key to subgroups

BAFA. Haplaquands that have a lithic contact within 50 cm of the soil surface.

Lithic Haplaquands

BAFB. Other Haplaquands that have a petroferric contact within 100 cm of the soil surface.

Petroferric Haplaquands

BAFC. Other Haplaquands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Haplaquands

BAFD. Other Haplaquands that have a histic epipedon.

Histic Haplaquands

BAFE. Other Haplaquands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm.

Alic Haplaquands

BAFF. Other Haplaquands that have, undried,1500 kPa water of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm.

Hydric Haplaquands

BAFG. Other Haplaquands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Haplaquands

BAFH. Other Haplaquands.

Typic Haplaquands

Melanaquands

Key to subgroups

BAEA. Melanaquands that have a lithic contact within 50 cm of the soil surface.

Lithic Melanaquands

BAEB. Other Melanaquands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm.

Acraquoxic Melanaquands

BAEC. Other Melanaquands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have both more than 6.0 percent organic carbon and colors of a mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Hydric Pachic Melanaquands

BAED. Other Melanaquands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm.

Hydric Melanaquands

BAEE. Other Melanaquands that have, between 40 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Melanaquands

BAEF. Other Melanaquands.

Typic Melanaquands

Placaquands

Key to subgroups

BABA. Placaquands that have a lithic contact within 50 cm of the soil surface.

Lithic Placaquands

BABB. Other Placaquands that have a histic epipedon, and have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Histic Placaquands

BABC. Other Placaquands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Placaquands

BABD. Other Placaquands that have a histic epipedon.

Histic Placaquands

BABE. Other Placaquands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Placaquands

BABF. Other Placaquands.

Typic Placaquands

Vitraquands

Key to subgroups

BADA. Vitraquands that have a lithic contact within 50 cm of the soil surface.

Lithic Vitraquands

BADB. Other Vitraquands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Vitraquands

BADC. Other Vitraquands that have a histic epipedon.

Histic Vitraquands

BADD. Other Vitraquands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Vitraquands

BADE. Other Vitraquands.

Typic Vitraquands

CRYANDS

Key to great groups

BBA. Cryands that have a mean annual soil temperature of $0^{o}C$ or lower.

Gelicryands, p. 135

BBB. Other Cryands that have a melanic epipedon.

Melanocryands, p. 137

BBC. Other Cryands that have an epipedon meeting the depth, thickness and organic carbon requirements of a melanic epipedon and having color value and chroma, moist, of 3 or less.

Fulvicryands, p. 134

BBD. Other Cryands that have a 1500 kPa water retention of undried samples of 100 percent or more on the weighted average throughout a thickness of 35 cm or more within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Hydrocryands, p. 136

BBE. Other Cryands that have 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples, throughout a thickness of 35 cm or more within 60 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitricryands, p. 137

BBF. Other Cryands.

Haplocryands, p. 135

Fulvicryands

Key to subgroups

BBCA. Fulvicryands that have a lithic contact within 50 cm of the soil surface.

Lithic Fulvicryands

BBCB. Other Fulvicryands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitric Fulvicryands

BBCC. Other Fulvicryands.

Typic Fulvicryands

Gelicryands

Key to subgroups

BBAA. All Gelicryands are regarded as Typic.

Typic Gelicryands

Haplocryands

Key to subgroups

BBFA. Haplocryands that have a lithic contact within 50 cm of the soil surface.

Lithic Haplocryands

BBFB. Other Haplocryands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm.

Alic Haplocryands

BBFC. Other Haplocryands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Haplocryands

BBFD. Other Haplocryands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm.

Acrudoxic Haplocryands

BBFE. Other Haplocryands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitric Haplocryands

BBFF. Other Haplocryands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Haplocryands

BBFG. Other Haplocryands that have a xeric soil moisture regime.

Xeric Haplocryands

BBFH. Other Haplocryands that have a spodic horizon, and an associated eluvial horizon with 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.

Spodic Haplocryands

BBFI. Other Haplocryands.

Typic Haplocryands

Hydrocryands

Key to subgroups

BBDA. Hydrocryands that have a lithic contact within 50 cm of the soil surface.

Lithic Hydrocryands

BBDB. Other Hydrocryands that have a placic horizon within 100 cm of the soil surface.

Placic Hydrocryands

BBDC. Other Hydrocryands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Hydrocryands

BBDD. Other Hydrocryands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Hydrocryands

BBDE. Other Hydrocryands.

Typic Hydrocryands

Melanocryands

Key to subgroups

BBBA. Melanocryands that have a lithic contact within 50 cm of the soil surface.

Lithic Melanocryands

BBBB. Other Melanocryands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm.

Alic Melanocryands

BBBC. Other Melanocryands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitric Melanocryands

BBBD. Other Melanocryands.

Typic Melanocryands

Vitricryands

Key to subgroups

BBEA. Vitricryands that have a lithic contact within 50 cm of the soil surface.

Lithic Vitricryands

BBEB. Other Vitricryands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Vitricryands

BBEC. Other Vitricryands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Vitricryands

BBED. Other Vitricryands that have a xeric moisture regime.

Xeric Vitricryands

BBEE. Other Vitricryands that have a spodic horizon, and an associated eluvial horizon with 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.

Spodic Vitricryands

BBEF. Other Vitricryands that have an argillic or kandic horizon with 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 Vitricryands

BBEG. Other Vitricryands.

Typic Vitricryands

TORRANDS

Key to great groups

BCA. All Torrands are regarded as Vitritorrands.

Vitritorrands, p. 138

Vitritorrands

Key to subgroups

BCAA. Vitritorrands that have a lithic contact within 50 cm of the soil surface.

Lithic Vitritorrands

BCAB. Other Vitritorrands that have a petrocalcic horizon with its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Vitritorrands

BCAC. Other Vitritorrands that have a horizon with its upper boundary within 100 cm of a mineral soil surface which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Vitritorrands

BCAD. Other Vitritorrands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year.

Aquic Vitritorrands

BCAE. Other Vitritorrands that have a calcic horizon with its upper boundary within 125 cm of the mineral soil surface.

Calcic Vitritorrands

BCAF. Other Vitritorrands.

Typic Vitritorrands

UDANDS

Key to great groups

BGA. Udands that have a placic horizon within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, in half or more of each pedon.

Placudands, p. 149

BGB. Other Udands that have a cemented layer in 75 percent or more of each pedon which does not slake in water after air drying, with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Durudands, p. 139

BGC. Other Udands that have a melanic epipedon.

Melanudands, p. 146

BGD. Other Udands that have an epipedon meeting the depth, thickness and organic carbon requirements of a melanic epipedon and having color value and chroma, moist, of 3 or less.

Fulvudands, p. 140

BGE. Other Udands that have a 1500 kPa water retention of undried samples of 100 percent or more on the weighted average throughout a thickness of 35 cm or more within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Hydrudands, p. 145

BGF. Other Udands.

Hapludands, p. 142

Durudands

Key to subgroups

BGBA. Durudands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Durudands

BGBB. Other Durudands that have extractable bases plus 1N KCl extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm.

Acrudoxic Durudands

BGBC. Other Durudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have both more than 6.0 percent organic carbon and colors of a mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Hydric Pachic Durudands

BGBD. Other Durudands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Durudands

BGBE. Other Durudands.

Typic Durudands

Fulvudands

Key to subgroups

BGDA. Fulvudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more, and have a lithic contact within 50 cm of the soil surface.

Hydric Lithic Fulvudands

BGDB. Other Fulvudands that have a lithic contact within 50 cm of the soil surface.

Lithic Fulvudands

BGDC. Other Fulvudands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm.

Alic Fulvudands

BGDD. Other Fulvudands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of ped, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Fulvudands

BGDE. Other Fulvudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have, undried, kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm.

Acrudoxic Hydric Fulvudands

BGDF. Other Fulvudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have an argillic or kandic horizon with 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 base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of that horizon.

Acrudoxic Ultic Fulvudands

BGDG. Other Fulvudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm.

Acrudoxic Fulvudands

BGDH. Other Fulvudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Hydric Pachic Fulvudands

BGDI. Other Fulvudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm, and have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Eutric Pachic Fulvudands

BGDJ. Other Fulvudands that have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Pachic Fulvudands

BGDK. Other Fulvudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Hydric Thaptic Fulvudands

BGDL. Other Fulvudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm.

Hydric Fulvudands

BGDM. Other Fulvudands that have, between 40 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Fulvudands

BGDN. Other Fulvudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Fulvudands

BGDO. Other Fulvudands.

Typic Fulvudands

Hapludands

Key to subgroups

BGFA. Hapludands that have a lithic contact within 50 cm of the soil surface.

Lithic Hapludands

BGFB. Other Hapludands that have a petroferric contact within 100 cm of the soil surface.

Petroferric Hapludands

BGFC. Other Hapludands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying, and have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Duric Hapludands

BGFD. Other Hapludands that have a horizon with its upper boundary within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, which is more than 15 cm thick and contains 20 percent or more (by volume) cemented soil material that does not slake in water after air drying.

Duric Hapludands

BGFE. Other Hapludands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm.

Alic Hapludands

BGFF. Other Hapludands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces or peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Hapludands

BGFG. Other Hapludands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm.

Acrudoxic Hydric Hapludands

BGFH. Other Hapludands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Acrudoxic Thaptic Hapludands

BGFI. Other Hapludands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have an argillic or kandic horizon with 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 base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of that horizon.

Acrudoxic Ultic Hapludands

BGFJ. Other Hapludands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm.

Acrudoxic Hapludands

BGFK. Other Hapludands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitric Hapludands

BGFL. Other Hapludands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Hydric Thaptic Hapludands

BGFM. Other Hapludands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm.

Hydric Hapludands

BHFN. Other Hapludands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower, and have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Eutric Thaptic Hapludands

BGFO. Other Hapludands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Hapludands

BGFP. Other Hapludands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Hapludands

BGFQ. Other Hapludands that have an oxic horizon with 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.

Oxic Hapludands

BGFR. Other Hapludands that have an argillic or kandic horizon with 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 base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of that horizon.

Ultic Hapludands

BGFS. Other Hapludands that have an argillic or kandic horizon with 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 Hapludands

BGFT. Other Hapludands.

Typic Hapludands

Hydrudands

Key to subgroups

BGEA. Hydrudands that have a lithic contact within 50 cm of the soil surface.

Lithic Hydrudands

BGEB. Other Hydrudands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Hydrudands

BGEC. Other Hapludands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Acrudoxic Thaptic Hydrudands

BGED. Other Hydrudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm.

Acrudoxic Hydrudands

BGEE. Other Hydrudands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Hydrudands

BGEF. Other Hydrudands that have a sum of bases of *more than* 25.0 *cmol*(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Hydrudands

BGEG. Other Hydrudands that have an argillic or kandic horizon with 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.

Ultic Hydrudands

BGEH. Other Hydrudands.

Typic Hydrudands

Melanudands

Key to subgroups

BGCA. Melanudands that have a lithic contact within 50 cm of the soil surface.

Lithic Melanudands

BGCB. Other Melanudands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm, and have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Alic Aquic Melanudands

BGCC. Other Melanudands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm, and have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Alic Pachic Melanudands

BGCD. Other Melanudands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm, and have, between 40 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Alic Thaptic Melanudands

BGCE. Other Melanudands that have 1N KCl-extractable Al^{3+} of more than 2.0 cmol(+) kg^{-1} fine earth throughout a layer 10 cm or more thick between 25 and 50 cm.

Alic Melanudands

BGCF. Other Melanudands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Melanudands

BGCG. Other Melanudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Vitric Melanudands

BGCH. Other Melanudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hydric Melanudands

BGCI. Other Melanudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Melanudands

BGCJ. Other Melanudands that have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Pachic Vitric Melanudands

BGCK. Other Melanudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Vitric Melanudands

BGCL. Other Hapludands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitric Melanudands

BGCM. Other Melanudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Hydric Pachic Melanudands

BGCN. Other Melanudands that have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Pachic Melanudands

BGCO. Other Melanudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm, and have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Hydric Melanudands

BGCP. Other Melanudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Hydric Melanudands

BGCQ. Other Melanudands that have, between 40 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Melanudands

BGCR. Other Melanudands that have an argillic or kandic horizon with 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.

Ultic Melanudands

BGCS. Other Melanudands.

Typic Melanudands

Placudands

Key to subgroups

BGAA. Placudands that have a lithic contact within 50 cm of the soil surface.

Lithic Placudands

BGAB. Other Placudands that have, in some subhorizon between 50 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Placudands

BGAC. Other Placudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm, and have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hydric Placudands

BGAD. Other Placudands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 2.0 cmol(+) kg^{-1} fine earth in some subhorizon 30 cm or more thick between 25 and 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Placudands

BGAE. Other Placudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Vitric Placudands

BGAF. Other Placudands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitric Placudands

BGAG. Other Placudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm, and have both more than 6 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Hydric Pachic Placudands

BGAH. Other Placudands that have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Pachic Placudands

BGAI. Other Placudands that have, undried, 1500 kPa water retention of 70 percent or more throughout a continuous thickness of 35 cm or more within the upper 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Hydric Placudands

BGAJ. Other Placudands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Placudands

BGAK. Other Placudands that have a sum of bases of more than 25.0 cmol(+) kg^{-1} fine earth throughout some subhorizon 15 cm or more thick between 25 and 75 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Eutric Placudands

BGAL. Other Placudands.

Typic Placudands

USTANDS

Key to great groups

BFA. Ustands that have a duripan with its upper boundary within 100 cm of the mineral soil surface.

Durustands, p. 151

BFB. Other Ustands.
Haplustands, p. 151

Durustands

Key to subgroups

BFAA. Durustands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.
Aquic Durustands

BFAB. Other Durustands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.
Thaptic Durustands

BFAC. Other Durustands that have a mollic epipedon.
Mollic Durustands

BFAD. Other Durustands that have an umbric epipedon.
Umbric Durustands

BFAE. Other Durustands.
Typic Durustands

Haplustands

Key to subgroups

BFBA. Haplustands that have a lithic contact within 50 cm of the soil surface.
Lithic Haplustands

BFBB. Other Haplustands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.
Aquic Haplustands

BFBC. Other Haplustands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 15.0 cmol(+) kg^{-1} in the fine earth throughout at least 60 cm of the upper 75 cm, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface.

Dystric Vitric Haplustands

BFBD. Other Haplustands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Vitric Haplustands

BFBE. Other Haplustands that have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Pachic Haplustands

BFBF. Other Haplustands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Haplustands

BFBG. Other Haplustands that have a calcic horizon with its upper boundary within 125 cm of the mineral soil surface.

Calcic Haplustands

BFBH. Other Haplustands that have extractable bases plus 1N KCl-extractable Al^{3+} of less than 15.0 cmol(+) kg^{-1} in the fine earth throughout at least 60 cm of the upper 75 cm.

Dystric Haplustands

BFBI. Other Haplustands that have an oxic horizon with its upper boundary within 125 cm of the mineral soil surface.

Oxic Haplustands

BFBJ. Other Haplustands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Alfic Haplustands

BFBK. Other Haplustands that have a mollic epipedon.

Mollic Haplustands

BFBL. Other Haplustands that have an umbric epipedon.

Umbric Haplustands

BFBM. Other Haplustands.

Typic Haplustands

VITRANDS

Key to great groups

BEA. Vitrands that have an ustic soil moisture regime.
Ustivitrands, p. 153

BEB. Other Vitrands.
Udivitrands, p. 153

Udivitrands

Key to subgroups

BEBA. Udivitrands that have a lithic contact within 50 cm of the soil surface.
Lithic Udivitrands

BEBB. Other Udivitrands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Udivitrands

BEBC. Other Udivitrands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.
Thaptic Udivitrands

BEBD. Other Udivitrands that have a spodic horizon, and an associated eluvial horizon with 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.
Spodic Udivitrands

BEBE. Other Udivitrands.
Typic Udivitrands

Ustivitrands

Key to subgroups

BEAA. Ustivitrands that have a lithic contact within 50 cm of the soil surface.
Lithic Ustivitrands

BEAB. Other Ustivitrands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Ustivitrands

BEAC. Other Ustivitrands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Ustivitrands

BEAD. Other Ustivitrands that have a calcic horizon with its upper boundary within 125 cm of the mineral soil surface.

Calcic Ustivitrands

BEAE. Other Ustivitrands that have a mollic epipedon.

Mollic Ustivitrands

BEAF. Other Ustivitrands that have an umbric epipedon.

Umbric Ustivitrands

BEAG. Other Ustivitrands.

Typic Ustivitrands

XERANDS

Key to great groups

BDA. Xerands that have 1500 kPa water retention of less than 15 percent on air-dried samples and less than 30 percent on undried samples, throughout a thickness of 35 cm or more within 60 cm of the mineral soil surface.

Vitrixerands, p. 156

BDB. Other Xerands that have a melanic epipedon.

Melanoxerands, p. 156

BDC. Other Xerands.

Haploxerands, p. 154

Haploxerands

Key to subgroups

BDCA. Haploxerands that have a lithic contact within 50 cm of the soil surface.

Lithic Haploxerands

BDCB. Other Haploxerands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Haploxerands

BDCC. Other Haploxerands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface, and base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of that horizon, and have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface.

Ultic Vitric Haploxerands

BDCD. Other Haploxerands that have less than 30 percent, undried, 1500 kPa water retention in some subhorizon that meets the requirements for andic soil properties and that is at least 25 cm thick within 100 cm of the mineral soil surface.

Vitric Haploxerands

BDCE. Other Haploxerands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Haploxerands

BDCF. Other Haploxerands that have a calcic horizon with its upper boundary within 125 cm of the mineral soil surface.

Calcic Haploxerands

BDCG. Other Haploxerands that have an argillic or kandic horizon with 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 base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of that horizon.

Ultic Haploxerands

BDCH. Other Haploxerands that have

1. A mollic epipedon; *and*

2. An argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Argixerollic Haploxerands

BDCI. Other Haploxerands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Alfic Haploxerands

BDCJ. Other Haploxerands that have a mollic epipedon.

Mollic Haploxerands

BDCK. Other Haploxerands that have an umbric epipedon.

Umbric Haploxerands

BDCL. Other Haploxerands.

Typic Haploxerands

Melanoxerands

Key to subgroups

BDBA. Melanoxerands that have both more than 6.0 percent organic carbon and colors of the mollic epipedon throughout at least 50 cm of the upper 60 cm, excluding any overlying layers that do not have andic soil properties.

Pachic Melanoxerands

BDBB. Other Melanoxerands.

Typic Melanoxerands

Vitrixerands

Key to subgroups

BDAA. Vitrixerands that have a lithic contact within 50 cm of the soil surface.

Lithic Vitrixerands

BDAB. Other Vitrixerands that have, in some subhorizon between 50 and 100 cm:

1. Two percent or more redox segregations; *or*

2. Dominant chromas, moist, of 2 or less on faces of peds, or in the matrix if peds are absent, other than in any horizon that has color values, moist, of 3 or less; *or*

3. Sufficient active ferrous iron to give a positive reaction to a,a'-dipyridyl at some time of the year when not being irrigated.

Aquic Vitrixerands

BDAC. Other Vitrixerands that have, between 25 and 100 cm, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, occurring below a horizon or horizons, 10 cm or more thick, with color value 1 unit or more higher and organic carbon content 1 percent or more lower than the underlying layer.

Thaptic Vitrixerands

BDAD. Other Vitrixerands that have a spodic horizon, and an associated eluvial horizon with its upper boundary within 125 cm of the mineral soil surface.

Spodic Vitrixerands

BDAE. Other Vitrixerands that have

1. A mollic epipedon; *and*

2. An argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Argixerollic Vitrixerands

BDAF. Other Vitrixerands that have an argillic or kandic horizon with its upper boundary within 125 cm of the mineral soil surface.

Alfic Vitrixerands

BDAG. Other Vitrixerands that have a mollic epipedon.

Mollic Vitrixerands

BDAH. Other Vitrixerands that have an umbric epipedon.

Umbric Vitrixerands

BDAI. Other Vitrixerands.

Typic Vitrixerands

Chapter 7

Aridisols

KEY TO SUBORDERS

FA. Aridisols that have an argillic or a natric horizon.
Argids, p. 159

FB. Other Aridisols.
Orthids, p. 178

ARGIDS

Key to great groups

FAA. Argids that have a duripan[1] below an argillic horizon and do not have a natric horizon.
Durargids, p.159

FAB. Other Argids that have a duripan below a natric horizon.
Nadurargids, p. 169

FAC. Other Argids that have a natric horizon and do not have a petrocalcic horizon.
Natrargids, p. 170

FAD. Other Argids that do not have a lithic or paralithic contact within 50 cm of the soil surface, that have a petrocalcic horizon or that have an argillic horizon that has 35 percent or more clay in some part, and that have *either*:

1. An increase of 15 percent or more clay (absolute) within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon; *or*

2. An increase of 10 percent or more clay (absolute) if cultivated and the lower boundary of the Ap horizon is the upper boundary of the argillic horizon.
Paleargids, p. 174

FAE. Other Argids.
Haplargids, p. 163

Durargids

Key to subgroups

FAAA. Durargids that are saturated with water within 100 cm of the surface for 90 consecutive days or more in most years, *or* have any of the following characteristics within 100 cm of the soil surface if there is ground water within this depth at some time in most years:

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[1] A duripan or a petrocalcic horizon must have its upper boundary within 100 cm of the surface to be diagnostic in Aridisols.

1. Dominant chroma of 1 or less throughout the horizons and hue as yellow or yellower than 2.5Y in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable sodium) in more than half the thickness of the horizon between the surface and 50 cm depth than in the saturated zone.

Aquic Durargids

FAAB. Other Durargids that have the following combination of characteristics:

1. A duripan at a depth 18 cm or more; *and*

2. The weighted average percentage of organic carbon in the upper soil to a depth of 40 cm is 0.6 or more if the weighted average ratio of sand to clay in the upper soil to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay in the upper soil is more than 1.0 but less than 13; and the weighted average percentage of organic carbon in the upper soil to a depth of 18 cm is one-fifth or more higher than the values just stated if a duripan is present at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime; *and*

4. An argillic horizon that has 35 percent or more clay in some part and also has *either*:

a. An increase of 15 percent or more clay (absolute) within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon; *or*

b. An increase of 10 percent or more clay (absolute) if cultivated and the lower boundary of the Ap horizon is the upper boundary of the argillic horizon.

Abruptic Xerollic Durargids

FAAC. Other Durargids that have an argillic horizon that has 35 percent or more clay in some part, and also have *either*:

1. An increase of 15 percent or more clay (absolute) within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon; *or*

2. An increase of 10 percent or more clay (absolute) if cultivated and the lower boundary of the Ap horizon is the upper boundary of the argillic horizon.

Abruptic Durargids

FAAD. Other Durargids that have

1. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime; *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. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrixerandic Durargids

FAAE. Other Durargids that

1. Are dry in all parts of the moisture control section three-fourths of the time (cumulative) or less that the soil temperature at a depth of 50 cm is 5°C or higher; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrustandic Durargids

FAAF. Other Durargids that do not have a platy or massive duripan that is indurated in some subhorizon and that have the following combination of characteristics:

1. A duripan at a depth of 18 cm or more; *and*

2. The weighted average percentage of organic carbon in the upper soil to a depth of 40 cm is 0.6 or more if the

weighted average ratio of sand to clay in the upper soil to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay in the upper soil is more than 1.0 but less than 13; and the weighted average percentage of organic carbon in the upper soil to a depth of 18 cm is one-fifth or more higher than the values just stated if a duripan is present at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Haploxerollic Durargids

FAAG. Other Durargids that do not have a platy or massive duripan that is indurated in some subhorizon.

Haplic Durargids

FAAH. Other Durargids that have the following combination of characteristics:

1. A duripan at a depth of 18 cm or more; *and*

2. The weighted average percentage of organic carbon in the upper soil to a depth of 40 cm is 0.6 or more if the weighted average ratio of sand to clay in the upper soil to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay in the upper soil is more than 1.0 but less than 13; and the weighted average percentage of organic carbon in the upper soil to a depth of 18 cm is one-fifth or more higher than the values just stated if a duripan is present at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Durargids

FAAI. Other Durargids that are dry in all parts of the moisture control section three-fourths of the time (cumulative) or less that the soil temperature at a depth of 50 cm is 5°C or higher.

Ustalfic Durargids

FAAJ. Other Durargids.

Typic Durargids

Haplargids

Key to subgroups

FAEA. Haplargids that have the following combination of characteristics:

1. A frigid or colder temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. A lithic contact within 50 cm of the surface; *and*

3. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm.

Borollic Lithic Haplargids

FAEB. Other Haplargids that have the following combination of characteristics:

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

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. An argillic horizon that is not continuous throughout the area of each pedon; *and*

4. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Lithic Ruptic-Entic Xerollic Haplargids

FAEC. Other Haplargids that have the following combination of characteristics:

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

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or

more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Lithic Xerollic Haplargids

FAED. Other Haplargids that have the following combination of characteristics:

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

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Lithic Ustollic Haplargids

FAEE. Other Haplargids that have a lithic contact within 50 cm of the surface.

Lithic Haplargids

FAEF. Other Haplargids that have the following combination of characteristics:

1. A frigid or colder temperature regime; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; *and*

3. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface, to the base of an Ap horizon, or to the top of the argillic horizon, and the cracks are not closed for as many as 60 consecutive days of the 120 days following the winter solstice in 3 or more years out of 10; *and*

4. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

5. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Borollic Vertic Haplargids

FAEG. Other Haplargids that have:

1. A frigid or colder temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm.

Borollic Haplargids

FAEH. Other Haplargids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface, to the base of an Ap horizon, or to the top of the argillic horizon, and the cracks close for 60 consecutive days or more during the 120 days following the winter solstice in more than 7 out of 10 years; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

4. A thermic, mesic, or frigid soil temperature regime.

Xerertic Haplargids

FAEI. Other Haplargids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface, to the base of an Ap horizon, or to the top of the

argillic horizon, and the cracks remain open from 175 to 240 days, cumulative, in most years; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Ustertic Haplargids

FAEJ. Other Haplargids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface, to the base of an Ap horizon, or to the top of the argillic horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplargids

FAEK. Other Haplargids that are saturated with water for 90 consecutive days or more within 100 cm of the surface in most years or have any of the following characteristics within a depth of 100 cm below the surface if there is ground water within this depth at some time in most years:

1. Dominant chroma of 1 or less throughout and a hue 2.5Y or yellower in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable Na) in more than half the thickness of the horizons between the surface and 50 cm depth than in the saturated zone.

Aquic Haplargids

FAEL. Other Haplargids that have the following combination of characteristics:

1. A texture that is loamy fine sand or coarser in all subhorizons above a depth of 50 cm; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate

between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Arenic Ustollic Haplargids

FAEM. Other Haplargids that have the following combination of characteristics:

1. A texture that is loamy fine sand or coarser in all subhorizons above a depth of 50 cm; *and*

2. Dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm; *and*

3. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Arenic Ustalfic Haplargids

FAEN. Other Haplargids that have a texture that is loamy fine sand or coarser in all subhorizons above a depth of 50 cm.

Arenic Haplargids

FAEO. Other Haplargids that have the following combination of characteristics:

1. A horizon within 100 cm of the surface that is more than 15 cm thick and that either contains 20 percent or more (by volume) durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Haplargids

FAEP. Other Haplargids that have a horizon within 100 cm of the surface that is more than 15 cm thick and that either contains 20 percent or more (by volume) durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist.

Duric Haplargids

FAEQ. Other Haplargids that have:

1. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Haplargids

FAER. Other Haplargids that are:

1. Dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xeralfic Haplargids

FAES. Other Haplargids that have:

1. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Ustollic Haplargids

FAET. Other Haplargids that are:

1. Dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm; *and*

2. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Ustalfic Haplargids

FAEU. Other Haplargids.

Typic Haplargids

Nadurargids

Key to subgroups

FABA. Nadurargids that:

1. Are saturated with water in some horizon within a depth of 100 cm at some time and have *either* of the following characteristics within the horizon or horizons that are saturated:

a. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

b. Both a dominant chroma of 2 or less and mottles that are not due to segregated lime; *and*

2. Do not have a platy or massive duripan that is indurated in some subhorizon.

Aquic Haplic Nadurargids

FABB. Other Nadurargids that are saturated with water in some horizon within a depth of 100 cm at some time and have *either* of the following characteristics within the horizon or horizons that are saturated:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Both a dominant chroma of 2 or less and mottles that are not due to segregated lime.

Aquic Nadurargids

FABC. Other Nadurargids that have the following combination of characteristics:

1. Do not have a duripan that is indurated in some subhorizon; *and*

2. A duripan 18 cm or deeper; *and*

3. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to clay to that depth is 1.0 or less, or that is one-seventh percent or more if the ratio of sand to clay is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a duripan that is shallower than 40 cm but deeper than 18 cm; *and*

4. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Haploxerollic Nadurargids

FABD. Other Nadurargids that do not have a platy or massive duripan that is indurated in some subhorizon.

Haplic Nadurargids

FABE. Other Nadurargids that have:

1. A duripan 18 cm or deeper; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to clay to that depth is 1.0 or less, or that is one-seventh percent or more if the ratio of sand to clay is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a duripan that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Nadurargids

FABF. Other Nadurargids.

Typic Nadurargids

Natrargids

Key to subgroups

FACA. Natrargids that have the following combination of characteristics:

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

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an

aridic moisture regime that borders on a xeric regime.

Lithic Xerollic Natrargids

FACB. Other Natrargids that have a lithic contact within 50 cm of the soil surface.

Lithic Natrargids

FACC. Other Natrargids that have the following combination of characteristics:

1. More than 10 percent of the ped surfaces deeper than 2.5 cm below the upper boundary of the natric horizon covered by skeletans; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but doeper than 18 cm; *and*

3. A frigid or colder temperature regime and an aridic moisture regime bordering on ustic.

Borollic Glossic Natrargids

FACD. Other Natrargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

2. A frigid or colder temperature regime and an aridic moisture regime bordering on ustic.

Borollic Natrargids

FACE. Other Natrargids that are saturated with water in some horizon within 100 cm of the surface at some time and have *either* of the following characteristics in the horizon or horizons that are saturated:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Both a dominant chroma of 2 or less and mottles that are not due to segregated lime.

Aquic Natrargids

FACF. Other Natrargids that have the following combination of characteristics:

1. A horizon within 100 cm of the surface that is more than 15 cm thick and that either contains 20 percent or more durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Natrargids

FACG. Other Natrargids that have a horizon within 100 cm of the surface that is more than 15 cm thick and that either contains 20 percent or more durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist.

Duric Natrargids

FACH. Other Natrargids that have the following combination of characteristics:

1. More than 10 percent of the ped surfaces deeper than 2.5 cm below the upper boundary of the natric horizon covered by skeletans; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. An aridic moisture regime that borders on ustic.

Glossic Ustollic Natrargids

FACI. Other Natrargids that have the following combination of characteristics:

1. An SAR of less than 13 or less than 15 percent saturation with sodium throughout the major part of the natric horizon; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13

or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on ustic.

Haplustollic Natrargids

FACJ. Other Natrargids that have the following combination of characteristics:

1. An SAR of less than 13 or less than 15 percent saturation with sodium throughout the major part of the natric horizon; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on xeric.

Haploxerollic Natrargids

FACK. Other Natrargids that have an SAR of less than 13 or less than 15 percent saturation with sodium throughout the major part of the natric horizon.

Haplic Natrargids

FACL. Other Natrargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

2. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on xeric.

Xerollic Natrargids

FACM. Other Natrargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average of sand to clay to that depth is 1.0 or less, or is one-seventh percent or more if the ratio is 13 or more, or is intermediate between 0.6 and one-seventh percent if the ratio is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact that is shallower than 40 cm but deeper than 18 cm; *and*

2. A mean annual soil temperature of 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Ustollic Natrargids

FACN. Other Natrargids that have more than 10 percent of the ped surfaces deeper than 2.5 cm below the upper boundary of the natric horizon covered by skeletans.

Glossic Natrargids

FACO. Other Natrargids.

Typic Natrargids

Paleargids

Key to subgroups

FADA. Paleargids that have the following combination of characteristics:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

2. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface, to the base of an Ap horizon, or to the top of the argillic horizon, and the cracks are not closed for as many as 60 consecutive days of the 120 days following the winter solstice in 3 or more years out of 10; *and*

3. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

4. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

5. A frigid or colder soil temperature regime.

Borollic Vertic Paleargids

FADB. Other Paleargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

2. A frigid or colder soil temperature regime and an aridic moisture regime that borders on an ustic regime.

Borollic Paleargids

FADC. Other Paleargids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface, to the base of an Ap horizon, or to the top of the argillic horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Paleargids

FADD. Other Paleargids that have the following combination of characteristics:

1. A petrocalcic horizon whose upper boundary is within 100 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Petrocalcic Xerollic Paleargids

FADE. Other Paleargids that have the following combination of characteristics:

1. A petrocalcic horizon whose upper boundary is within 100 cm of the soil surface; *and*

2. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

3. A mean annual soil temperature that is 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Petrocalcic Ustollic Paleargids

FADF. Other Paleargids that:

1. Have a petrocalcic horizon whose upper boundary is within 100 cm of the soil surface; *and*

2. Are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher; *and*

3. Have a mean annual soil temperature that is 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Petrocalcic Ustalfic Paleargids

FADG. Other Paleargids that have a petrocalcic horizon whose upper boundary is within 100 cm of the soil surface.

Petrocalcic Paleargids

FADH. Other Paleargids that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Duric Paleargids

FADI. Other Paleargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of

organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

2. A mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Paleargids

FADJ. Other Paleargids that have:

1. A weighted average percentage of organic carbon in the upper soil to a depth of 40 cm of 0.6 percent or more if the weighted average ratio of sand to clay above this depth is 1.0 or less, or one-seventh percent or less if the ratio is 13 or more, or an intermediate percentage of organic carbon if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon whose upper boundary is shallower than 40 cm but deeper than 18 cm; *and*

2. An aridic moisture regime that borders on an ustic regime.

Ustollic Paleargids

FADK. Other Paleargids that:

1. Are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more; and an aridic moisture regime that borders on a xeric regime.

Xeralfic Paleargids

FADL. Other Paleargids that:

1. Are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher; *and*

2. A mean annual soil temperature that is 8°C or higher and an aridic moisture regime that borders on an ustic regime.

Ustalfic Paleargids

FADM. Other Paleargids.

Typic Paleargids

ORTHIDS

Key to great groups

FBA. Orthids that have a salic horizon whose upper boundary is within 75 cm of the soil surface, and are saturated with water within a depth of 100 cm for 1 month or more in most years or have artificial drainage, and do not have a duripan that has an upper boundary within 100 cm of the soil surface.

Salorthids, p. 194

FBB. Other Orthids that have a petrocalcic horizon whose upper boundary is within 100 cm of the soil surface and which is *not* overlain by a duripan.

Paleorthids, p.192

FBC. Other Orthids that have a duripan whose upper boundary is within 100 cm of the soil surface.

Durorthids, p. 189

FBD. Other Orthids that have a gypsic or petrogypsic horizon whose upper boundary is within 100 cm of the soil surface.

Gypsiorthids, p. 192

FBE. Other Orthids that have a calcic horizon whose upper boundary is within 100 cm of the surface, and that are calcareous in all parts above the calcic horizon after the upper soil, to a depth of 18 cm, is mixed unless the texture is as coarse or coarser than loamy fine sand.

Calciorthids, p. 178

FBF. Other Orthids (that have a cambic horizon).

Camborthids, p. 182

Calciorthids

Key to subgroups

FBEA. Calciorthids that have the following combination of characteristics:

1. Have a frigid temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. Have a lithic contact within 50 cm of the surface; *and*

3. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm.

Borollic Lithic Calciorthids

FBEB. Other Calciorthids that have:

1. A frigid temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. A weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm.

Borollic Calciorthids

FBEC. Other Calciorthids that have the following combination of characteristics:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Lithic Xerollic Calciorthids

FBED. Other Calciorthids that have the following combination of characteristics:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. Have an aridic moisture regime that borders on an ustic regime.

Lithic Ustollic Calciorthids

FBEE. Other Calciorthids that have a lithic contact within 50 cm of the surface.

Lithic Calciorthids

FBEF. Other Calciorthids that have the following combination of characteristics:

1. Are saturated with water for 90 consecutive days or more in most years within 100 cm of the surface or have any of the following characteristics within a depth of 100 cm below the surface if the soil above that depth is saturated with water at some period in most years or the soil is artificially drained:

   a. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

   b. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

   c. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable Na) in more than half the thickness of the horizons between the surface and 50 cm than in the saturated zone; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Aquic Duric Calciorthids

FBEG. Other Calciorthids that are saturated with water for 90 consecutive days or more in most years within 100 cm of the surface or have any of the following characteristics within a depth of 100 cm below the surface if the soil above that depth is saturated with water at some period in most years or the soil is artificially drained:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable Na) in more than half the thickness of the horizons between the surface and 50 cm than in the saturated zone.

Aquic Calciorthids

FBEH. Other Calciorthids that have the following combination of characteristics:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to

clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Calciorthids

FBEI. Other Calciorthids that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Duric Calciorthids

FBEJ. Other Calciorthids that have the following combination of characteristics:

1. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Calciorthids

FBEK. Other Calciorthids that have the following combination of characteristics:

1. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Ustollic Calciorthids

FBEL. Other Calciorthids that are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm, and have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerochreptic Calciorthids

FBEM. Other Calciorthids that are dry in all parts of the moisture control section three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm and have an aridic moisture regime that borders on an ustic regime.

Ustochreptic Calciorthids

FBEN. Other Calciorthids that have reddish peds below the calcic horizon that are weakly calcareous or noncalcareous but that are thickly coated with lime.

Argic Calciorthids

FBEO. Other Calciorthids.

Typic Calciorthids

Camborthids

Key to subgroups

FBFA. Camborthids that have the following combination of characteristics:

1. Have a frigid or colder temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. Have a lithic contact within 50 cm of the surface; *and*

3. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm.

Borollic Lithic Camborthids

FBFB. Other Camborthids that have the following combination of characteristics:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist; *and*

2. Have a lithic contact within 50 cm of the surface; *and*

3. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more

if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

4. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Lithic Camborthids

FBFC. Other Camborthids that have the following combination of characteristics:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a lithic or paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Lithic Xerollic Camborthids

FBFD. Other Camborthids that have a lithic contact within 50 cm of the surface.

Lithic Camborthids

FBFE. Other Camborthids that have an SAR of more than 45, or 40 percent or more saturation with sodium, throughout the cambic horizon, and the saturated hydraulic conductivity is slow or very slow.

Natric Camborthids

FBFF. Other Camborthids that have the following combination of characteristics:

1. Have a frigid or colder temperature regime; *and*

2. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon, and the cracks are not closed for as many as 60 consecutive days of the 120 days following the winter solstice in 3 or more years out of 10; *and*

3. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

4. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

5. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13.

Borollic Vertic Camborthids

FBFG. Other Camborthids that have the following combination of characteristics:

1. Have a frigid or colder temperature regime and an aridic moisture regime that borders on an ustic regime; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm.

Borollic Camborthids

FBFH. Other Camborthids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

4. Have a thermic, mesic, or frigid soil temperature regime and have cracks that are closed for 60 consecutive days or more during the 120 days following the winter solstice in more than 7 years out of 10.

Xerertic Camborthids

FBFI. Other Camborthids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

4. In most years, unless irrigated, have cracks that remain open for 175 to 240 days, cumulative, and the cracks are not closed for as many as 60 consecutive days during the 120 days following the winter solstice in 3 or more years out of 10 if the soil temperature regime is thermic, mesic, or frigid.

Ustertic Camborthids

FBFJ. Other Camborthids that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

4. Unless the soils are irrigated, the cracks remain open in most years for more than 240 days, cumulative, and are not closed in most years for as many as 60 consecutive days at any season.

Vertic Camborthids

FBFK. Other Camborthids that have the following combination of characteristics:

1. Are saturated with water for 90 consecutive days or more within 100 cm of the surface in most years or have any of the following characteristics within 100 cm of the soil surface if the soil of that zone is saturated with water at some period in most years or the soil is artificially drained:

a. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

b. Dominant chroma of 2 or less and mottles that are due to segregation of iron or manganese; *or*

c. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable Na) in more than half the thickness of the horizons between the surface and a depth of 50 cm than in the saturated zone; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Aquic Duric Camborthids

FBFL. Other Camborthids that are saturated with water for 90 consecutive days or more within 100 cm of the surface in most years or have any of the following characteristics within 100 cm of the soil surface if the soil of that zone is saturated with water at some period in most years or the soil is artificially drained:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Dominant chroma of 2 or less and mottles that are due to segregation of iron or manganese; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable Na) in more than half the thickness of the horizons between the surface and a depth of 50 cm than in the saturated zone.

Aquic Camborthids

FBFM. Other Camborthids that:

1. Are dry in all parts of the moisture control section for three-fourths or less of the time (cumulative) that the soil temperature is 5°C or more at a depth of 50 cm unless the soil is irrigated, and have an aridic moisture regime that borders on a xeric moisture regime; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrixerandic Camborthids

FBFN. Other Camborthids that:

1. Are dry in all parts of the moisture control section for three-fourths or less of the time (cumulative) that the soil temperature is 5°C or more at a depth of 50 cm unless the soil is irrigated, and have an aridic moisture regime that borders on an ustic moisture regime and a hyperthermic, thermic, or mesic soil temperature regime; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrustandic Camborthids

FBFO. Other Camborthids that have the following combination of characteristics:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

3. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Durixerollic Camborthids

FBFP. Other Camborthids that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Duric Camborthids

FBFQ. Other Camborthids that have a content of organic carbon that decreases irregularly with depth below a depth of 25 cm or, unless a lithic or paralithic contact occurs at a shallower depth, has a level of 0.2 percent or more at a depth 125 cm below the surface.

Fluventic Camborthids

FBFR. Other Camborthids that:

1. Have an anthropic epipedon; *and*

2. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm.

Anthropic Camborthids

FBFS. Other Camborthids that:

1. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and an aridic moisture regime that borders on a xeric regime.

Xerollic Camborthids

FBFT. Other Camborthids that:

1. Have a weighted average percentage of organic carbon in the upper 40 cm that is 0.6 percent or more if the weighted average ratio of sand to clay in the soil above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate between 0.6 percent and one-seventh percent if the ratio of sand to clay is between 1.0 and 13; and a weighted average percentage of organic carbon in the soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a paralithic contact at a depth of less than 40 cm but more than 18 cm; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Ustollic Camborthids

FBFU. Other Camborthids that are dry in all parts of the moisture control section for three-fourths or less of the time (cumulative) that the soil temperature is 5°C or more at a depth of 50 cm unless the soil is irrigated, and have an aridic moisture regime that borders on a xeric moisture regime.

Xerochreptic Camborthids

FBFV. Other Camborthids that are dry in all parts of the moisture control section for three-fourths or less of the time (cumulative) that the soil temperature is 5°C or more at a depth of 50 cm unless the soil is irrigated, and have an aridic moisture regime that borders on an ustic moisture regime and a hyperthermic, thermic, or mesic soil temperature regime.

Ustochreptic Camborthids

FBFW. Other Camborthids.

Typic Camborthids

Durorthids

Key to subgroups

FBCA. Durorthids that have the following combination of characteristics:

1. Are saturated with water for 90 consecutive days or more in most years within 100 cm of the surface, or have one or more subhorizons within 100 cm of the soil surface with any of the following characteristics if the horizon is saturated with water at some period in most years, or the soil is artificially drained:

    a. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

    b. Dominant chroma of 2 or less accompanied by mottles that are not due to segregated lime; *or*

    c. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable sodium) in more than half the thickness of the horizons between the surface and 50 cm depth than in the saturated zone; *and*

2. Have a duripan that is not indurated in any subhorizon.

Aquentic Durorthids

FBCB. Other Durorthids that are saturated with water for 90 consecutive days or more in most years within 100 cm of the surface, or have one or more subhorizons within 100 cm of the soil surface with any of the following characteristics if the horizon is saturated with water at some period in most years, or the soil is artificially drained:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Dominant chroma of 2 or less accompanied by mottles that are not due to segregated lime; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable sodium) in more than half the thickness of the horizons between the surface and 50 cm depth than in the saturated zone.
Aquic Durorthids

FBCC. Other Durorthids that:

1. Are dry in all parts of the moisture control section for three-fourths or less of the time that the soil temperature at a depth of 50 cm is 5°C or higher, and have an aridic moisture regime that borders on a xeric regime; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrixerandic Durorthids

FBCD. Other Durorthids that:

1. Are dry in all parts of the moisture control section for three-fourths or less of the time that the soil temperature at a depth of 50 cm is 5°C or higher; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrustandic Durorthids

FBCE. Other Durorthids that have the following combination of characteristics:

1. Have a duripan that is not indurated in any subhorizon; *and*

2. Have a duripan whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to noncarbonate clay above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; *and*

3. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and have an aridic moisture regime that borders on a xeric regime.

Haploxerollic Durorthids

FBCF. Other Durorthids that have the following combination of characteristics:

1. Have a duripan that is not indurated in any subhorizon; *and*

2. Have a duripan whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to noncarbonate clay above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; *and*

3. Have an aridic moisture regime that borders on an ustic regime.

Haplustollic Durorthids

FBCG. Other Durorthids that have the following combination of characteristics:

1. Have a duripan whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to noncarbonate clay above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and have an aridic moisture regime that borders on a xeric regime.

Xerollic Durorthids

FBCH. Other Durorthids that are dry in all parts of the moisture control section for three-fourths or less of the time that the soil temperature at a depth of 50 cm is 5°C or higher, and have an aridic moisture regime that borders on a xeric regime.

Xerochreptic Durorthids

FBCI. Other Durorthids that have the following combination of characteristics:

1. Have a duripan whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 or more if the weighted average ratio of sand to noncarbonate clay above that depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Ustollic Durorthids

FBCJ. Other Durorthids that are dry in all parts of the moisture control section for three-fourths or less of the time that the soil temperature at a depth of 50 cm is 5°C or higher.

Ustochreptic Durorthids

FBCK. Other Durorthids that have a duripan that is not indurated in any subhorizon.

Entic Durorthids

FBCL. Other Durorthids.

Typic Durorthids

Gypsiorthids

Key to subgroups

FBDA. Gypsiorthids that have a petrogypsic horizon whose upper boundary is within 100 cm of the soil surface.

Petrogypsic Gypsiorthids

FBDB. Other Gypsiorthids that have a gypsic horizon in which the product of the percentage of gypsum and the thickness in centimeters above a depth of 150 cm is less than 3,000, and have a calcic horizon above the gypsic horizon.

Calcic Gypsiorthids

FBDC. Other Gypsiorthids that have a gypsic horizon in which the product of the percentage of gypsum and the thickness in centimeters above a depth of 150 cm is less than 3,000.

Cambic Gypsiorthids

FBDD. Other Gypsiorthids.

Typic Gypsiorthids

Paleorthids

Key to subgroups

FBBA. Paleorthids that:

1. Have a petrocalcic horizon whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm

that is 0.6 percent or more if the weighted average ratio of sand to noncarbonate clay to this depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; and have a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon that is shallower than 40 cm but deeper than 18 cm; *and*

2. Have a frigid or colder temperature regime and an aridic moisture regime that borders on an ustic regime.

Borollic Paleorthids

FBBB. Other Paleorthids that are saturated with water for 90 consecutive days or more in most years within 100 cm below the soil surface, or have one or more subhorizons with any of the following characteristics within 100 cm of the surface if the horizon is saturated with water at some period in most years, or the soil is artificially drained:

1. Dominant chroma of 1 or less throughout and hue of 2.5Y or yellower in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Both a dominant chroma of 2 or less and a greater SAR (or percentage of exchangeable Na) in more than half the thickness of the horizons between the surface and 50 cm depth than in the saturated zone.

Aquic Paleorthids

FBBC. Other Paleorthids that:

1. Have a petrocalcic horizon whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 percent or more if the weighted average ratio of sand to noncarbonate clay to this depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; and have a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon that is shallower than 40 cm but deeper than 18 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and have an aridic moisture regime that borders on a xeric regime.

Xerollic Paleorthids

FBBD. Other Paleorthids that:

1. Have a petrocalcic horizon whose upper boundary is 18 cm or deeper, and have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 percent or more if the weighted average ratio of sand to noncarbonate clay to this depth is 1.0 or less,

or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13; and have a weighted average percentage of organic carbon in the surface soil to a depth of 18 cm that is one-fifth or more higher than the values just stated if there is a petrocalcic horizon that is shallower than 40 cm but deeper than 18 cm; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Ustollic Paleorthids

FBBE. Other Paleorthids that:

1. Are dry in all parts of the moisture control section for three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm; *and*

2. Have a mean annual soil temperature lower than 22°C, mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more, and have an aridic moisture regime that borders on a xeric regime.

Xerochreptic Paleorthids

FBBF. Other Paleorthids that:

1. Are dry in all parts of the moisture control section for three-fourths or less of the time (cumulative) that the soil temperature is 5°C or higher at a depth of 50 cm; *and*

2. Have a mesic, thermic, or hyperthermic soil temperature regime and an aridic moisture regime that borders on an ustic regime.

Ustochreptic Paleorthids

FBBG. Other Paleorthids.

Typic Paleorthids

Salorthids

Key to subgroups

FBAA. Salorthids that have a weighted average content of organic carbon in the upper soil to a depth of 40 cm that is 0.6 percent or more if the weighted average ratio of sand to noncarbonate clay to this depth is 1.0 or less, or is 0.15 percent or more if the ratio is 13 or more, or is intermediate if the ratio of sand to clay is between 1.0 and 13.

Aquollic Salorthids

FBAB. Other Salorthids.

Typic Salorthids

Chapter 8

Entisols

KEY TO SUBORDERS

KA. Entisols that

1. Have sulfidic materials within 50 cm of the mineral soil surface; *or*

2. Are permanently saturated with water and have in all horizons below 25 cm

a. Dominant hue that is neutral or bluer than 10Y; *and*

b. Colors that change on exposure to the air; *or*

3. Are saturated with water at some time of year or are artificially drained and have, within 50 cm of the surface, dominant color (moist) in the matrix as follows:

a. In horizons that have texture finer than loamy fine sand in some or all subhorizons, or that have more than 35 percent (by volume) of rock fragments in some subhorizon:

(1) If there is mottling, chroma is 2 or less; *or*

(2) If there is no mottling and the value is less than 4, chroma is less than 1; if the value is 4 or more, chroma is 1 or less; *or*

b. In horizons that have texture of loamy fine sand or coarser in all subhorizons:

(1) If the hue is as red or redder than 10YR and there is mottling, chroma is 2 or less; if there is no mottling and the value is less than 4, chroma is less than 1; or if the value is 4 or more, chroma is 1 or less; *or*

(2) If the hue is between 10YR and 10Y and there is distinct or prominent mottling, chroma is 3 or less; if there is no mottling, chroma is 1 or less; *or*

(3) Hue is bluer than 10Y; *or*

(4) Any color if the color is due to uncoated grains of sand.

Aquents, p. 196

KB. Other Entisols that have 3 percent or more, by volume, fragments of diagnostic horizons in one or more subhorizons between 25 and 100 cm below the soil surface, and the fragments are not arranged in discernible order.

Arents, p. 202

KC. Other Entisols that have below the Ap horizon or below a depth of 25 cm, whichever is deeper, less than 35 percent (by volume) of rock fragments and that have texture of loamy fine sand or coarser in all subhorizons[1] either to a depth of 100 cm or to a lithic, paralithic, or petroferric contact, whichever is shallower.

Psamments, p. 217

KD. Other Entisols that do not have a lithic or paralithic contact within 25 cm of the soil surface and that have slopes of less than 25 percent and organic-carbon content that decreases irregularly with depth or remains above a level of 0.2 percent to a depth of 125 cm, and the mean annual soil temperature is higher than 0°C. (Strata of sand or loamy sand may have less organic carbon if finer sediments at a depth of 125 cm or below have 0.2 percent organic carbon or more).

Fluvents, p. 203

KE. Other Entisols.

Orthents, p. 209

AQUENTS

Key to great groups

KAA. Aquents that have sulfidic materials within 50 cm of the mineral soil surface.

Sulfaquents, p. 202

KAB. Other Aquents that have an *n* value of more than 0.7 and that have at least 8 percent clay in all subhorizons between a depth of 20 and 50 cm and that have a mean annual soil temperature higher than 0°C.

Hydraquents, p. 201

KAC. Other Aquents that have a cryic but not a pergelic[2] soil temperature regime.

Cryaquents, p. 197

KAD. Other Aquents that have an organic-carbon content[3] that decreases irregularly with depth or that remains above 0.2 percent to a depth of 125 cm; and that have texture finer than loamy fine sand in some or all subhorizons between the Ap horizon or a depth of 25 cm, whichever is deeper, and 100 cm or a lithic or paralithic contact, whichever is shallower. Thin strata of sand may have less organic carbon if the finer sediments at a depth of 125 cm or below have 0.2 percent organic carbon or more.

Fluvaquents, p. 197

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[1] Lamellae that are less than 1 cm thick or that are too few to meet the requirements for an argillic horizon are permitted to have texture of sandy loam. See the definition of an argillic horizon (Ch. 1).

[2] Soils that otherwise could be Aquents are grouped with Aquepts if there is permafrost.

[3] The carbon should be of Holocene age. It is not the intent to include 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.

KAE. Other Aquents that have a difference of less than 5°C between the mean summer and mean winter soil temperatures at a depth of 50 cm.

Tropaquents, p. 202

KAF. Other Aquents that have a sandy particle-size class in all subhorizons between the Ap horizon or a depth of 25 cm, whichever is deeper, and 100 cm or a lithic or paralithic contact, whichever is shallower, and that have mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more.

Psammaquents, p. 201

KAG. Other Aquents.

Haplaquents, p. 200

Cryaquents

Key to subgroups

KACA. Cryaquents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Cryaquents

KACB. Other Cryaquents.

Typic Cryaquents

Fluvaquents

Key to subgroups

KADA. Fluvaquents that have sulfidic materials within 100 cm of the mineral soil surface.

Sulfic Fluvaquents

KADB. Other Fluvaquents that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm

long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. The cracks are not open permanently; *and*

3. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

4. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Fluvaquents

KADC. Other Fluvaquents that:

1. Have a buried Histosol or a buried histic epipedon that has its upper boundary within 100 cm of the soil surface; *and*

2. Have a difference of less than 5°C between the mean summer and mean winter soil temperatures at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Thapto-Histic Tropic Fluvaquents

KADD. Other Fluvaquents that have a buried Histosol or a buried histic epipedon that has its upper boundary within 100 cm of the soil surface.

Thapto-Histic Fluvaquents

KADE. Other Fluvaquents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Fluvaquents

KADF. Other Fluvaquents that:

1. Have in more than 40 percent of the matrix in one or more subhorizons between the Ap horizon or a depth of

25 cm, whichever is deeper, and a depth of 75 cm, *one or more* of the following:

a. If mottled and

(1) If the hue is 2.5Y or redder[4] and the value, moist, is more than 5, the chroma, moist, is 3 or more; *or*

(2) If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

(3) If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

b. The chroma, moist, is 2 or more and there are no mottles; *and*

2. Have a difference of less than 5°C between the mean summer and mean winter soil temperatures at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Aeric Tropic Fluvaquents

KADG. Other Fluvaquents that have in more than 40 percent of the matrix in one or more subhorizons between the Ap horizon or a depth of 25 cm, whichever is deeper, and a depth of 75 cm, *one or more* of the following:

1. If mottled and

a. If the hue is 2.5Y or redder[5] and the value, moist, is more than 5, the chroma, moist, is 3 or more; *or*

b. If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

c. If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

2. The chroma, moist, is 2 or more and there are no mottles.

Aeric Fluvaquents

KADH. Other Fluvaquents that have a difference of less than 5°C between the mean summer and mean winter soil temperatures at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Tropic Fluvaquents

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[4] If the hue of the matrix is 7.5YR or redder and if peds are present, ped exteriors have dominant chroma, moist, of 1 or less, and ped interiors have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, is 1 or less immediately below any surface horizon that has value, moist, of 3 or less.

[5] If the hue of the matrix is 7.5YR or redder and if peds are present, ped exteriors have dominant chroma, moist, of 1 or less, and ped interiors have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, is 1 or less immediately below any surface horizon that has value, moist, of 3 or less.

KADI. Other Fluvaquents that:

1. Have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors; *and*

2. Have base saturation (by NH_4OAc) of less than 50 percent in some horizon and it does not increase to 50 percent or more within a depth of 100 cm below the soil surface.

Humaqueptic Fluvaquents

KADJ. Other Fluvaquents that:

1. Have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors; *and*

2. Have base saturation (by NH_4OAc) of 50 percent or more throughout the soil or it increases to 50 percent or more within a depth of 100 cm below the soil surface.

Mollic Fluvaquents

KADK. Other Fluvaquents.

Typic Fluvaquents

Haplaquents

Key to subgroups

KAGA. Haplaquents that have sulfidic materials within 100 cm of the mineral soil surface.

Sulfic Haplaquents

KAGB. Other Haplaquents that have a lithic contact within 50 cm of the soil surface.

Lithic Haplaquents

KAGC. Other Haplaquents that have in more than 40 percent of the matrix in one or more subhorizons between the Ap horizon or a depth of 25 cm, whichever is deeper, and 75 cm *one or more* of the following:

1. If mottled and

   a. If the hue is 2.5Y or redder[6] and the value, moist, is more than 5, the chroma, moist, is 3 or more; *or*

   b. If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

   c. If the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

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6 If the hue of the matrix is 7.5YR or redder and if peds are present, ped exteriors have dominant chroma, moist, of 1 or less, and ped interiors have mottles that have chroma, moist, of 2 or less; if peds are absent, the chroma, moist, is 1 or less immediately below any surface horizon that has value, moist, of 3 or less.

2. The chroma, moist, is 2 or more if there are no mottles.

Aeric Haplaquents

KAGD. Other Haplaquents that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors.

Mollic Haplaquents

KAGE. Other Haplaquents.

Typic Haplaquents

Hydraquents

Key to subgroups

KABA. All Hydraquents (provisionally).

Typic Hydraquents

Psammaquents

Key to subgroups

KAFA. Psammaquents that have a lithic contact within 50 cm of the soil surface.

Lithic Psammaquents

KAFB. Other Psammaquents that have an albic horizon at the surface or immediately under an A or Ap horizon that, in turn, is underlain by another horizon that has a color value more than one unit darker or that has chroma of 6 or more.

Spodic Psammaquents

KAFC. Other Psammaquents that:

1. Have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors; *and*

2. Have base saturation (by NH_4OAc) of less than 50 percent in more than half the thickness of the subhorizons within the upper 100 cm.

Humaqueptic Psammaquents

KADD. Other Psammaquents that:

1. Have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors; *and*

2. Have base saturation (by NH_4OAc) of 50 percent or more in more than half the thickness of the subhorizons within the upper 100 cm.

Mollic Psammaquents

KADE. Other Psammaquents.

Typic Psammaquents

Sulfaquents

Key to subgroups

KAAA. Sulfaquents that have sulfidic materials at a depth *of 30 cm or more* and an *n* value of less than 1.

Haplic Sulfaquents

KAAB. Other Sulfaquents.

Typic Sulfaquents

Tropaquents

The definition of the great group of Tropaquents that follows cannot be tested in the United States and is provisional.

Tropaquents are the Aquents that

1. Have an isomesic or warmer *iso* temperature regime; *and*

2. Have an *n* value of 0.7 or less or have less than 8 percent clay in some subhorizon between 20 and 50 cm; *and*

3. Have an organic-carbon content[7] that decreases regularly with depth below 25 cm and reaches a level of 0.2 percent or less within a *depth of* 125 *cm*.

Subgroups have not been defined.

ARENTS

Key to great groups

KBA. Arents that have an ustic soil moisture regime.

Ustarents, p. 203

KBB. Other Arents that have a xeric soil moisture regime.

Xerarents, p. 203

KBC. Other Arents that have a torric soil moisture regime.

Torriarents, p. 202

KBD. Other Arents.

Udarents, p. 203

Torriarents

Torriarents are the Arents that have a torric soil moisture regime.

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[7] The carbon should be of Holocene age. It is not the intent to include 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.

Udarents

Key to subgroups

KBDA. Udarents that have fragments of an argillic horizon that has base saturation (by sum of cations) that is 35 percent or more within the upper 100 cm of the soil.
Alfic Udarents

KBDB. Other Udarents that have fragments of an argillic horizon within the upper 100 cm of the soil.
Ultic Udarents

KBDC. Other Udarents that have fragments of a mollic epipedon within the upper 100 cm of the soil.
Mollic Udarents

KBDC. 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 that has base saturation (by sum of cations) that is 35 percent or more within the upper 100 cm of the soil.
Alfic Xerarents

KBBB. Other Xerarents.
Xerarents

FLUVENTS

Key to great groups

KDA. Fluvents that have a cryic soil temperature regime.
Cryofluvents, p. 204

KDB. Other Fluvents that have a xeric moisture regime.
Xerofluvents, p. 208

KDC. Other Fluvents that have an ustic moisture regime.
Ustifluvents, p. 208

KDD. Other Fluvents that have a torric moisture regime.
Torrifluvents, p. 204

KDE. Other Fluvents that have an isomesic, isothermic, or isohyperthermic temperature regime.
Tropofluvents, p. 207

KDF. Other Fluvents.
Udifluvents, p. 207

Cryofluvents

Key to subgroups

KDAA. Cryofluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryofluvents

KDAB. Other Cryofluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Cryofluvents

KDAC. Other Cryofluvents that have mottles that have chroma of 2 or less within 50 cm of the soil surface.

Aquic Cryofluvents

KDAD. Other Cryofluvents that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors.

Mollic Cryofluvents

KDAE. Other Cryofluvents.

Typic Cryofluvents

Torrifluvents

Key to subgroups

KDDA. Torrifluvents that:

1. Have *all three* of the following characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness within the upper 100 cm; *and*

2. Unless the soils are irrigated, the cracks remain open in most years from 175 to 240 days, cumulative, and are not closed for as many as 60 consecutive days during the 120 days following the winter solstice in 3 or more years out of 10 if the soil temperature regime is thermic, mesic, or frigid.

Ustertic Torrifluvents

KDDB. Other Torrifluvents that have *all three* of the following characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness within the upper 100 cm.

Vertic Torrifluvents

KDDC. Other Torrifluvents that:

1. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or more and they have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrixerandic Torrifluvents

KDDD. Other Torrifluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Torrifluvents

KDDE. Other Torrifluvents that:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains as much as 20 percent durinodes or is brittle and has firm consistence when moist; *and*

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or more and they have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime.

Durorthidic Xeric Torrifluvents

KDDD. Other Torrifluvents that have a horizon within 100 cm of the surface that is more than 15 cm thick that either contains as much as 20 percent durinodes or is brittle and has firm consistence when moist.

Durorthidic Torrifluvents

KDDE. Other Torrifluvents that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or more and they have a torric moisture regime that borders on an ustic regime.

Ustic Torrifluvents

KDDF. Other Torrifluvents that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or more and they have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime.

Xeric Torrifluvents

KDDG. Other Torrifluvents that have an anthropic epipedon.

Anthropic Torrifluvents

KDDH. Other Torrifluvents.

Typic Torrifluvents

Tropofluvents

Tropofluvents are the Fluvents that

1. Have an isomesic or warmer *iso* temperature regime; *and*

2. Have a udic moisture regime.

Only one series of Tropofluvents has been recognized in the United States, and subgroups have not been defined. It is suggested that the definition of the typic subgroup should parallel that of Typic Udifluvents in the great group that is defined next.

Udifluvents

Key to subgroups

KDFA. Udifluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Udifluvents

KDFB. Other Udifluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Udifluvents

KDFC. Other Udifluvents that have mottles within 50 cm of the surface that have chroma of 2 or less or, at a depth between 50 and 100 cm, have one or more horizons that are saturated with water at some period or that are artificially drained and have chroma less than 1 or hue bluer than 10Y and value, moist, of 4 or more.

Aquic Udifluvents

KDFD. Other Udifluvents that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors.

Mollic Udifluvents

KDFE. Other Udifluvents.

Typic Udifluvents

Ustifluvents

Key to subgroups

KDCA. Ustifluvents that have the following combination of characteristics:

1. Cracks at some period in most years, when the soil is not irrigated, that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Ustifluvents

KDCB. Other Ustifluvents that have mottles within 50 cm of the surface that have chroma of 2 or less or have, at a depth within 150 cm of the surface, a horizon that is saturated with water at some period or is artificially drained and that has chroma less than 1 or a hue bluer than 10Y.

Aquic Ustifluvents

KDCC. Other Ustifluvents that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors.

Mollic Ustifluvents

KDCD. Other Ustifluvents.

Typic Ustifluvents

Xerofluvents

Key to subgroups

KDBA. Xerofluvents that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Xerofluvents

KDBB. Other Xerofluvents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Xerofluvents

KDBC. Other Xerofluvents that:

1. Are saturated with water within 150 cm of the surface during any period in most years; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Aquic Durorthidic Xerofluvents

KDBD. Other Xerofluvents that are saturated with water within 150 cm of the surface during any period in most years.

Aquic Xerofluvents

KDBE. Other Xerofluvents that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Xerofluvents

KDBF. Other Xerofluvents that have an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less when crushed and smoothed, or the A horizon is 15 cm or more thick and has these colors.

Mollic Xerofluvents

KDBG. Other Xerofluvents.

Typic Xerofluvents

ORTHENTS

Key to great groups

KEA. Orthents that have a cryic or pergelic temperature regime.

Cryorthents, p. 210

KEB. Other Orthents that have a torric moisture regime.

Torriorthents, p. 211

KEC. Other Orthents that have a xeric moisture regime.
Xerorthents, p. 216

KED. Other Orthents that have a udic moisture regime and mean summer and mean winter soil temperatures at a depth of 50 cm that differ by less than 5°C.
Troporthents, p. 214

KEE. Other Orthents that have a udic moisture regime.
Udorthents, p. 214

KEF. Other Orthents.
Ustorthents, p. 215

Cryorthents

Key to subgroups

KEAA. Cryorthents that have a lithic contact within 50 cm of the soil surface.
Lithic Cryorthents

KEAB. Other Cryorthents that have a mean annual soil temperature that is 0°C or lower.
Pergelic Cryorthents

KEAC. Other Cryorthents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Cryorthents

KEAD. Other Cryorthents that have mottles that have chroma of 2 or less within 50 cm of the soil surface.
Aquic Cryorthents

KEAE. Other Cryorthents that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness.[8]
Alfic Cryorthents

KEAF. Other Cryorthents.
Typic Cryorthents

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[8] The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

Torriorthents

Key to subgroups

KEBA. Torriorthents that:

1. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or the base of an Ap horizon; *and*

   b. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

   c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. Unless irrigated, they have cracks that remain open from 175 to 240 days, cumulative, and are not closed for as many as 60 consecutive days during the 120 days following the winter solstice in 3 or more years out of 10 if the soil temperature regime is thermic, mesic, or frigid.

Ustertic Torriorthents

KEBB. Other Torriorthents that:

1. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or the base of an Ap horizon; *and*

   b. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

   c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. Have a thermic, mesic, or frigid soil temperature regime and have cracks that are closed for 60 consecutive days or more during the 120 days following the winter solstice in more than 7 years out of 10.

Xerertic Torriorthents

KEBC. Other Torriorthents that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm

long in some part, and that extend upward to the soil surface or the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Torriorthents

KEBD. Other Torriorthents that:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they either (1) have a hyperthermic or an iso soil temperature regime or (2) have a thermic, mesic or frigid soil temperature regime and have an aridic moisture regime that borders on an ustic regime.

Lithic Ustic Torriorthents

KEBE. Other Torriorthents that:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they have a thermic, mesic, or frigid soil temperature regime and an aridic moisture regime that borders on a xeric regime.

Lithic Xeric Torriorthents

KEBF. Other Torriorthents that have a lithic contact within 50 cm of the surface.

Lithic Torriorthents

KEBG. Other Torriorthents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Torriorthents

KEBH. Other Torriorthents that:

1. Are saturated with water within 150 cm of the surface at any time of year in most years; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Aquic Durorthidic Torriorthents

KEBI. Other Torriorthents that are saturated with water within 150 cm of the surface at any time of year in most years.

Aquic Torriorthents

KEBJ. Other Torriorthents that:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist; *and*

2. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they have a thermic, mesic, or frigid soil temperature regime and have a torric moisture regime that borders on a xeric regime.

Durorthidic Xeric Torriorthents

KEBK. Other Torriorthents that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Torriorthents

KEBL. Other Torriorthents that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they either (1) have a hyperthermic or an iso soil temperature regime or (2) have a thermic, mesic, or a frigid soil temperature regime and have an aridic moisture regime that borders on an ustic regime.

Ustic Torriorthents

KEBM. Other Torriorthents that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and they have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime.

Xeric Torriorthents

KEBN. Other Torriorthents.

Typic Torriorthents

Troporthents

Key to subgroups

KEDA. Troporthents that have a lithic contact within 50 cm of the soil surface.

Lithic Troporthents

KEDB. Other Troporthents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Troporthents

KEDC. Other Troporthents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Troporthents

KEDD. Other Troporthents.

Typic Troporthents

Udorthents

Key to subgroups

KEEA. Udorthents that have a lithic contact within 50 cm of the surface.

Lithic Udorthents

KEEB. Other Udorthents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Udorthents

KEEC. Other Udorthents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrandic Udorthents

KEED. Other Udorthents that are saturated with water for as long as 1 month within 150 cm of the surface.
Aquic Udorthents

KEEE. Other Udorthents that have 50 percent or more by volume of wormholes, wormcasts, and filled animal burrows between the bottom of the Ap horizon or a depth of 25 cm, whichever is deeper, and a depth of 100 cm or a lithic or paralithic or petroferric contact, whichever is shallower.
Vermic Udorthents

KEEF. Other Udorthents.
Typic Udorthents

Ustorthents

Key to subgroups

KEFA. Other Ustorthents that have a lithic contact within 50 cm of the surface.
Lithic Ustorthents

KEFB. Ustorthents that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.
Vertic Ustorthents

KEFC. Other Ustorthents that are saturated with water within 150 cm of the surface for as long as 1 month in most years.
Aquic Ustorthents

KEFD. Other Ustorthents that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.
Durorthidic Ustorthents

KEFE. Other Ustorthents that have 50 percent or more (by volume) wormholes, wormcasts, and filled animal burrows between the bottom of the Ap horizon or a depth of 25 cm, whichever is deeper, and a depth of 100 cm or a lithic or paralithic or petroferric contact, whichever is shallower.

Vermic Ustorthents

KEFF. Other Ustorthents.

Typic Ustorthents

Xerorthents

Key to subgroups

KECA. Xerorthents that have a lithic contact within 50 cm of the soil surface.

Lithic Xerorthents

KECB. Other Xerorthents that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Xerorthents

KECC. Other Xerorthents that:

1. Are saturated with water within 150 cm of the surface at any time of year in most years; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Aquic Durorthidic Xerorthents

KECD. Other Xerorthents that are saturated with water within 150 cm of the surface at any time of year in most years.

Aquic Xerorthents

KECE. Other Xerorthents that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Xerorthents

KECF. Other Xerorthents that have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface.
Dystric Xerorthents

KEDG. Other Xerorthents.
Typic Xerorthents

PSAMMENTS

Key to great groups

KCA. Psamments that have a cryic or pergelic soil temperature regime.
Cryopsamments, p. 217

KCB. Other Psamments that have a torric moisture regime.
Torripsamments, p. 219

KCC. Other Psamments that have, in the particle size control section, more than 90 percent silica minerals (quartz, chalcedony or opal) or other extremely durable minerals in the 0.02 to 2.0 mm fraction that are resistant to weathering.
Quartzipsamments, p. 218

KCD. Other Psamments that have a udic moisture regime and mean summer and mean winter soil temperatures at a depth of 50 cm that differ by 5°C or more.
Udipsamments, p. 220

KCE. Other Psamments that have a udic moisture regime.
Tropopsamments, p. 220

KCF. Other Psamments that have a xeric moisture regime.
Xeropsamments, p. 222

KCG. Other Psamments.
Ustipsamments, p. 221

Cryopsamments

Key to subgroups

KCAA. Cryopsamments that have a lithic contact within 50 cm of the soil surface.
Lithic Cryopsamments

KCAB. Other Cryopsamments that have a mean annual soil temperature that is 0°C or lower.
Pergelic Cryopsamments

KCAC. Other Cryopsamments that have mottles that have chroma of 2 or less within 50 cm of the soil surface.
Aquic Cryopsamments

KCAD. Other Cryopsamments that have an albic horizon that is 5 cm or more thick and underlain by a horizon that has a color value one unit or more darker and that meets all requirements of a spodic horizon except the index of accumulation.

Spodic Cryopsamments

KCAE. Other Cryopsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness.

Alfic Cryopsamments

KCAF. Other Cryopsamments.

Typic Cryopsamments

Quartzipsamments

Key to subgroups

KCCA. Quartzipsamments that have a lithic contact within 50 cm of the soil surface.

Lithic Quartzipsamments

KCCB. Other Quartzipsamments that:

1. Have mottles above a depth of 100 cm that have chroma of 2 or less or, if the color is due to uncoated sand grains, have the water table within 100 cm of the soil surface for 60 or more days, cumulative, in most years; *and*

2. Have an albic horizon[9] at the surface or immediately under an A or an Ap horizon that is underlain by another horizon that has a color value more than one unit darker or chroma of 6 or more; *and*

3. Have a difference of less than 5°C between the mean winter and mean summer soil temperatures at a depth of 50 cm.

Tropaquodic Quartzipsamments

KCCC. Other Quartzipsamments that:

1. Have mottles above a depth of 100 cm that have chroma of 2 or less or, if the color is due to uncoated sand grains, have a water table within 100 cm of the soil surface for 60 or more days, cumulative, in most years; *and*

2. Have an albic horizon[10] at the surface or immediately under an A or an Ap horizon that is underlain by another horizon that has a color value more than one unit darker or chroma of 6 or more.

Haplaquodic Quartzipsamments

KCCD. Other Quartzipsamments that have mottles above a depth of 100 cm that have chroma of 2 or less or, if the color is due to uncoated sand grains, have the water table

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[9] The albic horizon must be thick enough to be preserved after the soil to a depth of 18 cm is mixed.

[10] The albic horizon must be thick enough to be preserved after the soil to a depth of 18 cm is mixed.

within 100 cm of the soil surface for 60 or more days, cumulative, in most years.

Aquic Quartzipsamments

KCCE. Other Quartzipsamments that:

1. Have an ustic moisture regime; *and*

2. Have a clay fraction that has a CEC equal to that of the clay of an oxic horizon and have enough clay to coat at least 75 percent of the surfaces of the sand grains.

Ustoxic Quartzipsamments

KCCF. Other Quartzipsamments that

1. Have a udic moisture regime; *and*

2. Have a clay fraction that has a CEC equal to that of the clay of an oxic horizon and have enough clay to coat at least 75 percent of the surfaces of the sand grains.

Orthoxic Quartzipsamments

KCCG. Other Quartzipsamments that have 5 percent or more plinthite in one or more subhorizons above a depth of 100 cm.

Plinthic Quartzipsamments

KCCH. Other Quartzipsamments that have an ustic moisture regime.

Ustic Quartzipsamments

KCCI. Other Quartzipsamments that have a xeric moisture regime.

Xeric Quartzipsamments

KCCJ. Other Quartzipsamments that have an albic horizon[11] at the surface or immediately under an A or an Ap horizon that is underlain by another horizon that has a color value more than one unit darker or chroma of 6 or more.

Spodic Quartzipsamments

KCCK. 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:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent

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11 The albic horizon must be thick enough to be preserved after the soil to a depth of 18 cm is mixed.

or more durinodes or is brittle and has firm consistence when moist; *and*

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on xeric.

Durorthidic Xeric Torripsamments

KCBC. Other Torripsamments that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Torripsamments

KCBD. Other Torripsamments that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and have a torric moisture regime that borders on an ustic regime.

Ustic Torripsamments

KCBE. Other Torripsamments that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) that the soil temperature at a depth of 50 cm is 5°C or higher and have a thermic, mesic, or frigid soil temperature regime and a torric moisture regime that borders on a xeric regime.

Xeric Torripsamments

KCBF. Other Torripsamments.

Typic Torripsamments

Tropopsamments

Key to subgroups

KCEA. Tropopsamments that have a lithic contact within 50 cm of the soil surface.

Lithic Tropopsamments

KCEB. Tropopsamments that have mottles above a depth of 100 cm that have chroma of 2 or less, or if the color is due to uncoated sand grains, have a ground-water table within 100 cm of the soil surface for 60 or more cumulative days in most years.

Aquic Tropopsamments

KCEC. Other Tropopsamments.

Typic Tropopsamments

Udipsamments

Key to subgroups

KCDA. Udipsamments that have a lithic contact within a depth of 50 cm.

Lithic Udipsamments

KCDB. Other Udipsamments that have mottles that have chroma of 2 or less above a depth of 100 cm.

Aquic Udipsamments

KCDC. Other Udipsamments that have an albic horizon that is thick enough to be preserved after the soil has been mixed to a depth of 18 cm and is underlain by a horizon that has a color value one unit or more darker and that meets all requirements for a spodic horizon except the index of accumulation.

Spodic Udipsamments

KCDD. Other Udipsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness[12], and either have base saturation of 35 percent or more at a depth of 125 cm below the uppermost lamella or have a frigid temperature regime.

Alfic Udipsamments

KCDE. Other Udipsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness.[13]

Ultic Udipsamments

KCDF. Other Udipsamments that have a surface horizon between 25 and 50 cm thick that meets all requirements for a plaggen epipedon except thickness.

Plaggeptic Udipsamments

KCDG. Other Udipsamments.

Typic Udipsamments

Ustipsamments

Key to subgroups

KCGA. Ustipsamments that have a lithic contact within 50 cm of the surface.

Lithic Ustipsamments

KCGB. Other Ustipsamments that have distinct or prominent mottles above a depth of 100 cm or are saturated with water within 100 cm of the surface during some time of year in most years.

Aquic Ustipsamments

KCGC. Other Ustipsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness[14] and base

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12 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

13 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

14 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

saturation of 35 percent or more at a depth of 125 cm below the uppermost lamella.

Alfic Ustipsamments

KCGD. Other Ustipsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness.[15]

Ultic Ustipsamments

KCGE. Other Ustipsamments.

Typic Ustipsamments

Xeropsamments

Key to subgroups

KCFA. Xeropsamments that have a lithic contact within 50 cm of the soil surface.

Lithic Xeropsamments

KCFB. Other Xeropsamments that:

1. Have distinct or prominent mottles above a depth of 100 cm or are saturated with water within 100 cm of the surface during some time of year in most years; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes in a nonbrittle matrix or is brittle and has firm consistence when moist.

Aquic Durorthidic Xeropsamments

KCFC. Other Xeropsamments that have distinct or prominent mottles above a depth of 100 cm or are saturated with water within 100 cm of the surface during some time of year in most years.

Aquic Xeropsamments

KCFD. Other Xeropsamments that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains 20 percent or more durinodes or is brittle and has firm consistence when moist.

Durorthidic Xeropsamments

KCFE. Other Xeropsamments that have lamellae within 150 cm of the soil surface that meet all requirements for an argillic horizon except thickness[16] and have base saturation of 35 percent or more at a depth of 125 cm below the uppermost lamella.

Alfic Xeropsamments

KCFF. Other Xeropsamments that have lamellae within

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15 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

16 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

150 cm of the soil surface that meet all requirements for an argillic horizon except thickness.[17]

Ultic Xeropsamments

KCFG. Other Xeropsamments that have base saturation (by NH_4OAc) of less than 60 percent throughout the soil between depths of 25 and 75 cm below the soil surface.

Dystric Xeropsamments

KCFH. Other Xeropsamments.

Typic Xeropsamments

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17 The clay content cannot be estimated with precision in lamellae that are very thin. The lamellae in soils of alfic subgroups generally are about 0.5 to 1 cm thick, but their total thickness is less than the 15 cm required for an argillic horizon.

Chapter 9

Histosols

KEY TO SUBORDERS

AA. Histosols that are never saturated with water for more than a few days following heavy rains; *and*

1. Have a lithic or paralithic contact less than 100 cm from the surface or have fragmental materials in which the interstices are filled or partly filled with organic materials in half or more of each pedon, or both; *and*

2. Less than three-fourths of the thickness of organic materials consists of *Sphagnum* fibers.

Folists, p. 231

AB. Other Histosols that

1. Are dominantly[1] fibric in the subsurface tier if that tier is wholly organic except for a thin mineral layer or layers, or the organic parts of the surface and subsurface tiers are dominantly fibric if a continuous mineral layer 40 cm or more thick begins within the depth limit of the subsurface tier; *or*

2. Have a surface mantle that has three-fourths or more of its volume consisting of fibers derived from *Sphagnum* and that rests on a lithic or paralithic contact, fragmental materials, or mineral soil, or on frozen[2] materials within the limits in depth of the surface or subsurface tier; *and*

3. Do not have a sulfuric horizon whose upper boundary is within 50 cm of the surface and do not have sulfidic materials within 100 cm of the surface.

Fibrists, p. 226

AC. Other Histosols that

1. Are dominantly hemic in the subsurface tier if that tier is wholly organic except for a thin mineral layer or layers; or are dominantly hemic in the organic part of the surface and subsurface tiers if a continuous mineral layer 40 cm or more thick begins within the depth limits of the subsurface tier; *or*

2. Have a sulfuric horizon whose upper boundary is within 50 cm of the surface or have sulfidic materials within 100 cm of the surface.

Hemists, p. 232

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[1] Dominant, in this context, means the most abundant. If only two kinds of organic materials are present, the fibric materials occupy half or more of the volume. If there are both hemic and sapric materials as well as fibric, the fibric materials may occupy less than half of the volume but have more volume than either the hemic or sapric materials.

[2] Frozen 2 months after the summer solstice.

AD. Other Histosols.

Saprists, p. 237

FIBRISTS

Key to great groups

ABA. Fibrists that have a surface mantle that is three-fourths or more fibric *Sphagnum* spp. and that either is 90 cm or more thick, or extends 10 cm or more below permafrost, or rests on a lithic or paralithic contact, fragmental materials, or mineral soil materials.

Sphagnofibrists, p. 229

ABB. Other Fibrists that are frozen in most years in some layer within the control section about 2 months after the summer solstice or that are never frozen in most years below a depth of 5 cm but have a mean annual soil temperature that is lower than 8°C.

Cryofibrists, p. 227

ABC. Other Fibrists that have a mean annual soil temperature lower than 8°C.

Borofibrists, p. 226

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.

Tropofibrists, p. 230

ABE. Other Fibrists that do not have a horizon 2 cm or more thick consisting of half or more humilluvic materials.

Medifibrists, p. 228

ABF. Other Fibrists.

Luvifibrists, p. 228

Borofibrists

Key to subgroups

ABCA. Borofibrists that have a layer of water within the control section below the surface tier.

Hydric Borofibrists

ABCB. Other Borofibrists that have a lithic contact within the control section.

Lithic Borofibrists

ABCC. Other Borofibrists that:

1. Have three-fourths or more of the fibers (by volume) derived from *Sphagnum* in the surface tier or more of the control section; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sphagnic Terric Borofibrists

ABCD. Other Borofibrists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Borofibrists

ABCE. Other Borofibrists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Borofibrists

ABCF. Other Borofibrists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Borofibrists

ABCG. Other Borofibrists that have limnic layer(s) within the control section 5 cm or more thick.

Limnic Borofibrists

ABCH. Other Borofibrists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Borofibrists

ABCI. Other Borofibrists that have three-fourths or more of the fibers (by volume) derived from *Sphagnum* in the surface tier or more of the control section.

Sphagnic Borofibrists

ABCJ. Other Borofibrists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Borofibrists

ABCK. Other Borofibrists that have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials.

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 that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Cryofibrists

ABBD. Other Cryofibrists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Cryofibrists

ABBE. Other Cryofibrists that have three-fourths or more of their fiber volume derived from *Sphagnum* spp. in the surface tier or more of the control section.

Sphagnic Cryofibrists

ABBF. Other Cryofibrists.

Typic Cryofibrists

Luvifibrists

Luvifibrists are not known to occur in the United States, but the great group is provided tentatively for use in other countries if needed. These soils are the Fibrists that have a horizon within the control section that is 2 cm or more thick consisting of half or more humilluvic materials. Because these soils cannot be studied in the United States, a precise definition is not attempted here. It should be noted, however, that the soils normally are acid and that they have been cultivated for a long time.

Medifibrists

Key to subgroups

ABEA. Medifibrists that have a layer of water within the control section below the surface tier.

Hydric Medifibrists

ABEB. Other Medifibrists that have a lithic contact within the control section.

Lithic Medifibrists

ABEC. Other Medifibrists that:

1. Have three-fourths or more of the fibers (by volume) derived from *Sphagnum* in the surface tier or more of the control section; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sphagnic Terric Medifibrists

ABED. Other Medifibrists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Medifibrists

ABEE. Other Medifibrists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Medifibrists

ABEF. Other Medifibrists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Medifibrists

ABEG. Other Medifibrists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Medifibrists

ABEH. Other Medifibrists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Medifibrists

ABEI. Other Medifibrists that have three-fourths or more of the fiber volume in the surface tier or more of the control section derived from *Sphagnum*.

Sphagnic Medifibrists

ABEJ. Other Medifibrists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Medifibrists

ABEK. Other Medifibrists that have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials.

Sapric Medifibrists

ABEL. Other Medifibrists.

Typic Medifibrists

Sphagnofibrists

Key to subgroups

ABAA. Sphagnofibrists that:

1. Have a mean annual soil temperature of 0°C or less; *and*

2. Are frozen within the control section about 2 months after the summer solstice or are frozen below a depth of 5 cm in most years.

Pergelic Sphagnofibrists

ABAB. Other Sphagnofibrists that have a layer of water within the control section beneath the surface tier.

Hydric Sphagnofibrists

ABAC. Other Sphagnofibrists that have a lithic contact within the control section.

Lithic Sphagnofibrists

ABAD. Other Sphagnofibrists that are frozen within the control section about 2 months after the summer solstice or are frozen below a depth of 5 cm in most years and have a mean annual soil temperature lower than 8°C but higher than 0°C.

Cryic Sphagnofibrists

ABAE. Other Sphagnofibrists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Sphagnofibrists

ABAF. Other Sphagnofibrists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Sphagnofibrists

ABAG. Other Sphagnofibrists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Sphagnofibrists

ABAH. Other Sphagnofibrists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Sphagnofibrists

ABAI. Other Sphagnofibrists that have 12.5 cm or more of the subsurface and bottom tiers consisting of sapric materials.

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 that:

1. Have 25 cm or more of the thickness of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Tropofibrists

ABDD. Other Tropofibrists that:

1. Have 12.5 cm or more of the thickness of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Tropofibrists

ABDE. Other Tropofibrists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Tropofibrists

ABDF. Other Tropofibrists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Tropofibrists

ABDG. Other Tropofibrists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Tropofibrists

ABDH. Other Tropofibrists that have 25 cm or more of the thickness of the subsurface and bottom tiers consisting of hemic materials.

Hemic Tropofibrists

ABDI. Other Tropofibrists that have 12.5 cm or more of the thickness of the subsurface and bottom tiers consisting of sapric materials.

Sapric Tropofibrists

ABDJ. Other Tropofibrists.

Typic Tropofibrists

FOLISTS

Key to great groups

AAA. Folists that have a cryic or colder temperature regime.

Cryofolists, p. 232

AAB. Other Folists that have an isomesic or warmer temperature regime.

Tropofolists, p. 232

AAC. Other Folists that have a frigid temperature regime.

Borofolists, p. 232

Borofolists

Key to subgroups

AACA. Borofolists that have a lithic contact within 100 cm of the surface.

Lithic Borofolists

AACB. Other Borofolists.

Typic Borofolists

Cryofolists

Key to subgroups

AAAA. Cryofolists that have a lithic contact within 100 cm of the surface.

Lithic Cryofolists

AAAB. Other Cryofolists.

Typic Cryofolists

Tropofolists

Key to subgroups

AABA. Tropofolists that have a lithic contact within 100 cm of the surface.

Lithic Tropofolists

AABB. Other Tropofolists.

Typic Tropofolists

HEMISTS

Key to great groups

ACA. Hemists that have a sulfuric horizon that has its upper boundary within 50 cm of the surface.

Sulfohemists, p. 235

ACB. Other Hemists that have sulfidic materials within 100 cm of the surface.

Sulfihemists, p. 235

ACC. Other Hemists that have a horizon 2 cm or more thick in which half or more of the volume is humilluvic materials.

Luvihemists, p. 234

ACD. Hemists that are frozen in some layers within the control section about 2 months after the summer solstice in most years or that are never frozen below a depth of 5 cm in most years but have a mean annual soil temperature lower than 8°C.

Cryohemists, p. 234

ACE. Other Hemists that have a mean annual soil temperature lower than 8°C.

Borohemists, p. 233

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.

Tropohemists, p. 236

ACG. Other Hemists.

Medihemists, p. 234

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 that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Borohemists

ACED. Other Borohemists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Borohemists

ACEE. Other Borohemists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Borohemists

ACEF. Other Borohemists that have limnic layer(s) 5 cm or more thick within the control section.

Limnic Borohemists

ACEG. Other Borohemists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Borohemists

ACEH. Other Borohemists that have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Borohemists

ACEI. Other Borohemists that have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials.

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°C or lower.

Pergelic Cryohemists

ACDC. Other Cryohemists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Cryohemists

ACDD. Other Cryohemists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Cryohemists

ACDE. Other Cryohemists.

Typic Cryohemists

Luvihemists

Luvihemists are not known to occur in the United States but the great group is provided tentatively for use in other countries if needed. They are the Hemists that have a horizon that is 2 cm or more thick within the control section, and half or more of the volume of that horizon consists of humilluvic materials. Because these soils cannot be studied in the United States, a precise definition is not attempted here. It should be noted, however, that they are normally acid and that they have been cultivated for a long time.

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 that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Medihemists

ACGD. Other Medihemists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Medihemists

ACGE. Other Medihemists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Medihemists

ACGF. Other Medihemists that have limnic layer(s) 5 cm or more thick within the control section.

Limnic Medihemists

ACGG. Other Medihemists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Medihemists

ACGH. Other Medihemists that have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Medihemists

ACGI. Other Medihemists that have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials.

Sapric Medihemists

ACGJ. Other Medihemists.

Typic Medihemists

Sulfihemists

Key to subgroups

ACBA. Sulfihemists that have a mineral layer 30 cm or more thick that has its upper boundary in 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 that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Tropohemists

ACFD. Other Tropohemists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Sapric Terric Tropohemists

ACFE. Other Tropohemists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Tropohemists

ACFF. Other Tropohemists that have limnic layer(s) 5 cm or more thick within the control section.

Limnic Tropohemists

ACFG. Other Tropohemists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Tropohemists

ACFH. Other Tropohemists that have 25 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Tropohemists

ACFI. Other Tropohemists that have 25 cm or more of the subsurface and bottom tiers consisting of sapric materials.

Sapric Tropohemists

ACFJ. Other Tropohemists.

Typic Tropohemists

SAPRISTS

Key to great groups

ADA. Saprists that are frozen in some layer within the control section about 2 months after the summer solstice or that are never frozen below a depth of 5 cm but have a mean annual soil temperature lower than 8°C.

Cryosaprists, p. 238

ADB. Other Saprists that have a mean annual soil temperature lower than 8°C.

Borosaprists, p. 237

ADC. Other Saprists that have less than 5°C difference between mean summer and mean winter soil temperatures at a depth of 30 cm.

Troposaprists, p. 239

ADD. Other Saprists that do not have a horizon of humilluvic materials 2 cm or more thick.

Medisaprists, p. 238

Borosaprists

Key to subgroups

ADBA. Borosaprists that have a lithic contact within the control section.

Lithic Borosaprists

ADBB. Other Borosaprists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Borosaprists

ADBC. Other Borosaprists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Borosaprists

ADBD. Other Borosaprists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Borosaprists

ADBE. Other Borosaprists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Borosaprists

ADBF. Other Borosaprists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Borosaprists

ADBG. Other Borosaprists that have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Borosaprists

ADBH. Other Borosaprists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Borosaprists

ADBI. Other Borosaprists.

Typic Borosaprists

Cryosaprists

Key to subgroups

ADAA. Cryosaprists that have a lithic contact within the control section.

Lithic Cryosaprists

ADAB. Other Cryosaprists that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryosaprists

ADAC. Other Cryosaprists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Cryosaprists

ADAD. Other Cryosaprists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Cryosaprists

ADAE. Other Cryosaprists.

Typic Cryosaprists

Medisaprists

Key to subgroups

ADDA. Medisaprists that have a lithic contact within the control section.

Lithic Medisaprists

ADDB. Other Medisaprists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Medisaprists

ADDC. Other Medisaprists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Medisaprists

ADDD. Other Medisaprists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Medisaprists

ADDE. Other Medisaprists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Medisaprists

ADDF. Other Medisaprists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Medisaprists

ADDG. Other Medisaprists that have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Medisaprists

ADDH. Other Medisaprists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Medisaprists

ADDI. Other Medisaprists.

Typic Medisaprists

Troposaprists

Key to subgroups

ADCA. Troposaprists that have a lithic contact within the control section.

Lithic Troposaprists

ADCB. Other Troposaprists that:

1. Have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Fibric Terric Troposaprists

ADCC. Other Troposaprists that:

1. Have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials; *and*

2. Have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Hemic Terric Troposaprists

ADCD. Other Troposaprists that have a mineral layer 30 cm or more thick that has its upper boundary in the control section below the surface tier.

Terric Troposaprists

ADCE. Other Troposaprists that have limnic layer(s) that are 5 cm or more thick within the control section.

Limnic Troposaprists

ADCF. Other Troposaprists that have a mineral layer between 5 and 30 cm thick or two or more thin, continuous mineral layers, within organic materials, in the control section below the surface tier.

Fluvaquentic Troposaprists

ADCG. Other Troposaprists that have 12.5 cm or more of the subsurface and bottom tiers consisting of fibric materials.

Fibric Troposaprists

ADCH. Other Troposaprists that have 25 cm or more of the subsurface and bottom tiers consisting of hemic materials.

Hemic Troposaprists

ADCI. Other Troposaprists.

Typic Troposaprists

Chapter 10

Inceptisols

KEY TO SUBORDERS

JA. Inceptisols that

1. Have an aquic moisture regime or are artificially drained and have *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. An umbric or mollic epipedon that is underlain immediately or at a depth of less than 50 cm below the soil surface by a horizon that has dominant colors, moist, on ped faces, or in the matrix if peds are absent, as follows:

(1) If there is mottling, chroma is 2 or less;[1] *or*

(2) If there is no mottling, chroma is 1 or less; *or*

d. An ochric epipedon that is underlain at a depth of less than 50 cm below the mineral soil surface by a cambic horizon or a fragipan, either or both of which have dominant color, moist, on ped faces, or in the matrix if peds are absent as follows:

(1) If there is mottling, chroma is 2 or less;[2] *or*

(2) If there is no mottling, chroma is 1 or less; *or*

2. Have an SAR of 13 or more (or sodium saturation that is 15 percent or more) in half or more of the soil to a depth of 50 cm that decreases with depth below 50 cm, and ground water within 100 cm of the surface at some time of the year.

Aquepts, p. 242

JB. Other Inceptisols that have a plaggen epipedon.

Plaggepts, p. 263

JC. Other Inceptisols that have an isomesic or warmer iso temperature regime.

Tropepts, p. 263

JD. Other Inceptisols that have an ochric epipedon; or that have an umbric or mollic epipedon that is less than 25 cm thick and have also a mesic or warmer soil temperature regime.

Ochrepts, p. 251

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1 If the hue is redder than 10YR because of red parent materials that remain red after citrate-dithionite extraction, the requirement for low chroma is waived.

2 If the hue is redder than 10YR because of red parent materials that remain red after citrate-dithionite extraction, the requirement for low chroma is waived.

JE. Other Inceptisols.

Umbrepts, p. 269

AQUEPTS

Key to great groups

JAA. Aquepts that have a sulfuric horizon whose upper boundary is within 50 cm of the mineral soil surface.

Sulfaquepts, p. 249

JAB. Other Aquepts that have a placic horizon within 100 cm of the mineral soil surface in half or more of each pedon.

Placaquepts, p. 248

JAC. Other Aquepts that have an SAR of 13 or more (or have sodium saturation that is 15 percent or more) in half or more of the upper 50 cm of soil that decreases with depth below 50 cm.

Halaquepts, p. 244

JAD. Other Aquepts that have a fragipan.

Fragiaquepts, p. 244

JAE. Other Aquepts that have a cryic or pergelic soil temperature regime.

Cryaquepts, p. 242

JAF. Other Aquepts that have plinthite that forms a continuous phase or constitutes more than half the matrix within some subhorizon in the upper 125 cm of the soil.

Plinthaquepts, p. 249

JAG. Other Aquepts that have a difference of less than 5°C between the mean summer and mean winter soil temperatures at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

Tropaquepts, p. 249

JAH. Other Aquepts that have an umbric, a mollic, or a histic epipedon.

Humaquepts, p. 247

JAI. Other Aquepts.

Haplaquepts, p. 245

Cryaquepts

Key to subgroups

JAEA. Cryaquepts that have a histic epipedon and have a lithic contact within 50 cm of the soil surface.

Histic Lithic Cryaquepts

JAEB. Other Cryaquepts that:

1. Have a histic epipedon that is continuous in each pedon; *and*

2. Have a mean annual soil temperature that is 0°C or lower.

Histic Pergelic Cryaquepts

JAEC. Other Cryaquepts that:

1. Have a histic epipedon that is discontinuous in each pedon; *and*

2. Have a mean annual soil temperature that is 0°C or lower.

Pergelic Ruptic-Histic Cryaquepts

JAED. Other Cryaquepts that:

1. Have an umbric epipedon; *and*

2. Have a mean annual soil temperature that is 0°C or lower.

Humic Pergelic Cryaquepts

JAEE. Other Cryaquepts that have a mean annual soil temperature that is 0°C or lower.

Pergelic Cryaquepts

JAEF. Other Cryaquepts that have a histic epipedon.

Histic Cryaquepts

JAEG. Other Cryaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Cryaquepts

JAEH. Other Cryaquepts that:

1. Have chroma of 3 or more in more than 40 percent of the mass of one or more horizons between depths of 15 and 50 cm; *and*

2. Have an umbric epipedon.

Aeric Humic Cryaquepts

JAEI. Other Cryaquepts that have chroma of 3 or more in more than 40 percent of the mass of one or more horizons between depths of 15 and 50 cm.

Aeric Cryaquepts

JAEJ. Other Cryaquepts that have an umbric epipedon.

Humic Cryaquepts

JAEK. Other Cryaquepts.

Typic Cryaquepts

Fragiaquepts

Key to subgroups

JADA. Fragiaquepts that have in more than 40 percent of the matrix of one or more subhorizons between the plow layer and 75 cm or, if there is no plow layer, between a depth of 15 and 75 cm, moist colors as follows:

1. If there is mottling, chroma of 3 or more; *or*

2. If there is no mottling, chroma of 2 or more.

Aeric Fragiaquepts

JADB. Other Fragiaquepts that have a histic, mollic, or umbric epipedon.

Humic Fragiaquepts

JADC. Other Fragiaquepts.

Typic Fragiaquepts

Halaquepts

Key to subgroups

JACA. Halaquepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Halaquepts

JACB. Other Halaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2

acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Halaquepts

JACC. Other Halaquepts that have chroma of 3 or more in more than 40 percent of the matrix in one or more subhorizons between depths of 15 and 75 cm.

Aeric Halaquepts

JACD. Other Halaquepts that have a mollic epipedon.

Mollic Halaquepts

JACE. Other Halaquepts.

Typic Halaquepts

Haplaquepts

Key to subgroups

JAIA. Haplaquepts that have *one or both* of the following:

1. Jarosite mottles and a pH between 3.5 and 4.0 (1:1 water, air dried slowly in shade) in some subhorizon within 50 cm of the soil surface; *or*

2. Jarosite mottles and a pH of less than 4.0 (1:1 water, air dried slowly in shade) in some subhorizon between depths of 50 and 150 cm.

Sulfic Haplaquepts

JAIB. Other Haplaquepts that have a lithic contact within 50 cm of the soil surface.

Lithic Haplaquepts

JAIC. Other Haplaquepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplaquepts

JAID. Other Haplaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Haplaquepts

JAIE. Other Haplaquepts that have in more than 40 percent of the matrix in one or more subhorizons between the A or Ap horizon and a depth of 75 cm, *one or more* of the following:

1. If mottled and the mean annual soil temperature is lower than 15°C, moist chroma of 3 or more; *or*

2. If mottled and the mean annual soil temperature is 15°C or higher:

a. If the hue is 2.5Y or redder[3] and the value, moist, is more than 5, the chroma, moist, is 3 or more; *or*

b. If the hue is 2.5Y or redder and the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

c. If the hue is 5Y or yellower, the chroma, moist, is 3 or more; *or*

3. The chroma, moist, is 2 or more if mottles are not present.

Aeric Haplaquepts

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[3] If the hue is 7.5YR or redder in the matrix and if peds are present, the ped exteriors should have dominant chroma, moist, of 1 or less and the ped interiors should have mottles that have chroma, moist, of 2 or less; if there are no peds, the chroma, moist, should be 1 or less immediately below any surface horizon that has a value, moist, of less than 5.

JAIF. Other Haplaquepts that:

1. Have an Ap horizon that has a color value, moist, of 3 or less and a value, dry, of 5 or less when crushed and smoothed, or have an A horizon that is 15 cm or more thick if its color value, moist, is 3 or less; *and*

2. Have base saturation (by NH_4OAc) of less than 50 percent in some horizon and it does not increase with depth to a value of 50 percent or more.

Humic Haplaquepts

JAIG. Other Haplaquepts that:

1. Have an Ap horizon that has a color value, moist, of 3 or less and a value, dry, of 5 or less when crushed and smoothed, or have an A horizon that is 15 cm or more thick if its color value, moist, is 3 or less; *and*

2. Have base saturation (by NH_4OAc) of 50 percent or more throughout or it increases with depth to a value of 50 percent or more.

Mollic Haplaquepts

JAIH. Other Haplaquepts.

Typic Haplaquepts

Humaquepts

Key to subgroups

JAHA. Humaquepts that have an *n* value of 0.9 or more between depths of 50 and 80 cm, or of more than 0.7 in one or more layers between depths of 20 and 50 cm.

Hydraquentic Humaquepts

JAHB. Other Humaquepts that have a histic epipedon whose upper boundary is at or near the soil surface.

Histic Humaquepts

JAHC. Other Humaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Humaquepts

JAHD. Other Humaquepts that:

1. Have an epipedon that is 60 cm or more thick; *and*

2. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface.

Cumulic Humaquepts

JAHE. Other Humaquepts that have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface.

Fluvaquentic Humaquepts

JAHF. Other Humaquepts that have chroma of 3 or more, moist, and hue of 5Y or redder in more than 40 percent of the matrix in one or more subhorizons between depths of 15 and 75 cm.

Aeric Humaquepts

JAHG. Other Humaquepts.

Typic Humaquepts

Placaquepts

Key to subgroups

JABA. Placaquepts that have a histic epipedon.

Histic Placaquepts

JABB. Other Placaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Placaquepts

JABC. Other Placaquepts that do not have a continuous placic horizon within 100 cm of the soil surface throughout each pedon.

Haplic Placaquepts

JABD. Other Placaquepts.

Typic Placaquepts

Plinthaquepts

These are mainly Aquepts of intertropical regions. They have plinthite that forms a continuous phase or occupies more than half the matrix of some subhorizon deeper than 30 cm but within 125 cm of the soil surface. These are soils in which the ground-water level fluctuates appreciably during the year. Water is at or near the surface during the rainy season but drops during a dry season. Most of these soils are in relatively recent alluvium, probably of late- Pleistocene or Holocene age. Weatherable minerals are present in appreciable amounts. These soils are not known to occur in the United States, but the great group is provided because the soils are thought to be extensive in parts of the Amazon basin.

Sulfaquepts

Key to subgroups

JAAA. All Sulfaquepts (provisional).

Typic Sulfaquepts

Tropaquepts

Key to subgroups

JAGA. Tropaquepts that have *one or both* of the following:

1. Jarosite mottles and a pH between 3.5 and 4.0 (1:1 water, air dried slowly in shade) in some subhorizon within 50 cm of the soil surface; *or*

2. Jarosite mottles and a pH of less than 4.0 (1:1 water, air dried slowly in shade) in some subhorizon between depths of 50 and 150 cm.

Sulfic Tropaquepts

JAGB. Other Tropaquepts that have a lithic contact within 50 cm of the soil surface.

Lithic Tropaquepts

JAGC. Other Tropaquepts that have the following combination of characteristics:

1. Cracks at some time in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Tropaquepts

JAGD. Other Tropaquepts that have a histic epipedon that has its upper boundary at or near the surface.

Histic Tropaquepts

JAGE. Other Tropaquepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Tropaquepts

JAGF. Other Tropaquepts that have 5 percent or more (by volume) of plinthite in one or more subhorizons within 150 cm of the soil surface.

Plinthic Tropaquepts

JAGG. Other Tropaquepts that have in more than 40 percent of the matrix in one or more subhorizons between the A or Ap horizon and a depth of 75 cm *one or more* of the following:

1. If mottled and if the hue is 2.5Y or redder and the value, moist, is more than 5, the chroma, moist, is 3 or more; if the value, moist, is 5 or less, the chroma, moist, is 2 or more; *or*

2. If mottled and if the hue is yellower than 2.5Y, the chroma, moist, is 3 or more; *or*

3. The chroma, moist, is 2 or more if not mottled.

Aeric Tropaquepts

JAGH. Other Tropaquepts.

Typic Tropaquepts

OCHREPTS

Key to great groups

JDA. Ochrepts that have a fragipan.

Fragiochrepts, p. 257

JDB. Other Ochrepts that have a duripan whose upper boundary is within 100 cm of the soil surface.

Durochrepts, p. 252

JDC. Other Ochrepts that have a cryic or pergelic temperature regime.

Cryochrepts, p. 251

JDD. Other Ochrepts that have an ustic moisture regime.

Ustochrepts, p. 258

JDE. Other Ochrepts that have a xeric moisture regime.

Xerochrepts, p. 260

JDF. Other Ochrepts that have *one or both* of the following:

1. Carbonates in the cambic horizon or in the C horizon but within the soil; *or*

2. Base saturation (by NH_4OAc) that is 60 percent or more in some subhorizon between depths of 25 and 75 cm below the soil surface.

Eutrochrepts, p. 255

JDG. Other Ochrepts.

Dystrochrepts, p. 253

Cryochrepts

Key to subgroups

JDCA. Cryochrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Cryochrepts

JDCB. Other Cryochrepts that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryochrepts

JDCC. Other Cryochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryochrepts

JDCD. Other Cryochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Cryochrepts

JDCE. Other Cryochrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage.

Aquic Cryochrepts

JDCF. Other Cryochrepts that have lamellae within 75 cm of the soil surface that meet all requirements for an argillic horizon except thickness.

Alfic Cryochrepts

JDCG. Other Cryochrepts that have base saturation (by NH_4OAc) that is less than 60 percent in all subhorizons within 75 cm of the surface.

Dystric Cryochrepts

JDCH. Other Cryochrepts.

Typic Cryochrepts

Durochrepts

Key to subgroups

JDBA. Durochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Durochrepts

JDBB. Other Durochrepts that have distinct or prominent mottles within the upper 30 cm.

Aquic Durochrepts

JDBC. Other Durochrepts that do not have a xeric moisture regime.

Ustic Durochrepts

JDBD. Other Durochrepts that:

1. Do not have a platy or massive indurated duripan; *and*

2. Have base saturation (by NH_4OAc) of less than 60 percent throughout the soil between depths of 25 and 75 cm below the soil surface.

Dystric Entic Durochrepts

JDBE. Other Durochrepts that do not have a platy or massive indurated duripan.

Entic Durochrepts

JDBF. Other Durochrepts that have base saturation (by NH_4OAc) of less than 60 percent throughout the soil between depths of 25 and 75 cm below the soil surface.

Dystric Durochrepts

JDBG. Other Durochrepts.

Typic Durochrepts

Dystrochrepts

Key to subgroups

JDGA. Dystrochrepts that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an argillic horizon in less than half of each pedon, and the base saturation (by sum of cations) in the subhorizon just above the lithic contact is 35 percent or more.

Lithic Ruptic-Alfic Dystrochrepts

JDGB. Other Dystrochrepts that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an argillic horizon in less than half of each pedon and have base saturation (by sum of cations) in the subhorizon just above the lithic contact that is less than 35 percent.

Lithic Ruptic-Ultic Dystrochrepts

JDGC. Other Dystrochrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Dystrochrepts

JDGD. Other Dystrochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Dystrochrepts

JDGE. Other Dystrochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Dystrochrepts

JDGF. Other Dystrochrepts that:

1. Have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at a time when its temperature is 5°C or higher, or the soil has artificial drainage; *and*

2. Have a content of organic carbon[4] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

3. Have slopes of 25 percent or less.

Fluvaquentic Dystrochrepts

JDGG. Other Dystrochrepts that have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at a time when its temperature is 5°C or higher, or the soil has artificial drainage.

Aquic Dystrochrepts

JDGH. Other Dystrochrepts that:

1. Have a content of organic carbon[5] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less; *and*

3. Have an Ap horizon that has a color value, moist, of 3 or less or a color value, dry, of 5 or less, crushed and smoothed, or the upper soil to a depth of 18 cm, after mixing, has these colors.

Fluventic Umbric Dystrochrepts

JDGI. Other Dystrochrepts that:

1. Have a content of organic carbon[6] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Dystrochrepts

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[4] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

[5] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

[6] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

JDGJ. Other Dystrochrepts that have an Ap horizon that has a color value, moist, of 3 or less or a color value, dry, of 5 or less, crushed and smoothed, or the upper soil to a depth of 18 cm, after mixing, has these colors.

Umbric Dystrochrepts

JDGK. Other Dystrochrepts that have an argillic horizon in less than half of each pedon, and the base saturation (by sum of cations) at a depth of 125 cm below the upper boundary of the argillic horizon or in the subhorizon just above a lithic or paralithic contact is 35 percent or more.

Ruptic-Alfic Dystrochrepts

JDGL. Other Dystrochrepts that have an argillic horizon in less than half of each pedon, and the base saturation (by sum of cations) at a depth of 125 cm below the upper boundary of the argillic horizon or in the subhorizon just above a lithic or paralithic contact is less than 35 percent.

Ruptic-Ultic Dystrochrepts

JDGM. Other Dystrochrepts.

Typic Dystrochrepts

Eutrochrepts

Key to subgroups

JDFA. Eutrochrepts that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an argillic horizon in some part but in less than half of each pedon.

Lithic Ruptic-Alfic Eutrochrepts

JDFB. Other Eutrochrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Eutrochrepts

JDFC. Other Eutrochrepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Eutrochrepts

JDFD. Other Eutrochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Eutrochrepts

JDFE. Other Eutrochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Eutrochrepts

JDFF. Other Eutrochrepts that:

1. Have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage; *and*

2. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

3. Have slopes of 25 percent or less.

Fluvaquentic Eutrochrepts

JDFG. Other Eutrochrepts that:

1. Have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage; *and*

2. Do not have carbonates within a depth of 100 cm in all parts of each pedon.

Aquic Dystric Eutrochrepts

JDFH. Other Eutrochrepts that have mottles that have chroma of 2 or less within 60 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage.

Aquic Eutrochrepts

JDFI. Other Eutrochrepts that:

1. Do not have carbonates within a depth of 100 cm in all parts of each pedon; *and*

2. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

3. Have slopes of 25 percent or less.

Dystric Fluventic Eutrochrepts

JDFJ. Other Eutrochrepts that:

1. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Eutrochrepts

JDFK. Other Eutrochrepts that have a sandy particle-size class from the soil surface to a depth of 50 cm or more.

Arenic Eutrochrepts

JDFL. Other Eutrochrepts that do not have carbonates within a depth of 100 cm in all parts of each pedon.

Dystric Eutrochrepts

JDFM. Other Eutrochrepts that have 40 percent or more carbonates, including the coarse fragments up to 75 mm in diameter, in and below the cambic horizon but above a lithic or paralithic contact and above a depth of 100 cm.

Rendollic Eutrochrepts

JDFN. Other Eutrochrepts that have an argillic horizon in some part but in less than half of each pedon.

Ruptic-Alfic Eutrochrepts

JDFO. Other Eutrochrepts.

Typic Eutrochrepts

Fragiochrepts

Key to subgroups

JDAA. Fragiochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Fragiochrepts

JDAB. Other Fragiochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Fragiochrepts

JDAC. Other Fragiochrepts that have distinct or prominent mottles in the upper 30 cm of the soil.

Aquic Fragiochrepts

JDAD. Other Fragiochrepts that do not have an ochric epipedon.

Umbric Fragiochrepts

JDAE. Other Fragiochrepts.

Typic Fragiochrepts

Ustochrepts

Key to subgroups

JDDA. Ustochrepts that have a lithic contact within 50 cm of the surface.

Lithic Ustochrepts

JDDB. Other Ustochrepts that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and that are at least 30 cm long in some part and that extend upward to the soil surface or the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Udertic Ustochrepts

JDDC. Other Ustochrepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and that are at least 30 cm long in some part and that extend upward to the soil surface or the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Ustochrepts

JDDD. Other Ustochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Ustochrepts

JDDE. Other Ustochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Ustochrepts

JDDF. Other Ustochrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some period when its temperature is 5°C or more, or the soil has artificial drainage.

Aquic Ustochrepts

JDDG. Other Ustochrepts that:

1. Have a content of organic carbon[7] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2

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[7] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Ustochrepts

JDDH. Other Ustochrepts that when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry sixth-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature, at a depth of 50 cm, exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic or isomesic or warmer, are moist in some or all parts of the soil moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm is higher than 8°C.

Aridic Ustochrepts

JDDI. Other Ustochrepts that when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Ustochrepts

JDDJ. Other Ustochrepts.

Typic Ustochrepts

Xerochrepts

Key to subgroups

JDEA. Xerochrepts that have a lithic contact within 50 cm of the soil surface in some part but less than half of each pedon.

Ruptic-Lithic Xerochrepts

JDEB. Other Xerochrepts that:

1. Have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface; *and*

2. Have a lithic contact within 50 cm of the soil surface.
Dystric Lithic Xerochrepts

JDEC. Other Xerochrepts that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have an intermittent cambic horizon.
Lithic Ruptic-Xerorthentic Xerochrepts

JDED. Other Xerochrepts that have a lithic contact within 50 cm of the soil surface.
Lithic Xerochrepts

JDEE. Other Xerochrepts that have a petrocalcic horizon within a depth of 100 cm of the soil surface.
Petrocalcic Xerochrepts

JDEF. Other Xerochrepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.
Vertic Xerochrepts

JDEG. Other Xerochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.
Andic Xerochrepts

JDEH. Other Xerochrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Xerochrepts

JDEI. Other Xerochrepts that have a gypsic horizon within a depth of 100 cm of the soil surface.

Gypsic Xerochrepts

JDEJ. Other Xerochrepts that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface; *and*

2. Have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface.

Aquic Dystric Xerochrepts

JDEK. Other Xerochrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface.

Aquic Xerochrepts

JDEL. Other Xerochrepts that:

1. Have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface; *and*

2. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

3. Have slopes of 25 percent or less.

Dystric Fluventic Xerochrepts

JDEM. Other Xerochrepts that:

1. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Xerochrepts

JDEN. Other Xerochrepts that have base saturation (by NH_4OAc) of less than 60 percent in all parts of the soil between depths of 25 and 75 cm below the soil surface.

Dystric Xerochrepts

JDEO. Other Xerochrepts that have a calcic horizon or soft powdery lime within a depth of 150 cm if the weighted average particle-size class from depths of 25 to 100 cm is sandy or to a lithic or paralithic contact if one is shallower than 100 cm, or within a depth of 110 cm if the weighted average particle-size class is loamy, or within a depth of 90 cm if it is clayey.

Calcixerollic Xerochrepts

JDEP. Other Xerochrepts.

Typic Xerochrepts

PLAGGEPTS

Plaggepts are the soils that have a plaggen epipedon.

TROPEPTS

Key to great groups

JCA. Tropepts that have base saturation of less than 50 percent (by NH_4OAc) in some subhorizon between depths of 25 and 100 cm and have 12 kg or more organic carbon, exclusive of surface litter, per square meter in the soil to a depth of 100 cm, or to a lithic, paralithic, or petroferric contact if one is shallower than 100 cm, and do not have a sombric horizon.

Humitropepts, p. 267

JCB. Other Tropepts that have a sombric horizon.

Sombritropepts, p. 268

JCC. Other Tropepts that have an ustic moisture regime and have base saturation (by NH_4OAc) of 50 percent or more in all subhorizons between depths of 25 and 100 cm, or between 25 cm and a lithic, paralithic or petroferric contact if one is shallower than 100 cm.

Ustropepts, p. 268

JCD. Other Tropepts that have base saturation (by NH_4OAc) of 50 percent or more in all subhorizons between depths of 25 and 100 cm, or between 25 cm and a lithic or paralithic contact if one is shallower than 100 cm.

Eutropepts, p. 265

JCE. Other Tropepts.

Dystropepts, p. 263

Dystropepts

Key to subgroups

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

Lithic Dystropepts

JCEB. Other Dystropepts that have a petroferric contact within 50 cm of the soil surface.

Petroferric Dystropepts

JCEC. Other Dystropepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more if the soil moisture regime is udic, or 0.07 or more if it is ustic, in a horizon or horizons at least 50 cm

thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm or 125 cm, respectively, of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm or 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Dystropepts

JCED. Other Dystropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Dystropepts

JCEE. Other Dystropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Dystropepts

JCEF. Other Dystropepts that have mottles that have chroma of 2 or less within 100 cm of the soil surface, and the mottled horizon is saturated with water at some time of year, or the soil has artificial drainage.

Aquic Dystropepts

JCEG. Other Dystropepts that:

1. Have a content of organic carbon[8] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Dystropepts

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8 The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

JCEH. Other Dystropepts that:

1. Have an ustic moisture regime; *and*

2. Have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[9] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Ustoxic Dystropepts

JCEI. Other Dystropepts that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[10] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Oxic Dystropepts

JCEJ. Other Dystropepts that have an ustic moisture regime.

Ustic Dystropepts

JCEK. Other Dystropepts.

Typic Dystropepts

Eutropepts

Key to subgroups

JCDA. Eutropepts that have a lithic contact within 50 cm of the soil surface.

Lithic Eutropepts

JCDB. Other Eutropepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil, or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Eutropepts

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Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

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Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

JCDC. Other Eutropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Eutropepts

JCDD. Other Eutropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Eutropepts

JCDE. Other Eutropepts that:

1. Have a content of organic carbon[11] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less; *and*

3. Have mottles that have chroma of 2 or less within 100 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year, or there is artificial drainage.

Fluvaquentic Eutropepts

JCDF. Other Eutropepts that have mottles that have chroma of 2 or less within 100 cm of the soil surface, and the mottled horizon is saturated with water at some time during the year, or there is artificial drainage.

Aquic Eutropepts

JCDG. Other Eutropepts that:

1. Have a content of organic carbon[12] that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

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[11] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

[12] The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

2. Have slopes of 25 percent or less.

Fluventic Eutropepts

JCDH. Other Eutropepts.

Typic Eutropepts

Humitropepts

Key to subgroups

JCAA. Humitropepts that have a lithic contact within 50 cm of the soil surface.

Lithic Humitropepts

JCAB. Other Humitropepts that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. Have an ustic moisture regime.

Ustandic Humitropepts

JCAC. Other Humitropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Humitropepts

JCAD. Other Humitropepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Humitropepts

JCAE. Other Humitropepts that have mottles that have chroma of 2 or less within 100 cm of the soil surface, and the mottled horizon is saturated with water at some time of year, or there is artificial drainage.

Aquic Humitropepts

JCAF. Other Humitropepts that:

1. Have a content of organic carbon that decreases irregularly with depth to the base of the cambic horizon; *and*

2. Have slopes of 25 percent or less.

Fluventic Humitropepts

JCAG. Other Humitropepts that:

1. Have an ustic moisture regime; *and*

2. Have a CEC (by NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[13] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Ustoxic Humitropepts

JCAH. Other Humitropepts that have a CEC (by NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[14] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Oxic Humitropepts

JCAI. Other Humitropepts that have an ustic soil moisture regime.

Ustic Humitropepts

JCAJ. Other Humitropepts.

Typic Humitropepts

Sombritropepts

These soils are the dark, humus-rich Tropepts of perhumid, cool, hilly or mountainous regions. They have a sombric horizon in or below a cambic horizon. Most of them have an umbric epipedon, a perudic soil moisture regime, and an isomesic temperature regime. They are not known to occur in the United States and their classification has not been developed.

Ustropepts

Key to subgroups

JCCA. Ustropepts that have a lithic contact within 50 cm of the soil surface.

Lithic Ustropepts

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13 Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

14 Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

JCCB. Other Ustropepts that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 com thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Ustropepts

JCCC. Other Ustropepts that have mottles that have chroma of 2 or less within 100 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year, or there is artificial drainage.

Aquic Ustropepts

JCCD. Other Ustropepts that have a CEC (by NH_4OAc pH 7) of less than 24 cmol(+) per kg clay[15] in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Oxic Ustropepts

JCCE. Other Ustropepts that:

1. Have a content of organic carbon that decreases irregularly with depth, or are 125 cm or more deep to a lithic or a paralithic contact and have more than 0.2 percent organic carbon at 125 cm below the soil surface; *and*

2. Have slopes of 25 percent or less.

Fluventic Ustropepts

JCCF. Other Ustropepts.

Typic Ustropepts

UMBREPTS

Key to great groups

JEA. Umbrepts that have a fragipan.

Fragiumbrepts, p. 271

JEB. Other Umbrepts that have a cryic or pergelic temperature regime.

Cryumbrepts, p. 270

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15 Some cambic horizons that have properties that approach those of an oxic horizon do not disperse well. If the ratio of the percentage of water retained at tension of 1500 kPa to the percentage of measured clay is 0.6 or more, the percentage of clay is determined by the higher value of (1) the measured percentage of clay or (2) 2.5 times the percentage of water retained at tension of 1500 kPa.

JEC. Other Umbrepts that have a xeric moisture regime.
Xerumbrepts, p. 273

JED. Other Umbrepts.
Haplumbrepts, p. 271

Cryumbrepts

Key to subgroups

JEBA. Cryumbrepts that have a lithic contact within 50 cm of the surface in only part of each pedon.
Ruptic-Lithic Cryumbrepts

JEBB. Other Cryumbrepts that:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Have 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 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 a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.
Andic Cryumbrepts

JEBF. Other Cryumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.
Vitrandic Cryumbrepts

JEBG. Other Cryumbrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when its temperature is 5°C or more, or there is artificial drainage.

Aquic Cryumbrepts

JEBH. Other Cryumbrepts that do not have a cambic horizon.

Entic Cryumbrepts

JEBI. Other Cryumbrepts.

Typic Cryumbrepts

Fragiumbrepts

Key to subgroups

The definitions that follow are incomplete because there are few of these soils in the United States.

JEAA. Fragiumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Fragiumbrepts

JEAB. Other Fragiumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

   a. More than 30 percent volcanic glass; *or*

   b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Fragiumbrepts

JEAC. Other Fragiumbrepts that have mottles that have chroma of 2 or less within 50 cm of the soil surface.

Aquic Fragiumbrepts

JEAD. Other Fragiumbrepts.

Typic Fragiumbrepts

Haplumbrepts

Key to subgroups

JEDA. Haplumbrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Haplumbrepts

JEDB. Other Haplumbrepts that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. Have mottles that have chroma of 2 or less within 50 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when its temperature is more than 5°C, or there is artificial drainage.

Aquandic Haplumbrepts

JEDC. Other Haplumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haplumbrepts

JEDD. Other Haplumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Haplumbrepts

JEDE. Other Haplumbrepts that:

1. Do not have a cambic horizon; *and*

2. Have sandy particle-size class from the mineral soil surface to a depth of 100 cm or more, and have in the 0.02 to 2.0 mm fraction more than 90 percent silica minerals (quartz, chalcedony or opal) or other extremely durable minerals that are resistant to weathering.

Quartzipsammentic Haplumbrepts

JEDF. Other Haplumbrepts that have a sandy particle-size class from the mineral soil surface to a depth of 100 cm or more.

Psammentic Haplumbrepts

JEDG. Other Haplumbrepts that:

1. Have an umbric or a mollic epipedon that is 50 cm or more thick; *and*

2. Have a content of organic carbon[16] that decreases irregularly with depth; *and*

3. Have slopes of 25 percent or less.

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 mottles that have chroma of 2 or less within 50 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when its temperature is more than 5°C, or there is artificial drainage.

Aquic Haplumbrepts

JEDJ. Other Haplumbrepts that:

1. Have a content of organic carbon[17] that decreases irregularly with depth; *and*

2. Have slopes of 25 percent or less.

Fluventic Haplumbrepts

JEDK. Other Haplumbrepts that do not have a cambic horizon.

Entic Haplumbrepts

JEDL. Other Haplumbrepts.

Typic Haplumbrepts

Xerumbrepts

Key to subgroups

JECA. Xerumbrepts that have a lithic contact within 50 cm of the soil surface.

Lithic Xerumbrepts

JECB. Other Xerumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Xerumbrepts

JECC. Other Xerumbrepts that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

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16 The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

17 The carbon should be of Holocene age. It is not the intent to include fossil carbon from bedrock.

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Xerumbrepts

JECD. Other Xerumbrepts that have an umbric or mollic epipedon that is 50 cm or more thick.

Pachic Xerumbrepts

JECE. Other Xerumbrepts that have mottles that have chroma of 2 or less within 75 cm of the soil surface, and the mottled horizon is saturated with water at some time of the year when its temperature is more than 5°C, or there is artificial drainage.

Aquic Xerumbrepts

JECF. Other Xerumbrepts that:

1. Have a content of organic carbon that decreases irregularly with depth; *and*

2. Have slopes of 25 percent or less.

Fluventic Xerumbrepts

JECG. Other Xerumbrepts that do not have a cambic horizon.

Entic Xerumbrepts

JECH. Other Xerumbrepts.

Typic Xerumbrepts

Chapter 11

Mollisols

KEY TO SUBORDERS

HA. Mollisols that have all the following:

1. An albic horizon that lies immediately below the mollic epipedon or that separates horizons that together meet all the requirements of a mollic epipedon; *and*

2. An argillic or a natric horizon; *and*

3. Chroma of 2 or less in the albic horizon or characteristics associated with wetness in the albic, argillic, or natric horizon, namely mottles or iron-manganese concretions larger than 2 mm or both.
Albolls, p. 277

HB. Other Mollisols that either have an aquic moisture regime or are artificially drained, and that have *one or more* of the following characteristics associated with wetness:

1. A histic epipedon overlying the mollic epipedon; *or*

2. An SAR of 13 or more (or sodium saturation of 15 percent or more) in the upper part of the mollic epipedon and decreasing SAR (or sodium saturation) with increasing depth below 50 cm; *or*

3. One of the following combinations of colors, moist:

a. If the lower part of the mollic epipedon[1] has chroma of 1 or less, there are *either*

(1) Distinct or prominent mottles in the lower part of the mollic epipedon; *or*

(2) A color value, moist, of 4 or more immediately below the mollic epipedon, or within 75 cm of the surface if a calcic horizon intervenes, and *one* of the following:

(a) If the hue is 10YR or redder and there are mottles, chroma is less than 1 or less on ped surfaces or in the matrix; if there are no mottles, chroma is less than 1; *or*

(b) If the hue is nearest 2.5Y and there are distinct or prominent mottles, chroma is 2 or less on ped surfaces or in the matrix; if there are no mottles, chroma is 1 or less; *or*

(c) If the nearest hue is 5Y or yellower and there are distinct or prominent mottles, chroma is 3 or

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[1] If the mollic epipedon extends to a lithic contact within 30 cm of the surface, the requirement for mottles is waived.

less on ped surfaces or in the matrix; if there are no mottles, chroma is 1 or less; *or*

(d) The hue is bluer than 10Y or the color is neutral; *or*

(e) The color results from uncoated mineral grains; *or*

b. If the lower part of the mollic epipedon has chroma of more than 1 but not more than 2, there are *either*

(1) Distinct or prominent mottles in the lower mollic epipedon; *or*

(2) Base colors immediately below the mollic epipedon that have *one or more* of the following properties:

(a) Value of 4 and chroma of 2 and also some mottles that have value of 4 or more and chroma less than 2; *or*

(b) Value of 5 or more and chroma of 2 or less and also mottles that have higher chroma; *or*

(c) Value of 4 and chroma less than 2; *or*

4. A calcic or petrocalcic horizon that has its upper boundary within 40 cm of the surface.

Aquolls, p. 278

HC. Other Mollisols that have all the following characteristics:

1. Have a mollic epipedon that is not more than 50 cm thick; *and*

2. Do not have an argillic horizon; *and*

3. Do not have a calcic horizon; *and*

4. The soil materials in or immediately below any mollic epipedon, including coarse fragments less than 7.5 cm in diameter, have a $CaCO_3$ equivalent of 40 percent or more; *and*

5. Have a udic moisture regime or a cryic temperature regime.

Rendolls, p. 296

HD. Other Mollisols that have a xeric moisture regime or an aridic moisture regime bordering on xeric but do not have a cryic temperature regime.

Xerolls, p. 320

HE. Other Mollisols that have a frigid, cryic, or pergelic temperature regime.

Borolls, p. 282

HF. Other Mollisols that have an ustic or an aridic moisture regime that borders on ustic.

Ustolls, p. 302

HG. Other Mollisols.

Udolls, p. 297

ALBOLLS

Key to great groups

HAA. Albolls that have a natric horizon.

Natralbolls, p. 278

HAB. Other Albolls.

Argialbolls, p. 277

Argialbolls

Key to subgroups

HABA. Argialbolls that:

1. Do not have an abrupt textural change from the albic to the argillic horizon; *and*

2. When not irrigated, are dry in all parts of the moisture control section for as long as 45 consecutive days during the 120 days following the summer solstice in more than 6 out of 10 years.

Argiaquic Xeric Argialbolls

HABB. Other Argialbolls that do not have an abrupt textural change from the albic to the argillic horizon.

Argiaquic Argialbolls

HABC. Other Argialbolls that, when not irrigated, are dry in all parts of the moisture control section for as long as 45 consecutive days during the 120 days following the summer solstice in more than 6 out of 10 years.

Xeric Argialbolls

HABD. Other Argialbolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Argialbolls

HABE. 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 temperature regime.

Cryaquolls, p. 279

HBB. Other Aquolls that have a duripan that has its upper boundary within 100 cm of the surface.

Duraquolls, p. 280

HBC. Other Aquolls that have a natric horizon.

Natraquolls, p. 282

HBD. Other Aquolls that have a calcic or gypsic horizon that has its upper boundary within 40 cm of the surface and do not have an argillic horizon unless it is a buried horizon.

Calciaquolls, p. 279

HBE. Other Aquolls that have an argillic horizon.

Argiaquolls, p. 278

HBF. Other Aquolls.

Haplaquolls, p. 280

Argiaquolls

Key to subgroups

HBEA. Argiaquolls that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to the upper boundary of the argillic horizon and the upper boundary of the argillic horizon is between 50 and 100 cm below the soil surface.

Arenic Argiaquolls

HBEB. Other Argiaquolls that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to the upper boundary of the argillic horizon and the upper boundary of the argillic horizon is more than 100 cm below the soil surface.

Grossarenic Argiaquolls

HBEC. Other Argiaquolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface of the soil or to the base of the Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the soil to a depth of 100 cm or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Argiaquolls

HBED. Other Argiaquolls that have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary.

Abruptic Argiaquolls

HBEE. Other Argiaquolls.

Typic Argiaquolls

Calciaquolls

Key to subgroups

HBDA. Calciaquolls that have a petrocalcic horizon that has its upper boundary within 100 cm of the surface.

Petrocalcic Calciaquolls

HBDB. Other Calciaquolls that have color that has dominant chroma of 3 or more in the matrix or on the ped surfaces in one or more subhorizons within 75 cm of the surface or have one of the following colors immediately below the mollic epipedon:

1. If the hue is 2.5Y or yellower and there are distinct or prominent mottles, the chroma, moist, is 3 or more; if there are no mottles, the chroma, moist, is 2 or more; *or*

2. If the hue is 10YR or redder the chroma, moist, is 2 or more.

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 that have a histic epipedon.

Histic Cryaquolls

HBAC. Other Cryaquolls that have a buried Histosol that has its upper boundary within a depth of 100 cm.

Thapto-Histic Cryaquolls

HBAD. Other Cryaquolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

    a. More than 30 percent volcanic glass; *or*

    b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Cryaquolls

HBAE. Other Cryaquolls that have an argillic horizon.

Argic Cryaquolls

HBAF. Other Cryaquolls that have a calcic horizon within or immediately below the mollic epipedon.

Calcic Cryaquolls

HBAG. Other Cryaquolls that have a mollic epipedon that is 50 cm or more thick.

Cumulic Cryaquolls

HBAH. Other Cryaquolls.

Typic Cryaquolls

Duraquolls

Key to subgroups

HBBA. Duraquolls that have a natric horizon.

Natric Duraquolls

HBBB. Other Duraquolls that have an argillic horizon.

Argic Duraquolls

HBBC. Other Duraquolls.

Typic Duraquolls

Haplaquolls

Key to subgroups

HBFA. Haplaquolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Haplaquolls

HBFB. Other Haplaquolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplaquolls

HBFC. Other Haplaquolls that have a histic epipedon.

Histic Haplaquolls

HBFD. Other Haplaquolls that have a buried Histosol that has its upper boundary within 100 cm of the soil surface.

Thapto-Histic Haplaquolls

HBFE. Other Haplaquolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *or*

2. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

3. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Aquandic Haplaquolls

HBFF. Other Haplaquolls that have a horizon 15 cm or more thick that is within 100 cm of the surface and that contains at least 20 percent (by volume) of durinodes or is brittle and has firm consistence when moist.

Duric Haplaquolls

HBFG. Other Haplaquolls that have a mollic epipedon that is 60 cm or more thick.

Cumulic Haplaquolls

HBFH. Other Haplaquolls that have slope of less than 25 percent; *and*

1. Have a content of organic carbon that decreases irregularly with increasing depth; *or*

2. Have more than 0.3 percent carbon in all subhorizons within 125 cm of the soil surface.

Fluvaquentic Haplaquolls

HBFI. Other Haplaquolls.

Typic Haplaquolls

Natraquolls

Key to subgroups

HBCA. All Natraquolls (provisional).

Typic Natraquolls

BOROLLS

Key to great groups

HEA. Borolls that have an argillic horizon that has its upper boundary deeper than 60 cm below the mineral soil surface[2], and that have texture finer than loamy fine sand in all subhorizons above the argillic horizon.

Paleborolls, p. 295

HEB. Other Borolls that have a cryic or pergelic temperature regime.

Cryoborolls, p. 286

HEC. Other Borolls that 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. 294

HED. Other Borolls that 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. 283

HEE. Other Borolls that have a mollic epipedon that, below any Ap horizon, is 50 percent or more by volume wormholes, wormcasts, or filled animal burrows and that either rests on a lithic contact or has a transition to the underlying horizon in which 25 percent or more of the material is discrete wormholes, wormcasts, or animal burrows filled with material from the mollic epipedon and the underlying horizon.

Vermiborolls, p. 296

HEF. Other Borolls that have a calcic or petrocalcic horizon whose upper boundary is within 100 cm of the soil surface and that are calcareous in all parts of all horizons above the calcic or petrocalcic horizon, after the upper soil to a depth of 18 cm has been mixed, unless the texture is coarser than loamy very fine sand.

Calciborolls, p. 286

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2 If there is a surface mantle that has 60 percent or more vitric volcanic ash, cinders, or other vitric pyroclastic materials, the depth to the argillic horizon is measured from the base of this mantle rather than from the mineral soil surface.

HEG. Other Borolls.

Haploborolls, p. 290

Argiborolls

Key to subgroups

HEDA. Argiborolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Argiborolls

HEDB. Other Argiborolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary; *and*

2. Have either or both

a. A color value, dry, of 5 or more in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *or*

b. A moisture control section that is dry in some part six-tenths or more of the time in most years that the soil temperature at a depth of 50 cm is above 5°C.

Abruptic Aridic Argiborolls

HEDC. Other Argiborolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary; *and*

2. Have a chroma (rubbed), moist, of 1 or less in the upper 18 cm of the mollic epipedon after mixing, or in any Ap horizon that is more than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years.

Abruptic Udic Argiborolls

HEDD. Other Argiborolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary; *and*

2. Have an albic horizon immediately below the mollic epipedon; *and*

3. Have mottles that have chroma of 2 or less within 100 cm of the surface and, if undrained, are continuously saturated with water for as long as 90 days within 100 cm of the surface.

Albic Argiborolls

HEDE. Other Argiborolls that have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary.

Abruptic Argiborolls

HEDF. Other Argiborolls that:

1. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

   b. A potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

   c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. Have both

   a. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

   b. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years.

Ustertic Argiborolls

HEDG. Other Argiborolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Argiborolls

HEDH. Other Argiborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Argiborolls

HEDI. Other Argiborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and

pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Argiborolls

HEDJ. Other Argiborolls that:

1. Have a mollic epipedon that is 40 cm or more thick, and its texture is finer than loamy fine sand; *and*

2. Have a chroma (rubbed), moist, of 1 or less in the upper 18 cm of the mollic epipedon after mixing, or in any Ap horizon that is more than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years.

Pachic Udic Argiborolls

HEDK. Other Argiborolls that have a mollic epipedon that is 40 cm or more thick, and its texture is finer than loamy fine sand.

Pachic Argiborolls

HEDL. Other Argiborolls that have both:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years.

Aridic Argiborolls

HEDM. Other Argiborolls that have mottles that have chroma of 2 or less within 100 cm of the surface and, if undrained, are continuously saturated with water for as long as 90 days within 100 cm of the surface.

Aquic Argiborolls

HEDN. Other Argiborolls that:

1. Have tonguing or interfingering of albic materials in the upper part of the argillic horizon, or skeletans of clean silt and sand covering more than half the ped faces in the upper 5 cm or more of the argillic horizon; *and*

2. Have a chroma (rubbed), moist, of 1 or less in the upper 18 cm of the mollic epipedon after mixing, or in any Ap horizon that is more than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years.

Boralfic Udic Argiborolls

HEDO. Other Argiborolls that have tonguing or interfingering of albic materials in the upper part of the argillic horizon, or skeletans of clean silt and sand covering more than half the ped faces in the upper 5 cm or more of the argillic horizon.

Boralfic Argiborolls

HEDP. Other Argiborolls that have a chroma (rubbed), moist, of 1 or less in the upper 18 cm of the mollic epipedon after mixing, or in any Ap horizon that is more than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years.

Udic Argiborolls

HEDQ. Other Argiborolls that have an albic horizon that lies immediately below the mollic epipedon.

Albollic Argiborolls

HEDR. Other Argiborolls.

Typic Argiborolls

Calciborolls

Key to subgroups

HEFA. Calciborolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Calciborolls

HEFB. Other Calciborolls that have a petrocalcic horizon that has its upper boundary within 100 cm of the surface.

Petrocalcic Calciborolls

HEFC. Other Calciborolls that have both the following:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time in most years that the soil temperature at a depth of 50 cm is above 5°C.

Aridic Calciborolls

HEFD. Other Calciborolls that have distinct or prominent mottles that are due to segregation of iron or manganese within 100 cm of the surface and, if undrained, are continuously saturated with water for as long as 90 days within 100 cm of the surface.

Aquic Calciborolls

HEFE. Other Calciborolls.

Typic Calciborolls

Cryoborolls

Key to subgroups

HEBA. Cryoborolls that have the following combination of characteristics:

1. Have an argillic horizon; *and*

2. Have an albic horizon immediately below the mollic epipedon; *and*

3. Have a lithic contact within a depth of 50 cm of the surface.

Boralfic Lithic Cryoborolls

HEBB. Other Cryoborolls that have an argillic horizon that is continuous throughout each pedon, and have a lithic contact within a depth of 50 cm of the surface.

Argic Lithic Cryoborolls

HEBC. Other Cryoborolls that have a lithic contact within a depth of 50 cm of the surface and have a mollic epipedon that is discontinuous in each pedon.

Lithic Ruptic-Entic Cryoborolls

HEBD. Other Cryoborolls that have a lithic contact within a depth of 50 cm of the surface and have an argillic horizon that is intermittent in each pedon.

Lithic Ruptic-Argic Cryoborolls

HEBE. Other Cryoborolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Cryoborolls

HEBF. Other Cryoborolls that have a mean annual soil temperature of 0°C or less.

Pergelic Cryoborolls

HEBG. Other Cryoborolls that have an argillic horizon and an SAR of 13 or more (or 15 percent or more saturation with exchangeable sodium) in the major part of the argillic horizon.

Natric Cryoborolls

HEBH. Other Cryoborolls that have an argillic horizon and the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Argic Vertic Cryoborolls

HEBI. Other Cryoborolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or the whole soil if a lithic or

paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Cryoborolls

HEBJ. Other Cryoborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryoborolls

HEBK. Other Cryoborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, one or more of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Cryoborolls

HEBL. Other Cryoborolls that have a duripan that has its upper boundary within 100 cm of the soil surface.

Duric Cryoborolls

HEBM. Other Cryoborolls that have an albic horizon immediately below the mollic epipedon and have an argillic horizon.

Boralfic Cryoborolls

HEBN. Other Cryoborolls that:

1. Have a mollic epipedon that is 40 cm or more thick and that has texture finer than loamy fine sand; *and*

2. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of 25 percent or less.

Cumulic Cryoborolls

HEBO. Other Cryoborolls that:

1. Have a calcic horizon within or immediately below the mollic epipedon and do not have an argillic horizon in the lower part of the mollic epipedon; *and*

2. Have a mollic epipedon that is 40 cm or more thick and that has texture finer than loamy fine sand.
Calcic Pachic Cryoborolls

HEBP. Other Cryoborolls that:

1. Have an argillic horizon; *and*

2. Have a mollic epipedon that is 40 cm or more thick and that has texture finer than loamy fine sand.
Argic Pachic Cryoborolls

HEBQ. Other Cryoborolls that have a mollic epipedon that is 40 cm or more thick and that has texture finer than loamy fine sand.
Pachic Cryoborolls

HEBR. Other Cryoborolls that:

1. Have an argillic horizon; *and*

2. Have distinct or prominent mottles that are due to segregation of iron or manganese within 100 cm of the surface if artificially drained and, if undrained, are continuously saturated with water within a depth of 100 cm for 90 days or longer.
Argiaquic Cryoborolls

HEBS. Other Cryoborolls that:

1. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm of the surface; *and*

2. Have distinct or prominent mottles that are due to segregation of iron or manganese within 100 cm of the surface and, if undrained, are continuously saturated with water within a depth of 100 cm for 90 days or longer; *and*

3. Have a slope of less than 25 percent.
Fluvaquentic Cryoborolls

HEBT. Other Cryoborolls that have distinct or prominent mottles that are due to segregation of iron or manganese within 100 cm of the surface and, if undrained, are continuously saturated with water within a depth of 100 cm for 90 days or longer.
Aquic Cryoborolls

HEBU. Other Cryoborolls that:

1. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

2. Have a slope of less than 25 percent.
Fluventic Cryoborolls

HEBV. Other Cryoborolls that:

1. Have an argillic horizon; *and*

2. Have an albic horizon immediately below the mollic epipedon; *and*

3. Have an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below the upper boundary of the argillic horizon.

Abruptic Cryoborolls

HEBW. Other Cryoborolls that have an argillic horizon that is continuous throughout each pedon.

Argic Cryoborolls

HEBX. Other Cryoborolls that have a calcic horizon within or immediately below the mollic epipedon.

Calcic Cryoborolls

HEBY. Other Cryoborolls that have an albic horizon immediately below the mollic epipedon.

Albic Cryoborolls

HEBZ. Other Cryoborolls.

Typic Cryoborolls

Haploborolls

Key to subgroups

HEGA. Haploborolls that have a salic horizon that has its upper boundary within a depth of 75 cm below the surface.

Salorthidic Haploborolls

HEGB. Other Haploborolls that have a lithic contact within a depth of 50 cm in part of each pedon.

Ruptic-Lithic Haploborolls

HEGC. Other Haploborolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Haploborolls

HEGD. Other Haploborolls that:

1. Have a chroma, moist, after rubbing of 1 or less in the upper part of the mollic epipedon after it has been mixed to a depth of 18 cm or in any Ap horizon that is more than 18 cm thick, or the soil is not dry in all parts of the moisture control section at some time in most years; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and that are at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap horizon; *and*

b. Potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Udertic Haploborolls

HEGE. Other Haploborolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm and that are at least 30 cm long in some part and that extend upward to the surface or to the base of an Ap horizon; *and*

2. Potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haploborolls

HEGF. Other Haploborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haploborolls

HEGG. Other Haploborolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Haploborolls

HEGH. Other Haploborolls that:

1. Have a mollic epipedon 40 cm or more thick, and the epipedon does not have a sandy particle-size class in the major part, and there is no paralithic contact or a sandy contrasting layer between depths of 40 and 50 cm; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of less than 25 percent and a concave shape; *and*

4. Have a chroma, moist, after rubbing of 1 or less in the upper part of the mollic epipedon after it has been mixed to a depth of 18 cm, or in any Ap horizon that is more

than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years.

Cumulic Udic Haploborolls

HEGI. Other Haploborolls that:

1. Have a mollic epipedon 40 cm or more thick, and the epipedon does not have a sandy particle-size class in the major part, and there is no paralithic contact or a sandy contrasting layer between depths of 40 and 50 cm; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of less than 25 percent and a concave shape.

Cumulic Haploborolls

HEGJ. Other Haploborolls that:

1. Have a mollic epipedon 40 cm or more thick, and the epipedon does not have a sandy particle-size class in the major part, and there is no paralithic contact or a sandy contrasting layer between depths of 40 and 50 cm; *and*

2. Have a chroma, moist, after rubbing of 1 or less in the upper part of the mollic epipedon after it has been mixed to a depth of 18, cm or in any Ap horizon that is more than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years.

Pachic Udic Haploborolls

HEGK. Other Haploborolls that have a mollic epipedon 40 cm or more thick, and the epipedon does not have a sandy particle-size class in the major part, and there is no paralithic contact or a sandy contrasting layer between depths of 40 and 50 cm.

Pachic Haploborolls

HEGL. Other Haploborolls that:

1. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

2. Have mottles that have chroma of 2 or less within 100 cm of the surface and, if undrained, are continuously saturated with water in the mottled horizon for 90 days or more in most years; *and*

3. Have a slope of less than 25 percent.

Fluvaquentic Haploborolls

HEGM. Other Haploborolls that have mottles that have chroma of 2 or less within 100 cm of the surface and, if undrained, are continuously saturated with water in the mottled horizon for 90 days or more in most years.

Aquic Haploborolls

HEGN. Other Haploborolls that:

1. Have both of the following:

a. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

b. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of less than 25 percent.

Torrifluventic Haploborolls

HEGO. Other Haploborolls that have the following combination of characteristics:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years; *and*

3. Do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color.

Torriorthentic Haploborolls

HEGP. Other Haploborolls that have both of the following:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years.

Aridic Haploborolls

HEGQ. Other Haploborolls that have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; and have a slope of less than 25 percent.

Fluventic Haploborolls

HEGR. Other Haploborolls that:

1. Have a chroma, moist, after rubbing of 1 or less in the upper part of the mollic epipedon after it has been mixed to a depth of 18 cm, or in any Ap horizon that is more

than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years; *and*

2. Do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color.

Udorthentic Haploborolls

HEGS. Other Haploborolls that have a chroma, moist, after rubbing of 1 or less in the upper part of the mollic epipedon after it has been mixed to a depth of 18 cm, or in any Ap horizon that is more than 18 cm thick, or the soil is moist in some or all parts of the moisture control section at all times in most years.

Udic Haploborolls

HEGT. Other Haploborolls that do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color.

Entic Haploborolls

HEGU. Other Haploborolls.

Typic Haploborolls

Natriborolls

Key to subgroups

HECA. Natriborolls that have visible crystals or nests of gypsum or more soluble salts within 40 cm of the surface of the soil.

Leptic Natriborolls

HECB. Other Natriborolls that have both of the following:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years.

Aridic Natriborolls

HECC. Other Natriborolls that:

1. Have tonguing or interfingering of an albic horizon more than 2.5 cm into the natric horizon; *and*

2. Have a chroma, moist, after rubbing, of 1 or less in the upper part of the mollic epipedon to a depth of 18 cm, after mixing, or in any Ap horizon that is more than 18 cm thick.

Glossic Udic Natriborolls

HECD. Other Natriborolls that have a chroma, moist, after rubbing, of 1 or less in the upper part of the mollic epipedon to a depth of 18 cm, after mixing, or in any Ap horizon that is more than 18 cm thick.

Udic Natriborolls

HECE. Other Natriborolls that have tonguing or interfingering of an albic horizon more than 2.5 cm into the natric horizon.

Glossic Natriborolls

HECF. Other Natriborolls.

Typic Natriborolls

Paleborolls

Key to subgroups

HEAA. Paleborolls that:

1. Have a mean summer soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon or less than 8°C if there is an O horizon; *and*

2. Have a mollic epipedon that is 50 cm or more thick.

Cryic Pachic Paleborolls

HEAB. Other Paleborolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below its upper boundary; *and*

2. Have a mean summer soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon or less than 8°C if there is an O horizon.

Abruptic Cryic Paleborolls

HEAC. Other Paleborolls that have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm below its upper boundary.

Abruptic Paleborolls

HEAD. Other Paleborolls that have a mean summer soil temperature at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower, of less than 15°C if there is no O horizon or less than 8°C if there is an O horizon.

Cryic Paleborolls

HEAE. Other Paleborolls that have a mollic epipedon that is 50 cm or more thick.

Pachic Paleborolls

HEAF. Other Paleborolls that have mottles that have chroma of 2 or less within 100 cm of the surface and, if undrained, are continuously saturated with water in the mottled horizon for as long as 90 days in most years.

Aquic Paleborolls

HEAG. Other Paleborolls.

Typic Paleborolls

Vermiborolls

Key to subgroups

HEEA. Vermiborolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Vermiborolls

HEEB. Other Vermiborolls that have both of the following:

1. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in any Ap horizon that is more than 18 cm thick; *and*

2. A moisture control section that is dry in some part six-tenths or more of the time that the soil temperature at a depth of 50 cm is above 5°C in most years.

Aridic Vermiborolls

HEEC. Other Vermiborolls that:

1. Have a mollic epipedon less than 75 cm thick; *and*

2. Have a chroma, moist, after rubbing, of 1 or less in the upper part of the mollic epipedon to a depth of 18 cm, after mixing, or in any Ap horizon that is more than 18 cm thick.

Hapludic Vermiborolls

HEED. Other Vermiborolls that have a chroma, moist, after rubbing, of 1 or less in the upper part of the mollic epipedon to a depth of 18 cm, after mixing, or in any Ap horizon that is more than 18 cm 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:

1. Have a soil temperature regime that is cryic or pergelic; *and*

2. Have a lithic contact within a depth of 50 cm of the surface.

Cryic Lithic Rendolls

HCAB. Other Rendolls that have a lithic contact within a depth of 50 cm of the surface.

Lithic Rendolls

HCAC. Other Rendolls that have a soil temperature regime that is cryic or pergelic.

Cryic Rendolls

HCAD. Other Rendolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Rendolls

HCAE. Other Rendolls that have a cambic horizon throughout the pedon and the mean summer and mean winter soil temperatures at a depth of 50 cm differ by less than 5°C.

Eutropeptic Rendolls

HCAF. Other Rendolls that have a cambic horizon throughout the pedon.

Eutrochreptic Rendolls

HCAG. Other Rendolls that have a dry color value of 6 or more after the surface soil to a depth of 18 cm has been mixed or of any Ap horizon that is deeper than 18 cm.

Entic Rendolls

HCAH. Other Rendolls.

Typic Rendolls

UDOLLS

Key to great groups

HGA. Udolls that have an argillic horizon and a clay distribution such that the clay content does not decrease by as much as 20 percent of the maximum clay content within 150 cm of the soil surface and there is no lithic or paralithic contact within that depth, and there is *one or both* of the following features:

1. Hue redder than 10YR and chroma greater than 4 dominant in the matrix in at least the lower part of an argillic horizon; *or*

2. Many coarse mottles that have hue redder than 7.5YR or chroma greater than 5.

Paleudolls, p. 301

HGB. Other Udolls that have an argillic horizon.

Argiudolls, p. 298

HGC. Other Udolls that have a mollic epipedon that, below any Ap horizon, is 50 percent or more by volume wormholes, wormcasts, or filled animal burrows and that either rests on a lithic contact or has a transition to an underlying horizon in which 25 percent or more of the material is discrete wormholes, wormcasts, or filled animal burrows that contain material from the mollic epipedon and from the underlying horizon.

Vermudolls, p. 302

HGD. Other Udolls.

Hapludolls, p. 299

Argiudolls

Key to subgroups

HGBA. Argiudolls that have a lithic contact within 50 cm of the surface.

Lithic Argiudolls

HGBB. Other Argiudolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Argiudolls

HGBC. Other Argiudolls that have texture that is loamy fine sand or coarser in the argillic horizon, or the argillic horizon consists entirely of lamellae with a combined thickness of 15 cm or more.

Psammentic Argiudolls

HGBD. Other Argiudolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Argiudolls

HGBE. Other Argiudolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Argiudolls

HGBF. Other Argiudolls that have mottles within 40 cm of the surface and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C, or have a horizon 15 cm or more thick immediately below the mollic epipedon that:

1. Has a hue of 10YR or redder and chroma of 2 or less, or has mottles that have chroma of 2 or less and value of 4 or more and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C; *or*

2. Has a hue of 2.5Y or yellower and chroma of 3 or less.

Aquic Argiudolls

HGBG. Other Argiudolls that have CEC (by 1N NH_4OAc pH 7) of less than 24 in the major part of the argillic horizon, or the major part of the upper 100 cm of the argillic horizon if the argillic horizon is thicker than 100 cm.

Oxic Argiudolls

HGBH. Other Argiudolls.

Typic Argiudolls

Hapludolls

Key to subgroups

HGDA. Hapludolls that have a lithic contact within 50 cm of the surface.

Lithic Hapludolls

HGDB. Other Hapludolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Hapludolls

HGDC. Other Hapludolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Hapludolls

HGDD. Other Hapludolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Hapludolls

HGDE. Other Hapludolls that:

1. Have a mollic epipedon 60 cm or more thick with a texture finer than loamy fine sand; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface and no lithic or paralithic contact within a depth of 125 cm; *and*

3. Have a slope of 25 percent or less.

Cumulic Hapludolls

HGDF. Other Hapludolls that:

1. Have mottles within 40 cm of the surface and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C, or have a horizon 15 cm or more thick immediately below the mollic epipedon that:

a. Has a hue of 10YR or redder and chroma of 2 or less, or has mottles that have chroma of 2 or less and value of 4 or more and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C; *or*

b. Has a hue of 2.5Y or yellower and chroma of 3 or less; *and*

2. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

3. Have a slope of less than 25 percent.

Fluvaquentic Hapludolls

HGDG. Other Hapludolls that have mottles within 40 cm of the surface and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C, or have a horizon 15 cm or more thick immediately below the mollic epipedon that:

1. Has a hue of 10YR or redder and chroma of 2 or less, or has mottles that have chroma of 2 or less and value of 4 or more and, unless artificially drained, the mottled horizon is saturated with water at some period of the year when the soil temperature in the mottled horizon is above 5°C; *or*

2. Has a hue of 2.5Y or yellower and chroma of 3 or less.

Aquic Hapludolls

HGDH. Other Hapludolls that:

1. Have an irregular decrease in organic carbon content with increasing depth or have an organic carbon content of more than 0.3 percent at a depth of 125 cm below the surface; *and*

2. Have a slope of less than 25 percent.

Fluventic Hapludolls

HGDI. Other Hapludolls that:

1. Have a mollic epipedon 60 cm or more thick with a texture finer than loamy fine sand; *and*

2. Do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color; or either the cambic horizon or the lower part of the epipedon have carbonates throughout; *and*

3. The mollic epipedon, below any Ap horizon, has 50 percent or more by volume of wormholes, wormcasts, or filled animal burrows.

Vermic Hapludolls

HGDJ. Other Hapludolls that do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color; or either the cambic horizon or the lower part of the epipedon have carbonates throughout.

Entic Hapludolls

HGDK. Other Hapludolls.

Typic Hapludolls

Paleudolls

<u>Key to subgroups</u>

HGAA. Paleudolls that have mottles that have chroma of 2 or less in the upper 50 cm of the argillic horizon, and the mottled horizon is saturated with water at some period when its temperature is more than 5°C, or the soil has artificial drainage.

Aquic Paleudolls

HGAB. Other Paleudolls.

Typic Paleudolls

Vermudolls

Key to subgroups

HGCA. Vermudolls that have a lithic contact within 50 cm of the surface.

Lithic Vermudolls

HGCB. Other Vermudolls that have a cambic horizon.

Haplic Vermudolls

HGCC. Other Vermudolls that have a mollic epipedon that is less than 75 cm thick.

Entic Vermudolls

HGCD. Other Vermudolls.

Typic Vermudolls

USTOLLS

Key to great groups

HFA. Ustolls that have a duripan with its upper boundary within 100 cm of the soil surface.

Durustolls, p. 309

HFB. Other Ustolls that have a natric horizon.

Natrustolls, p. 316

HFC. Other Ustolls that have a petrocalcic horizon that has its upper boundary within 150 cm of the soil surface, and that have an argillic horizon or are noncalcareous in some subhorizon above the petrocalcic horizon after the surface soil to a depth of 18 cm has been mixed, or that have an argillic horizon that has *one or both* of the following:

1. A vertical clay distribution such that the clay content does not decrease by as much as 20 percent of the maximum clay content within 150 cm of the soil surface and the soil does not have a lithic or paralithic contact within that depth, and the argillic horizon has *one or both* of these:

   a. A hue redder than 10YR and chroma higher than 4 in the matrix; *or*

   b. Common coarse mottles that have a hue of 7.5YR or redder or chroma higher than 5; *or*

2. A particle-size class in the upper part that is clayey, and an increase of at least 20 percent clay (absolute) within a vertical distance of 7.5 cm or of 15 percent clay (absolute) within 2.5 cm at the upper boundary, and

there is no lithic or paralithic contact within 50 cm of the surface of the soil.

Paleustolls, p. 317

HFD. Other Ustolls that do not have an argillic horizon above a calcic, gypsic, or petrocalcic horizon, and that have a calcic or gypsic horizon that has its upper boundary within 100 cm of the soil surface or that have a petrocalcic horizon that has its upper boundary within 150 cm of the surface, and that are calcareous in all overlying subhorizons after the upper soil to a depth of 18 cm has been mixed, unless the texture is coarser than loamy very fine sand or very fine sand.

Calciustolls, p. 307

HFE. Other Ustolls that have an argillic horizon.

Argiustolls, p. 303

HFF. Other Ustolls that have a mollic epipedon below any Ap horizon that is 50 percent or more by volume wormholes and wormcasts or filled animal burrows, and that either rests on a lithic contact or has a transition to the underlying horizon in which 25 percent or more of the material is discrete wormcasts or animal burrows filled with material from the mollic epipedon and the underlying horizon.

Vermustolls, p. 319

HFG. Other Ustolls.

Haplustolls, p. 310

Argiustolls

Key to subgroups

HFEA. Argiustolls that:

1. Have an albic horizon or other eluvial horizon above the argillic horizon that has a color value too high for a mollic epipedon and chroma too high for an albic horizon; *and*

2. Have a lithic contact within 50 cm of the surface.

Alfic Lithic Argiustolls

HFEB. Other Argiustolls that have a lithic contact within 50 cm of the surface.

Lithic Argiustolls

HFEC. Other Argiustolls that:

1. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. The cracks are open 6 months or more in most years.

Torrertic Argiustolls

HFED. Other Argiustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry in some or all parts of the moisture control section for four-tenths or less of the cumulative days when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

3. The cracks are open less than 135 days in most years.

Udertic Argiustolls

HFEE. Other Argiustolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Argiustolls

HFEF. Other Argiustolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Argiustolls

HFEG. Other Argiustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in some or all parts of the moisture control section (not necessarily the same part) in half or more years during the period when the soil temperature at a depth of 50 cm is higher than 5°C; *or*

b. If the soil temperature regime is hyperthermic, or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm is higher than 8°C; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitritorrandic Argiustolls

HFEH. Other Argiustolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Argiustolls

HFEI. Other Argiustolls that have an albic horizon or other eluvial horizon above the argillic horizon that has a color value too high for a mollic epipedon and chroma too high for an albic horizon, and the mean annual soil temperature is lower than 10°C.

Boralfic Argiustolls

HFEJ. Other Argiustolls that have an albic horizon or other eluvial horizon above the argillic horizon that has a color value too high for a mollic epipedon and chroma too high for an albic horizon, and the mean annual soil temperature is 10°C or more.

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 mottles that have chroma of 2 or less within 100 cm of the soil surface and are continuously saturated with water within 100 cm of the soil surface for 3 months or more in most years unless artificially drained.

Aquic Argiustolls

HFEM. Other Argiustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in some or all parts of the moisture control section (not necessarily the same part) in half or more years during the period when the soil temperature at a depth of 50 cm is higher than 5°C; *or*

2. If the soil temperature regime is hyperthermic, or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm is higher than 8°C.

Aridic Argiustolls

HFEN. Other Argiustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Argiustolls

HFEO. Other Argiustolls that have a brittle horizon 15 cm or more thick within 100 cm of the soil surface that contains some opal coatings or 20 percent or more by volume durinodes.

Duric Argiustolls

HFEP. Other Argiustolls.

Typic Argiustolls

Calciustolls

Key to subgroups

HFDA. Calciustolls that have a salic horizon that has its upper boundary within 75 cm of the surface.

Salorthidic Calciustolls

HFDB. Other Calciustolls that have a petrocalcic horizon and have a lithic contact within 50 cm of the soil surface.

Lithic Petrocalcic Calciustolls

HFDC. Other Calciustolls that have a lithic contact within 50 cm of the soil surface.

Lithic Calciustolls

HFDD. Other Calciustolls that:

1. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

   b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

   c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. The cracks are open 180 days or more, cumulative, in most years.

Torrertic Calciustolls

HFDE. Other Calciustolls that:

1. When neither irrigated nor fallowed to store moisture:

   a. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

   b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

3. The cracks are open less than 135 days in most years.

Udertic Calciustolls

HFDF. Other Calciustolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Calciustolls

HFDG. Other Calciustolls that have a petrocalcic horizon that has its upper boundary within 100 cm of the surface.

Petrocalcic Calciustolls

HFDH. Other Calciustolls that have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Pachic Calciustolls

HFDI. Other Calciustolls that have mottles within 75 cm of the surface that are due to segregation of iron or manganese and are continuously saturated with water for 90 days or longer within 100 cm of the surface unless artificially drained.

Aquic Calciustolls

HFDJ. Other Calciustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry in some or all parts of the moisture control section six-tenths or more of the time in half or more years during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during any period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Calciustolls

HFDK. Other Calciustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry in some or all parts of the moisture control section for four-tenths or less of the cumulative days when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Calciustolls

HFDL. Other Calciustolls.

Typic Calciustolls

Durustolls

Key to subgroups

HFAA. Durustolls that have a natric horizon above the duripan.

Natric Durustolls

HFAB. Other Durustolls that do not have an argillic horizon above the duripan and, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during the period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during the period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

3. Have an aridic moisture regime that borders on ustic.

Orthidic Durustolls

HFAC. Other Durustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

3. Have an aridic moisture regime that borders on ustic.

Aridic Durustolls

HFAD. Other Durustolls that do not have an argillic horizon above the duripan.

Entic Durustolls

HFAE. Other Durustolls that have a duripan that is not massive or platy or that has less than half of its upper boundary coated or indurated with opal and silica with or without sesquioxides and that is not indurated in some subhorizon below its upper boundary.

Haplic Durustolls

HFAF. Other Durustolls.

Typic Durustolls

Haplustolls

Key to subgroups

HFGA. Haplustolls that have a salic horizon that has its upper boundary within 75 cm of the surface.

Salorthidic Haplustolls

HFGB. Other Haplustolls that:

1. Have a lithic contact within 50 cm of the surface; *and*

2. Have a cambic horizon in some part but less than half of each pedon.

Lithic Ruptic-Entic Haplustolls

HFGC. Other Haplustolls that have a lithic contact within 50 cm of the surface in a part of each pedon.

Ruptic-Lithic Haplustolls

HFGD. Other Haplustolls that have a lithic contact within 50 cm of the surface.

Lithic Haplustolls

HFGE. Other Haplustolls that:

1. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

2. The cracks are open more than 6 months in most years.

Torrertic Haplustolls

HFGF. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

c. More than 35 percent clay in horizons that total more than 50 cm in thickness; *and*

3. The cracks are open less than 135 days in most years.

Udertic Haplustolls

HFGG. Other Haplustolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *amd*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Haplustolls

HFGH. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Torroxic Haplustolls

HFGI. Other Haplustolls that have CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+) per kg clay in the major part of the soil below a depth of 25 cm but above 100 cm or a lithic or paralithic contact if one is shallower than 100 cm.

Oxic Haplustolls

HFGJ. Other Haplustolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haplustolls

HFGK. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitritorrandic Haplustolls

HFGL. Other Haplustolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Haplustolls

HFGM. Other Haplustolls that:

1. Have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand; *and*

2. Have an irregular decrease in organic-carbon content with increasing depth or have more than 0.3 percent at a depth of 125 cm of the surface; *and*

3. Have a slope of 25 percent or less.

Cumulic Haplustolls

HFGN. Other Haplustolls that have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Pachic Haplustolls

HFGO. Other Haplustolls that:

1. Have mottles that have chroma of 2 or less within 100 cm of the surface if artificially drained or, if undrained, are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years; *and*

2. Have an irregular decrease in organic-carbon content with increasing depth or have more than 0.3 percent at a depth of 125 cm of the surface; *and*

3. Have a slope of less than 25 percent.

Fluvaquentic Haplustolls

HFGP. Other Haplustolls that have mottles that have chroma of 2 or less within 100 cm of the surface if artificially drained or, if undrained, are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years.

Aquic Haplustolls

HFGQ. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have an irregular decrease in organic-carbon content with increasing depth or have more than 0.3 percent at a depth of 125 cm of the surface; *and*

3. Have a slope of less than 25 percent.

Torrifluventic Haplustolls

HFGR. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color and for organic-carbon content, or either the cambic horizon or the lower part of the mollic epipedon has carbonates throughout.

Torriorthentic Haplustolls

HFGS. Other Haplustolls that when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Haplustolls

HFGT. Other Haplustolls that:

1. Have an irregular decrease in organic-carbon content with increasing depth or have more than 0.3 percent at a depth of 125 cm of the surface; *and*

2. Have a slope of less than 25 percent.

Fluventic Haplustolls

HFGU. Other Haplustolls that have a brittle horizon 15 cm or more thick within 100 cm of the surface that contains some opal coatings or 20 percent or more by volume durinodes.

Duric Haplustolls

HFGV. Other Haplustolls that:

1. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color; or the cambic horizon and any part of the mollic epipedon below a depth of 25 cm has carbonates throughout.

Udorthentic Haplustolls

HFGW. Other Haplustolls that when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Haplustolls

HFGX. Other Haplustolls that do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color and for organic-carbon content, or either the cambic horizon or the lower part of the mollic epipedon has carbonates throughout.

Entic Haplustolls

HFGY. Other Haplustolls.

Typic Haplustolls

Natrustolls

Key to subgroups

HFBA. Natrustolls that have visible crystals or nests of gypsum or more soluble salts within 40 cm of the surface.

Leptic Natrustolls

HFBB. Other Natrustolls that have one or more of the following characteristics within 100 cm of the surface:

1. Dominant chroma of 1 or less throughout and hue as yellow or yellower than 2.5 Y in some part; *or*

2. Dominant chroma of 2 or less and mottles that are not due to segregated lime; *or*

3. Dominant chroma of 2 or less and a decrease in the percentage of exchangeable sodium from the upper 25-centimeter layer to the underlying layer.

Aquic Natrustolls

HFBC. Other Natrustolls that, when neither irrigated not fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, or isomesic or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Natrustolls

HFBD. Other Natrustolls that have a brittle horizon 15 cm or more thick that is within 100 cm of the surface and that contains some opal coatings or 20 percent or more by volume durinodes.

Duric Natrustolls

HFBE. Other Natrustolls that have tonguing or interfingering of an albic horizon more than 2.5 cm into a natric horizon.

Glossic Natrustolls

HFBF. Other Natrustolls.

Typic Natrustolls

Paleustolls

Key to subgroups

HFCA. Paleustolls that:

1. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

   b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

   c. More than 35 percent clay in horizons that have total thickness of more than 50 cm; *and*

2. The cracks are open for more than 180 days, cumulative, in most years.

Torrertic Paleustolls

HFCB. Other Paleustolls that:

1. When neither irrigated nor fallowed to store moisture:

   a. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

   b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C; *and*

2. Have the following combination of characteristics:

   a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

   b. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

   c. More than 35 percent clay in horizons that have total thickness of more than 50 cm; *and*

3. The cracks are open less than 135 days, cumulative, in most years.

Udertic Paleustolls

HFCC. Other Paleustolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.07 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 125 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 125 cm; *and*

3. More than 35 percent clay in horizons that have total thickness of more than 50 cm.

Vertic Paleustolls

HFCD. Other Paleustolls that have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Pachic Paleustolls

HFCE. Other Paleustolls that have a petrocalcic horizon within 150 cm of the surface.

Petrocalcic Paleustolls

HFCF. Other Paleustolls that have mottles that have chroma of 2 or less within 100 cm of the surface if artificially drained or, if undrained in most years, are continuously saturated with water in the mottled horizon for 90 days or more.

Aquic Paleustolls

HFCG. Other Paleustolls that:

1. Are calcareous throughout after the upper soil to a depth of 18 cm has been mixed and have a calcic horizon within a depth of 100 cm if the particle-size class of the upper 50 cm of the argillic horizon is sandy, 60 cm if loamy, and 50 cm if clayey; *and*

2. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Calciorthidic Paleustolls

HFCH. Other Paleustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry six-tenths or more of the time in half or more

years in some part of the moisture control section (not necessarily the same part) during a period when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic or isomesic, or warmer, are moist in some or all parts of the moisture control section for less than 90 consecutive days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Paleustolls

HFCI. Other Paleustolls that, when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for four-tenths or less of the cumulative days in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Paleustolls

HFCJ. Other Paleustolls that are calcareous throughout after the upper soil to a depth of 18 cm has been mixed and have a calcic horizon within a depth of 100 cm if the particle-size class of the upper 50 cm of the argillic horizon is sandy, 60 cm if it is loamy, and 50 cm if it is clayey.

Calcic Paleustolls

HFCK. Other Paleustolls that are calcareous throughout after the upper soil to a depth of 18 cm has been mixed.

Entic Paleustolls

HFCL. Other Paleustolls.

Typic Paleustolls

Vermustolls

Key to subgroups

HFFA. Vermustolls that have a lithic contact within 50 cm of the surface.

Lithic Vermustolls

HFFB. Other Vermustolls that have a mollic epipedon that is 75 cm or more thick.

Pachic Vermustolls

HFFC. Other Vermustolls that have mottles that have chroma of 2 or less within 100 cm of the surface.

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 soil surface.

Durixerolls, p. 324

HDB. Other Xerolls that have a natric horizon but do not have a petrocalcic horizon that has its upper boundary within 150 cm of the soil surface.

Natrixerolls, p. 331

HDC. Other Xerolls that have a petrocalcic horizon that has its upper boundary within 150 cm of the soil surface or an argillic horizon that has *either or both*

1. A vertical clay distribution such that the clay content does not decrease by as much as 20 percent of the maximum clay content within 150 cm of the soil surface, *and* also *one or more* of

   a. A hue redder than 10YR and chroma higher than 4 in the matrix; *or*

   b. Common coarse mottles that have a hue of 7.5YR or redder or chroma higher than 5, or both; *or*

2. A particle-size class in the upper part that is clayey and an increase in clay content of at least 20 percent clay (absolute) within a vertical distance of 7.5 cm or an increase of 15 percent clay (absolute) within a distance of 2.5 cm at the upper boundary and no lithic or paralithic contact within 50 cm of the soil surface.

Palexerolls, p. 332

HDD. Other Xerolls that have a calcic or gypsic horizon that has its upper boundary within 150 cm of the soil surface and that are calcareous in all parts of all horizons above the calcic or gypsic horizon after the upper soil to a depth of 18 cm has been mixed unless the texture is coarser than loamy very fine sand or very fine sand.

Calcixerolls, p.323

HDE. Other Xerolls that have an argillic horizon.

Argixerolls, p. 320

HDF. Other Xerolls.

Haploxerolls, p. 326

Argixerolls

Key to subgroups

HDEA. Argixerolls that have a lithic contact within 50 cm of the soil surface and have base saturation (by sum of cations) of 75 percent or less in some part of the soil above the lithic contact.

Lithic Ultic Argixerolls

HDEB. Other Argixerolls that have a lithic contact within 50 cm of the soil surface.

Lithic Argixerolls

HDEC. Other Argixerolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.

Vertic Argixerolls

HDED. Other Argixerolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Argixerolls

HDEE. Other Argixerolls that:

1. Have an aridic moisture regime; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitritorrandic Argixerolls

HDEF. Other Argixerolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Argixerolls

HDEG. Other Argixerolls that have an albic horizon above the argillic horizon and the mean annual soil temperature is lower than 10°C.

Boralfic Argixerolls

HDEH. Other Argixerolls that:

1. Have a calcic horizon or soft, powdery secondary lime within a depth of 150 cm if the weighted average particle-size class of the upper 50 cm of the argillic horizon is sandy, 110 cm if it is loamy, and 90 cm if it is clayey, or above a lithic contact that is shallower than these depths; *and*

2. Have a mollic epipedon that is 50 cm or more thick with a texture finer than loamy fine sand.

Calcic Pachic Argixerolls

HDEI. Other Argixerolls that:

1. Have a mollic epipedon that is 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part in the upper 75 cm or above a lithic or paralithic contact, whichever is shallower.

Pachic Ultic Argixerolls

HDEJ. Other Argixerolls that have a mollic epipedon that is 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Argixerolls

HDEK. Other Argixerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the surface and are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part in the upper 75 cm or above a lithic or paralithic contact, whichever is shallower.

Aquultic Argixerolls

HDEL. Other Argixerolls that have mottles that have chroma of 2 or less within 75 cm of the surface and are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained.

Aquic Argixerolls

HDEM. Other Argixerolls that:

1. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist; *and*

2. Have an aridic moisture regime.

Durargidic Argixerolls

HDEN. Other Argixerolls that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Duric Argixerolls

HDEO. Other Argixerolls that:

1. Have an aridic moisture regime; *and*

2. Have a calcic horizon or soft, powdery secondary lime within a depth of 150 cm if the weighted average particle-size class of the upper 50 cm of the argillic horizon is sandy, 110 cm if it is loamy, and 90 cm if it is clayey, or above a lithic contact that is shallower than these depths.

Aridic Calcic Argixerolls

HDEP. Other Argixerolls that have an aridic moisture regime.

Aridic Argixerolls

HDEQ. Other Argixerolls that have a calcic horizon or soft, powdery secondary lime within a depth of 150 cm if the weighted average particle-size class of the upper 50 cm of the argillic horizon is sandy, 110 cm if it is loamy, and 90 cm if it is clayey, or above a lithic contact that is shallower than these depths.

Calcic Argixerolls

HDER. Other Argixerolls that have base saturation (by sum of cations) of 75 percent or less in some part in the upper 75 cm or above a lithic or paralithic contact, whichever is shallower.

Ultic Argixerolls

HDES. Other Argixerolls that have an albic horizon above the argillic horizon.

Albic Argixerolls

HDET. Other Argixerolls.

Typic Argixerolls

Calcixerolls

Key to subgroups

HDDA. Calcixerolls that have a lithic contact within 50 cm of the soil surface.

Lithic Calcixerolls

HDDB. Other Calcixerolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm

long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.

Vertic Calcixerolls

HDDC. Other Calcixerolls that have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Pachic Calcixerolls

HDDD. Other Calcixerolls that have mottles within 75 cm of the surface that are due to segregation of iron or manganese, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained.

Aquic Calcixerolls

HDDE. Other Calcixerolls that have an aridic moisture regime.

Aridic Calcixerolls

HDDF. Other Calcixerolls that have a mollic epipedon that below any Ap horizon has 50 percent or more by volume wormholes, wormcasts, or filled animal burrows.

Vermic Calcixerolls

HDDG. Other Calcixerolls.

Typic Calcixerolls

Durixerolls

Key to subgroups

HDAA. Durixerolls that:

1. Have an aridic moisture regime; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitritorrandic Durixerolls

HDAB. Other Durixerolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Durixerolls

HDAC. Other Durixerolls that have mottles that have chroma of 2 or less above the duripan.

Aquic Durixerolls

HDAD. Other Durixerolls that:

1. Have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm or an increase of 15 percent or more (absolute) within a distance of 2.5 cm at the upper boundary; *and*

2. Have an aridic moisture regime.

Abruptic Aridic Durixerolls

HDAE. Other Durixerolls that:

1. Do not have an argillic horizon above the duripan; *and*

2. Have an aridic moisture regime.

Orthidic Durixerolls

HDAF. Other Durixerolls that have an aridic moisture regime.

Aridic Durixerolls

HDAG. Other Durixerolls that have an argillic horizon that has an increase in clay content of 20 percent (absolute) or more within a vertical distance of 7.5 cm or an increase of 15 percent or more (absolute) within a distance of 2.5 cm at the upper boundary.

Abruptic Durixerolls

HDAH. Other Durixerolls that:

1. Do not have a duripan that is massive, platy, or prismatic and that has half or more of its upper boundary indurated or coated with opal or opal and

sesquioxides or that is indurated in some subhorizon below its upper boundary; *and*

2. Do not have an argillic horizon above the duripan.
Entic Durixerolls

HDAI. Other Durixerolls that do not have an argillic horizon above the duripan.
Haplic Durixerolls

HDAJ. Other Durixerolls that do not have a duripan that is massive, platy, or prismatic and that has half or more of its upper boundary indurated or coated with opal or opal and sesquioxides or that is indurated in some subhorizon below its upper boundary.
Argic Durixerolls

HDAK. Other Durixerolls.
Typic Durixerolls

Haploxerolls

Key to subgroups

HDFA. Haploxerolls that:

1. Have a lithic contact within 50 cm of the soil surface; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part of the soil above the lithic contact.
Lithic Ultic Haploxerolls

HDFB. Other Haploxerolls that have a lithic contact within 50 cm of the soil surface.
Lithic Haploxerolls

HDFC. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have the following combination of characteristics:

a. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

b. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

c. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.
Torrertic Haploxerolls

HDFD. Other Haploxerolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.

Vertic Haploxerolls

HDFE. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

a. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

b. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

(1) More than 30 percent volcanic glass; *or*

(2) At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitritorrandic Haploxerolls

HDFF. Other Haploxerolls that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, *one or more* of the following:

1. Fragments coarser than 2.0 mm constitute more than 35 percent of the whole soil and cinders, pumice, and pumice-like fragments make up more than 66 percent of these fragments; *or*

2. The 0.02 to 2.0 mm fraction constitutes at least 30 percent of the less than 2.0 mm fraction and contains *either*:

a. More than 30 percent volcanic glass; *or*

b. At least 5 percent volcanic glass and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of 0.40 percent or more.

Vitrandic Haploxerolls

HDFG. Other Haploxerolls that:

1. Have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

3. Have a slope of 25 percent or less; *and*

4. Have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Cumulic Ultic Haploxerolls

HDFH. Other Haploxerolls that:

1. Have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

3. Have a slope of 25 percent or less.

Cumulic Haploxerolls

HDFI. Other Haploxerolls that:

1. Have a calcic horizon or soft, powdery secondary lime within a depth of 150 cm if the weighted average particle-size class between a depth of 25 and 100 cm, or between a depth of 25 cm and a lithic or paralithic contact that is shallower than 100 cm, is sandy; within 110 cm if the average particle-size class is loamy; or within 90 cm if it is clayey; *and*

2. Have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Calcic Pachic Haploxerolls

HDFJ. Other Haploxerolls that:

1. Have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Pachic Ultic Haploxerolls

HDFK. Other Haploxerolls that have a mollic epipedon that is 50 cm or more thick and its texture is finer than loamy fine sand.

Pachic Haploxerolls

HDFL. Other Haploxerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the surface, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

3. Have a slope of less than 25 percent.

Fluvaquentic Haploxerolls

HDFM. Other Haploxerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the surface, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Aquic Duric Haploxerolls

HDFN. Other Haploxerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the surface, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Aquultic Haploxerolls

HDFO. Other Haploxerolls that have mottles that have chroma of 2 or less within 75 cm of the surface, and the soils are continuously saturated with water within 100 cm of the soil surface for 90 days or more in most years, unless artificially drained.

Aquic Haploxerolls

HDFP. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

3. Have a slope of less than 25 percent.

Torrifluventic Haploxerolls

HDFQ. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Aridic Duric Haploxerolls

HDFR. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have a calcic horizon or soft, powdery secondary lime within a depth of 150 cm if the weighted average particle-size class between a depth of 25 and 100 cm, or between a depth of 25 cm and a lithic or paralithic contact that is shallower than 100 cm, is sandy; within 110 cm if the average particle-size class is loamy; or within 90 cm if it is clayey.

Calciorthidic Haploxerolls

HDFS. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Have a sandy particle-size class in all subhorizons to a depth of 100 cm or more.

Torripsammentic Haploxerolls

HDFT. Other Haploxerolls that:

1. Have an aridic moisture regime; *and*

2. Do not have a cambic horizon, and the lower part of the mollic epipedon does not meet the requirements of a cambic horizon except for color, or either the cambic horizon or the lower part of the epipedon has carbonates throughout.

Torriorthentic Haploxerolls

HDFU. Other Haploxerolls that have an aridic moisture regime.

Aridic Haploxerolls

HDFV. Other Haploxerolls that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Duric Haploxerolls

HDFW. Other Haploxerolls that:

1. Have an irregular decrease in organic carbon content with increasing depth, or have an organic carbon content of more than 0.3 percent throughout to a depth of 125 cm of the surface; *and*

2. Have a slope of less than 25 percent.

Fluventic Haploxerolls

HDFX. Other Haploxerolls that have a mollic epipedon that has granular structure and that, below any Ap horizon, has 50 percent or more by volume or wormholes, wormcasts, or filled animal burrows.

Vermic Haploxerolls

HDFY. Other Haploxerolls that have a calcic horizon or soft, powdery secondary lime within a depth of 150 cm if the weighted average particle-size class between a depth of 25 and 100 cm, or between a depth of 25 cm and a lithic or paralithic contact that is shallower than 100 cm, is sandy;

within 110 cm if the average particle-size class is loamy; or within 90 cm if it is clayey.

Calcic Haploxerolls

HDFZ. Other Haploxerolls that:

1. Do not have a cambic horizon, and the lower part of the epipedon does not meet the requirements of a cambic horizon except for color; *and*

2. Have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Entic Ultic Haploxerolls

HDFZa. Other Haploxerolls that have base saturation (by sum of cations) of 75 percent or less in some part within a depth of 75 cm from the soil surface or above a lithic or paralithic contact, whichever is shallower.

Ultic Haploxerolls

HDFZb. Other Haploxerolls that do not have a cambic horizon, and the lower part of the epipedon does not meet the requirements of a cambic horizon except for color, or either the cambic horizon or the lower part of the epipedon has carbonates throughout.

Entic Haploxerolls

HDFZc. Other Haploxerolls.

Typic Haploxerolls

Natrixerolls

<u>Key to subgroups</u>

HDBA. Natrixerolls that:

1. Have mottles that have chroma of 2 or less within 75 cm of the soil surface; *and*

2. Have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Aquic Duric Natrixerolls

HDBB. Other Natrixerolls that have mottles that have chroma of 2 or less within 75 cm of the soil surface.

Aquic Natrixerolls

HDBC. Other Natrixerolls that have an aridic moisture regime.

Aridic Natrixerolls

HDBD. Other Natrixerolls that have a horizon within 100 cm of the surface that is more than 15 cm thick and either contains at least 20 percent durinodes or is brittle and has firm consistence when moist.

Duric Natrixerolls

HDBE. Other Natrixerolls.

Typic Natrixerolls

Palexerolls

Key to subgroups

HDCA. Palexerolls that have a natric horizon.
Natric Palexerolls

HDCB. Other Palexerolls that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the surface or to the base of an Ap horizon; *and*

2. A coefficient of linear extensibility (COLE) of 0.05 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 150 cm of the soil or in the whole soil if a lithic or a paralithic contact is deeper than 50 cm but shallower than 150 cm; *and*

3. More than 35 percent clay in horizons that have a total thickness of more than 50 cm.
Vertic Palexerolls

HDCC. Other Palexerolls that have a mollic epipedon that is 50 cm or more thick, and its texture is finer than loamy fine sand.
Pachic Palexerolls

HDCD. Other Palexerolls that have mottles that have chroma of 2 or less within 75 cm of the soil surface.
Aquic Palexerolls

HDCE. Other Palexerolls that:

1. Have an aridic moisture regime; *and*

2. Have a petrocalcic horizon that has its upper boundary within 150 cm of the soil surface.
Aridic Petrocalcic Palexerolls

HDCF. Other Palexerolls that have an aridic moisture regime.
Aridic Palexerolls

HDCG. Other Palexerolls that have a petrocalcic horizon that has its upper boundary within 150 cm of the soil surface.
Petrocalcic Palexerolls

HDCH. Other Palexerolls that have base saturation of 75 percent or less in some part of the argillic horizon or in the upper 50 cm of the argillic horizon, whichever is thinner.
Ultic Palexerolls

HDCI. Other Palexerolls that have an argillic horizon that either does not have a clayey particle-size class in the upper part, or has an increase in clay content of less than 20 percent clay (absolute) within a vertical distance of 7.5

cm or of less than 15 percent clay (absolute) within a distance of 2.5 cm at the upper boundary.

Haplic Palexerolls

HDCJ. Other Palexerolls.

Typic Palexerolls

Chapter 12

Oxisols[1]

KEY TO SUBORDERS

DA. Oxisols that are either saturated with water within 30 cm of the mineral soil surface 30 days per year in most years or artificially drained, and have *one or more* of the following:

1. A histic epipedon; *or*

2. If faintly mottled or not mottled within 50 cm of the soil surface, an epipedon that has a moist color value of 3 or less and chroma of 2 or less immediately below the epipedon; *or*

3. If there are distinct or prominent mottles within 50 cm of the soil surface, a chroma of 3 or less or a hue of 2.5Y or yellower in 50 percent or more of the horizon immediately below the epipedon.

Aquox, p. 335

DB. Other Oxisols that have an aridic soil moisture regime.

Torrox, p. 343

DC. Other Oxisols that have an ustic soil moisture regime.

Ustox, p. 350

DD. Other Oxisols that have a perudic soil moisture regime.

Perox, p. 337

DE. Other Oxisols.

Udox, p. 344

AQUOX

Key to great groups

DAA. Aquox that have an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more in some part of the oxic horizon within a depth of 150 cm of the soil surface.

Acraquox, p. 336

DAB. Other Aquox that have plinthite forming a continuous phase within a depth of 125 cm of the soil surface.

Plinthaquox, p. 337

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[1] This chapter on Oxisols was rewritten in 1987 following the recommendations of the International Committee on the Classification of Oxisols (ICOMOX), chaired by H. Eswaran from 1978 to 1981 and then by S. Buol until its completion in 1987.

DAC. Other Aquox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutraquox, p. 336

DAD. Other Aquox.

Haplaquox, p. 336

Acraquox

Key to subgroups

DAAA. Acraquox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Acraquox

DAAB. Other Acraquox that have mottles with chroma of more than 2 in 50 percent or more of the horizon immediately below the epipedon.

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 more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Eutraquox

DACC. Other Eutraquox that have mottles with chroma of more than 2 in 50 percent or more of the horizon immediately below the epipedon.

Aeric Eutraquox

DACD. Other Eutraquox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

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 more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Haplaquox

DADC. Other Haplaquox that have mottles with chroma of more than 2 in 50 percent or more of the horizon immediately below the epipedon.

Aeric Haplaquox

DADD. Other Haplaquox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of the surface litter.

Humic Haplaquox

DADE. Other Haplaquox.

Typic Haplaquox

Plinthaquox

Key to subgroups

DABA. Plinthaquox that have mottles with chroma of more than 2 in 50 percent or more of the horizon immediately below the epipedon.

Aeric Plinthaquox

DABB. Other Plinthaquox.

Typic Plinthaquox

PEROX

Key to great groups

DDA. Perox that have a sombric horizon within 150 cm of the soil surface.

Sombriperox, p. 343

DDB. Other Perox that have both an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more in some part of the oxic or kandic horizon within a depth of 150 cm of the soil surface.

Acroperox, p. 337

DDC. Other Perox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutroperox, p. 339

DDD. Other Perox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth of 150 cm of the soil surface.

Kandiperox, p. 341

DDE. Other Perox.

Haploperox, p. 340

Acroperox

Key to subgroups

DDBA. Acroperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

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 mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Acroperox

DDBD. Other Acroperox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Acroperox

DDBE. Other Acroperox that have a delta pH (KCl pH - 1:1 water pH) with a 0 or net positive charge in some layer 18 cm or more thick within a depth of 125 cm of the soil surface.

Anionic Acroperox

DDBF. Other Acroperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Acroperox

DDBG. Other Acroperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Acroperox

DDBH. Other Acroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Acroperox

DDBI. Other Acroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Acroperox

DDBJ. Other Acroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Acroperox

DDBK. Other Acroperox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Acroperox

DDBL. Other Acroperox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Acroperox

DDBM. Other Acroperox.

Typic Acroperox

Eutroperox

Key to subgroups

DDCA. Eutroperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Eutroperox

DDCB. Other Eutroperox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Eutroperox

DDCC. Other Eutroperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Eutroperox

DDCD. Other Eutroperox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Eutroperox

DDCE. Other Eutroperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Eutroperox

DDCF. Other Eutroperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Eutroperox

DDCG. Other Eutroperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Eutroperox

DDCH. Other Eutroperox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth or 150 cm of the soil surface.

Kandiudalfic Eutroperox

DDCI. Other Eutroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and have the lower boundary of the oxic horizon within a depth of 125 cm of the soil surface.

Umbreptic Eutroperox

DDCJ. Other Eutroperox that have the lower boundary of the oxic horizon within a depth of 125 cm of the soil surface.

Inceptic Eutroperox

DDCK. Other Eutroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Eutroperox

DDCL. Other Eutroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Eutroperox

DDCM. Other Eutroperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Eutroperox

DDCN. Other Eutroperox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Eutroperox

DDCO. Other Eutroperox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Eutroperox

DDCP. Other Eutroperox.

Typic Eutroperox

Haploperox

Key to subgroups

DDEA. Haploperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Haploperox

DDEB. Other Haploperox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Haploperox

DDEC. Other Haploperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Haploperox

DDED. Other Haploperox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Haploperox

DDEE. Other Haploperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Haploperox

DDEF. Other Haploperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Haploperox

DDEG. Other Haploperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Haploperox

DDEH. Other Haploperox that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haploperox

DDEI. Other Haploperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Haploperox

DDEJ. Other Haploperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Haploperox

DDEK. Other Haploperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Haploperox

DDEL. Other Haploperox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Haploperox

DDEM. Other Haploperox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Haploperox

DDEN. Other Haploperox.

Typic Haploperox

Kandiperox

Key to subgroups

DDDA. Kandiperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Kandiperox

DDDB. Other Kandiperox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Kandiperox

DDDC. Other Kandiperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Kandiperox

DDDD. Other Kandiperox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Kandiperox

DDDE. Other Kandiperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Kandiperox

DDDF. Other Kandiperox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Kandiperox

DDDG. Other Kandiperox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Kandiperox

DDDH. Other Kandiperox that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kandiperox

DDDI. Other Kandiperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Kandiperox

DDDJ. Other Kandiperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Kandiperox

DDDK. Other Kandiperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Kandiperox

DDDL. Other Kandiperox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Kandiperox

DDDM. Other Kandiperox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Kandiperox

DDDN. Other Kandiperox.

Typic Kandiperox

Sombriperox

Key to subgroups

DDAA. Sombriperox that have a petroferric contact within a depth of 125 cm of the soil surface.

Petroferric Sombriperox

DDAB. Other Sombriperox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Sombriperox

DDAC. Other Sombriperox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Sombriperox

DDAD. Other Sombriperox.

Typic Sombriperox

TORROX

Key to great groups

DBA. Torrox that have both an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more in some part of the oxic horizon within a depth of 150 cm of the soil surface.

Acrotorrox, p. 343

DBB. Other Torrox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutrotorrox, p. 343

DBC. Other Torrox.

Haplotorrox, p. 344

Acrotorrox

Key to subgroups

DBAA. Acrotorrox that have a petroferric contact within a depth of 125 cm of the soil surface.

Petroferric Acrotorrox

DBAB. Other Acrotorrox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Acrotorrox

DBAC. Other Acrotorrox.

Typic Acrotorrox

Eutrotorrox

Key to subgroups

DBBA. Eutrotorrox that have a petroferric contact within a depth of 125 cm of the soil surface.

Petroferric Eutrotorrox

DBBB. Other Eutrotorrox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Eutrotorrox

DBBC. Other Eutrotorrox.

Typic Eutrotorrox

Haplotorrox

Key to subgroups

DBCA. Haplotorrox that have a petroferric contact within a depth of 125 cm of the soil surface.

Petroferric Haplotorrox

DBCB. Other Haplotorrox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Haplotorrox

DBCC. Other Haplotorrox.

Typic Haplotorrox

UDOX

Key to great groups

DEA. Udox that have a sombric horizon within a depth of 150 cm of the soil surface.

Sombriudox, p. 350

DEB. Other Udox that have both an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5.0 or more in some part of the oxic or kandic horizon within a depth of 150 cm of the soil surface.

Acrudox, p. 344

DEC. Other Udox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutrudox, p. 346

DED. Other Udox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth of 150 cm of the surface.

Kandiudox, p. 349

DEE. Other Udox.

Hapludox, p. 347

Acrudox

Key to subgroups

DEBA. Acrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Acrudox

DEBB. Other Acrudox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Acrudox

DEBC. Other Acrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Acrudox

DEBD. Other Acrudox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Acrudox

DEBE. Other Acrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and have a delta pH (KCl pH - 1:1 water pH) with a 0 or net positive charge in some layer 18 cm or more thick within a depth of 125 cm of the soil surface.

Aquic Anionic Acrudox

DEBF. Other Acrudox that have a delta pH (KCl pH - 1:1 water pH) with a 0 or net positive charge in some layer 18 cm or more thick within a depth of 125 cm of the soil surface.

Anionic Acrudox

DEBG. Other Acrudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Acrudox

DEBH. Other Acrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Acrudox

DEBI. Other Acrudox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutric Acrudox

DEBJ. Other Acrudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Acrudox

DEBK. Other Acrudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Acrudox

DEBL. Other Acrudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Acrudox

DEBM. Other Acrudox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Acrudox

DEBN. Other Acrudox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Acrudox

DEBO. Other Acrudox.

Typic Acrudox

Eutrudox

Key to subgroups

DECA. Eutrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Eutrudox

DECB. Other Eutrudox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Eutrudox

DECC. Other Eutrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Eutrudox

DECD. Other Eutrudox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Eutrudox

DECE. Other Eutrudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Eutrudox

DECF. Other Eutrudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Eutrudox

DECG. Other Eutrudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Eutrudox

DECH. Other Eutrudox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth or 150 cm of the soil surface.

Kandiudalfic Eutrudox

DECI. Other Eutrudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and have the lower boundary of the oxic horizon within a depth of 125 cm of the soil surface.

Umbreptic Eutrudox

DECJ. Other Eutrudox that have the lower boundary of the oxic horizon within a depth of 125 cm of the soil surface.

Inceptic Eutrudox

DECK. Other Eutrudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Eutrudox

DECL. Other Eutrudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Eutrudox

DECM. Other Eutrudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Eutrudox

DECN. Other Eutrudox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Eutrudox

DECO. Other Eutrudox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Eutrudox

DECP. Other Eutrudox.

Typic Eutrudox

Hapludox

Key to subgroups

DEEA. Hapludox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Hapludox

DEEB. Other Hapludox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Hapludox

DEEC. Other Hapludox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Hapludox

DEED. Other Hapludox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Hapludox

DEEE. Other Hapludox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Hapludox

DEEF. Other Hapludox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Hapludox

DEEG. Other Hapludox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Hapludox

DEEH. Other Hapludox that have the lower boundary of the oxic horizon within a depth or 125 cm of the soil surface.

Inceptic Hapludox

DEEI. Other Hapludox that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Hapludox

DEEJ. Other Hapludox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Hapludox

DEEK. Other Hapludox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Hapludox

DEEL. Other Hapludox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Hapludox

DEEM. Other Hapludox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Hapludox

DEEN. Other Hapludox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Hapludox

DEEO. Other Hapludox.

Typic Hapludox

Kandiudox

Key to subgroups

DEDA. Kandiudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Kandiudox

DEDB. Other Kandiudox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Kandiudox

DEDC. Other Kandiudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Kandiudox

DEDD. Other Kandiudox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Kandiudox

DEDE. Other Kandiudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Kandiudox

DEDF. Other Kandiudox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Kandiudox

DEDG. Other Kandiudox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Kandiudox

DEDH. Other Kandiudox that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kandiudox

DEDI. Other Kandiudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Kandiudox

DEDJ. Other Kandiudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Kandiudox

DEDK. Other Kandiudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Kandiudox

DEDL. Other Kandiudox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Kandiudox

DEDM. Other Kandiudox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Kandiudox

DEDN. Other Kandiudox.

Typic Kandiudox

Sombriudox

Key to subgroups

DEAA. Sombriudox that have a petroferric contact within a depth of 125 cm of the soil surface.

Petroferric Sombriudox

DEAB. Other Sombriudox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Sombriudox

DEAC. Other Sombriudox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Sombriudox

DEAD. Other Sombriudox.

Typic Sombriudox

USTOX

Key to great groups

DCA. Ustox that have a *sombric* horizon within 150 cm of the soil surface.

Sombriustox, p. 356

DCB. Other Ustox that have both an apparent ECEC of less than 1.50 cmol(+) per kg clay and a pH value (1N KCl) of 5 or more in some part of the oxic or kandic horizon within a depth of 150 cm of the soil surface.

Acrustox, p. 351

DCC. Other Ustox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutrustox, p. 352

DCD. Other Ustox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth of 150 cm of the soil surface.

Kandiustox, p. 355

DCE. Other Ustox.

Haplustox, p. 353

Acrustox

Key to subgroups

DCBA. Acrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Acrustox

DCBB. Other Acrustox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Acrustox

DCBC. Other Acrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Acrustox

DCBD. Other Acrustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Acrustox

DCBE. Other Acrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and have a delta pH (KCl pH - 1:1 water pH) with a 0 or net positive charge in some layer 18 cm or more thick within a depth of 125 cm of the soil surface.

Aquic Anionic Acrustox

DCBF. Other Acrustox that have a delta pH (KCl pH - 1:1 water pH) with a 0 or net positive charge in some layer 18 cm or more thick within a depth of 125 cm of the soil surface.

Anionic Acrustox

DCBG. Other Acrustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Acrustox

DCBH. Other Acrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Acrustox

DCBI. Other Acrustox that have more than 35 percent base saturation (NH_4OAc) in all parts within a depth of 125 cm of the soil surface.

Eutric Acrustox

DCBJ. Other Acrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Acrustox

DCBK. Other Acrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Acrustox

DCBL. Other Acrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Acrustox

DCBM. Other Acrustox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Acrustox

DCBN. Other Acrustox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Acrustox

DCBO. Other Acrustox.

Typic Acrustox

Eutrustox

Key to subgroups

DCCA. Eutrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Eutrustox

DCCB. Other Eutrustox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Eutrustox

DCCC. Other Eutrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Eutrustox

DCCD. Other Eutrustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Eutrustox

DCCE. Other Eutrustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Eutrustox

DCCF. Other Eutrustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Eutrustox

DCCG. Other Eutrustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Eutrustox

DCCH. Other Eutrustox that have more than 40 percent clay in the surface 18 cm after mixing, and have the upper boundary of a kandic horizon within a depth or 150 cm of the soil surface.

Kandiustalfic Eutrustox

DCCI. Other Eutrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and have the lower boundary of the oxic horizon within a depth of 125 cm of the soil surface.

Umbreptic Eutrustox

DCCJ. Other Eutrustox that have the lower boundary of the oxic horizon within a depth of 125 cm of the soil surface.

Inceptic Eutrustox

DCCK. Other Eutrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Eutrustox

DCCL. Other Eutrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Eutrustox

DCCM. Other Eutrustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Eutrustox

DCCN. Other Eutrustox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Eutrustox

DCCO. Other Eutrustox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Eutrustox

DCCP. Other Eutrustox.

Typic Eutrustox

Haplustox

Key to subgroups

DCEA. Haplustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Haplustox

DCEB. Other Haplustox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Haplustox

DCEC. Other Haplustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Haplustox

DCED. Other Haplustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Haplustox

DCEE. Other Haplustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Haplustox

DCEF. Other Haplustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Haplustox

DCEG. Other Haplustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and have the lower boundary of the oxic horizon within a depth or 125 cm of the soil surface.

Aqueptic Haplustox

DCEH. Other Haplustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Haplustox

DCEI. Other Haplustox that have the lower boundary of the oxic horizon within a depth or 125 cm of the soil surface.

Inceptic Haplustox

DCEJ. Other Haplustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Haplustox

DCEK. Other Haplustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Haplustox

DCEL. Other Haplustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Haplustox

DCEM. Other Haplustox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Haplustox

DCEN. Other Haplustox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Haplustox

DCEO. Other Haplustox.

Typic Haplustox

Kandiustox

Key to subgroups

DCDA. Kandiustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a petroferric contact within 125 cm of the soil surface.

Aquic Petroferric Kandiustox

DCDB. Other Kandiustox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Kandiustox

DCDC. Other Kandiustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface and a lithic contact within 125 cm of the soil surface.

Aquic Lithic Kandiustox

DCDD. Other Kandiustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Kandiustox

DCDE. Other Kandiustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface and mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Plinthaquic Kandiustox

DCDF. Other Kandiustox that have more than 5 percent plinthite in some horizon within a depth of 125 cm of the soil surface.

Plinthic Kandiustox

DCDG. Other Kandiustox that have mottles of 4 or more value moist and 2 or less chroma within a depth of 125 cm of the soil surface.

Aquic Kandiustox

DCDH. Other Kandiustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Humic Rhodic Kandiustox

DCDI. Other Kandiustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter, and color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Humic Xanthic Kandiustox

DCDJ. Other Kandiustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Kandiustox

DCDK. Other Kandiustox that have a color hue of 2.5YR or redder with moist values of less than 4 in most of the 25 to 125 cm depth from the soil surface.

Rhodic Kandiustox

DCDL. Other Kandiustox that have a color hue of 7.5YR or yellower with moist values of 6 or more in most of the 25 to 125 cm depth from the soil surface.

Xanthic Kandiustox

DCDM. Other Kandiustox.

Typic Kandiustox

Sombriustox

Key to subgroups

DCAA. Sombriustox that have a petroferric contact within a depth of 125 cm of the soil surface.

Petroferric Sombriustox

DCAB. Other Sombriustox that have a lithic contact within a depth of 125 cm of the soil surface.

Lithic Sombriustox

DCAC. Other Sombriustox that have 16 kg or more organic carbon per square meter to a depth of 100 cm, exclusive of surface litter.

Humic Sombriustox

DCAD. Other Sombriustox.

Typic Sombriustox

Chapter 13

Spodosols

KEY TO SUBORDERS

CA. Spodosols that either have an aquic moisture regime[1] or are artificially drained and have characteristics associated with wetness, namely one or more of the following:

1. A histic epipedon; *or*

2. Mottling in an albic horizon or in the upper part of the spodic horizon; *or*

3. A duripan in the albic horizon; *or*

4. If free iron and manganese are absent or if the color value, moist, is less than 4 in the upper part of the spodic horizon, *either*

   a. Have any color if there are no coatings of iron oxides on the individual grains of silt and sand in or immediately below the spodic horizon wherever the value, moist, is 4 or more; *or*

   b. Have fine or medium mottles of iron or manganese in the materials immediately below the spodic horizon; *or*

5. A placic horizon that rests on a fragipan or on a spodic horizon or on an albic horizon that is underlain by a spodic horizon but is not in a spodic horizon.

Aquods, p. 357

CB. Other Spodosols that have a spodic horizon in which the ratio of free iron (by dithionite-citrate) to carbon (both elemental) is 6 or more in all subhorizons.

Ferrods, p. 363

CC. Other Spodosols that have a spodic horizon in which some subhorizon that is present in more than half of each pedon has a ratio of free iron to carbon of less than 0.2.

Humods, p. 363

CD. Other Spodosols.

Orthods, p. 367

AQUODS

Key to great groups

CAA. Aquods that have a fragipan below the spodic horizon but do not have a placic horizon above the fragipan.

Fragiaquods, p. 359

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[1] If a placic horizon, duripan, or fragipan is present, the soil need not be saturated below that horizon.

CAB. Other Aquods that do not have a placic horizon but have a cryic temperature regime.

Cryaquods, p. 358

CAC. Other Aquods that have a strongly cemented or indurated albic horizon that does not slake in water when a dry fragment is immersed.

Duraquods, p. 359

CAD. Other Aquods that have a placic horizon that rests on a spodic horizon or on a fragipan or on an albic horizon that rests on a spodic horizon.

Placaquods, p. 361

CAE. Other Aquods that have a mean annual soil temperature of 8°C or higher and mean summer and mean winter soil temperatures at a depth of 50 cm that differ by less than 5°C.

Tropaquods, p. 362

CAF. Other Aquods that have in more than 50 percent of each pedon a spodic horizon in which some subhorizon has a ratio of free iron (by dithionite-citrate) to carbon (both elemental) that is less than 0.2.

Haplaquods, p. 359

CAG. Other Aquods.

Sideraquods, p. 361

Cryaquods

Key to subgroups

CABA. Cryaquods that have a lithic contact within 50 cm of the surface of the mineral soil.

Lithic Cryaquods

CABB. Other Cryaquods that:

1. Have a mean annual soil temperature of 0°C or less; *and*

2. Have a ratio of free iron to carbon (elemental) of 0.2 or more throughout.

Pergelic Sideric Cryaquods

CABC. Other Cryaquods that have a mean annual soil temperature of 0°C or less.

Pergelic Cryaquods

CABD. Other Cryaquods that have a ratio of free iron to carbon (elemental) of 0.2 or more throughout.

Sideric Cryaquods

CABE. Other Cryaquods that have an argillic or kandic horizon.

Alfic Cryaquods

CABF. Other Cryaquods that do not have a continuous spodic horizon that is 10 cm or more thick or that is very firm when moist.

Entic Cryaquods

CABG. Other Cryaquods.

Typic Cryaquods

Duraquods

Duraquods are the Aquods that have a duripan in the albic horizon and have a temperature regime warmer than that of Cryaquods.

Fragiaquods

Key to subgroups

CAAA. Fragiaquods that have a cryic or colder temperature regime.

Cryic Fragiaquods

CAAB. Other Fragiaquods that have a histic epipedon.

Histic Fragiaquods

CAAC. Other Fragiaquods that have 5 percent or more by volume of iron-cemented nodules 2.5 to 30 cm in diameter throughout the spodic horizon.

Sideric Fragiaquods

CAAD. Other Fragiaquods that have a surface horizon more than 30 cm thick that meets all requirements of a plaggen epipedon except thickness.

Plaggeptic Fragiaquods

CAAE. Other Fragiaquods that have an intermittent upper black subhorizon of the spodic horizon that has a ratio of free iron (elemental) to carbon that is less than 0.2; or if plowed and the Ap horizon rests directly on the spodic horizon, have tongues of such a subhorizon.

Humic Fragiaquods

CAAF. Other Fragiaquods that have an argillic or kandic horizon.

Alfic Fragiaquods

CAAG. Other Fragiaquods.

Typic Fragiaquods

Haplaquods

Key to subgroups

CAFA. Haplaquods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplaquods

CAFB. Other Haplaquods that have a placic horizon in or below the spodic horizon.

Placic Haplaquods

CAFC. Other Haplaquods that have a histic epipedon.

Histic Haplaquods

CAFD. Other Haplaquods that

1. Have an umbric epipedon or the surface layer would meet the requirements for an umbric epipedon if it were plowed to a depth of 25 cm; *and*

2. Have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is deeper than 75 cm below the soil surface.

Arenic Umbric Haplaquods

CAFE. Other Haplaquods that:

1. Have an argillic or kandic horizon underlying the spodic horizon and have either base saturation of 35 percent or more (by sum of cations) in some part of the argillic or kandic horizon or have a mean annual soil temperature lower than 8°C; *and*

2. Have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 75 and 125 cm below the soil surface.

Alfic Arenic Haplaquods

CAFF. Other Haplaquods that:

1. Have an argillic or kandic horizon underlying the spodic horizon; *and*

2. Have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 75 and 125 cm below the soil surface.

Arenic Ultic Haplaquods

CAFG. Other Haplaquods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 75 and 125 cm below the soil surface.

Arenic Haplaquods

CAFH. Other Haplaquods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 125 and 200 cm below the soil surface.

Grossarenic Haplaquods

CAFI. Other Haplaquods that:

1. Have an argillic or kandic horizon underlying the spodic horizon; *and*

2. Have 5 percent or more by volume of iron-cemented nodules 2.5 to 30 cm in diameter throughout the spodic horizon.

Ferrudalfic Haplaquods

CAFJ. Other Haplaquods that have 5 percent or more by volume of iron-cemented nodules 2.5 to 30 cm in diameter throughout the spodic horizon.

Sideric Haplaquods

CAFK. Other Haplaquods that have an argillic or kandic horizon underlying the spodic horizon and have either base saturation of 35 percent or more (by sum of cations) in some part of the argillic or kandic horizon or have a mean annual soil temperature lower than 8°C.

Alfic Haplaquods

CAFL. Other Haplaquods that have an argillic or kandic horizon underlying the spodic horizon.

Ultic Haplaquods

CAFM. Other Haplaquods that:

1. Have an ochric epipedon, and the surface layer would not meet the requirements for an umbric epipedon if it were plowed to a depth of 25 cm; *and*

2. Have a spodic horizon that has a weighted average of less than 0.6 percent organic carbon in the matrix of the upper 30 cm of the spodic horizon, and the upper subhorizon of the spodic horizon *either*

   a. Has less than 2.3 percent organic carbon in the upper 2 cm; *or*

   b. The subhorizon with 2.3 percent or more organic carbon is present in 90 percent or less of each pedon.

Entic Haplaquods

CAFN. Other Haplaquods that do not have an umbric epipedon or one that would meet the requirements for an umbric epipedon if it were plowed to a depth of 25 to 30 cm.

Aeric Haplaquods

CAFO. Other Haplaquods.

Typic Haplaquods

Placaquods

Key to subgroups

CADA. All Placaquods (provisional).

Typic Placaquods

Sideraquods

Key to subgroups

CAGA. Sideraquods that have a histic epipedon.

Histic Sideraquods

CAGB. Other Sideraquods that have an argillic or kandic horizon and have base saturation of 35 percent or more (by sum of cations) in some part of the argillic or kandic horizon or have a mean annual soil temperature lower than 8°C.

Alfic Sideraquods

CAGC. Other Sideraquods that have an argillic or kandic horizon.

Ultic Sideraquods

CAGD. Other Sideraquods that have a spodic horizon that *either*:

1. Is not very firm or firmer in any subhorizon when moist; *or*

2. Is 10 cm or less thick or contains less than 1.2 percent organic carbon in the upper 10 cm.

Entic Sideraquods

CAGE. Other Sideraquods.

Typic Sideraquods

Tropaquods

Key to subgroups

CAEA. Tropaquods that:

1. Have a histic epipedon; *and*

2. Have a lithic contact within 50 cm of the surface.

Histic Lithic Tropaquods

CAEB. Other Tropaquods that have a lithic contact within 50 cm of the surface.

Lithic Tropaquods

CAEC. Other Tropaquods that have a histic epipedon.

Histic Tropaquods

CAED. Other Tropaquods that

1. Have an umbric epipedon; *and*

2. Have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is deeper than 75 cm below the soil surface.

Arenic Umbric Tropaquods

CAEE. Other Tropaquods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 75 and 125 cm below the soil surface.

Aeric Arenic Tropaquods

CAEF. Other Tropaquods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 125 and 200 cm below the soil surface.

Aeric Grossarenic Tropaquods

CAEG. Other Tropaquods that have *either*

1. 5 percent or more by volume of iron-cemented nodules, 2.5 to 30 cm in diameter, throughout the spodic horizon; *or*

2. Have in less than 50 percent of each pedon a spodic horizon in which some subhorizon has a ratio of free iron (by dithionite-citrate) to carbon (both elemental) of less than 0.2.

Sideric Tropaquods

CAEH. Other Tropaquods that have an argillic or kandic horizon underlying the spodic horizon.

Ultic Tropaquods

CAEI. Other Tropaquods that have a spodic horizon that has a weighted average of less than 0.6 percent organic carbon in the matrix of the upper 30 cm of the spodic horizon, and the upper subhorizon of the spodic horizon *either*

1. Has less than 2.3 percent organic carbon in the upper 2 cm; *or*

2. The horizon with 2.3 percent or more organic carbon is present in 90 percent or less of each pedon.

Entic Tropaquods

CAEJ. Other Tropaquods that have an ochric epipedon, and the surface layer would not meet the requirements for an umbric epipedon if plowed to a depth of 25 cm.

Aeric Tropaquods

CAEK. Other Tropaquods.

Typic Tropaquods

FERRODS

This suborder is provisional. Ferrods are not known to occur in the United States, but the suborder is provided for use elsewhere. The classification has not been developed.

Ferrods are the Spodosols that

1. Have a spodic horizon that has in all subhorizons a ratio of percentage of free iron (by dithionite-citrate) to percentage of carbon (both elemental) of 6 or more; *and*

2. Do not have an aquic moisture regime or artificial drainage or do not have the characteristics associated with wetness as defined for Aquods.

HUMODS

Key to great groups

CCA. Humods that have a placic horizon in the spodic horizon.

Placohumods, p. 366

CCB. Other Humods that have an isomesic or warmer iso temperature regime.

Tropohumods, p. 366

CCC. Other Humods that have a fragipan below the spodic horizon.

Fragihumods, p. 364

CCD. Other Humods that have a cryic temperature regime.

Cryohumods, p. 364

CCE. Other Humods.

Haplohumods, p. 365

Cryohumods

Key to subgroups

CCDA. Cryohumods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryohumods

CCDB. Other Cryohumods that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryohumods

CCDC. Other Cryohumods that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryohumods

CCDD. Other Cryohumods that have an intermittent placic horizon in the spodic horizon.

Placic Cryohumods

CCDE. Other Cryohumods that have an argillic or kandic horizon below the spodic horizon.

Alfic Cryohumods

CCDF. Other Cryohumods that have less than 6 percent organic carbon (weighted average) in the matrix of the upper 30 cm of the spodic horizon or, if the spodic horizon is less than 30 cm thick, in the 30 cm directly below the top of the spodic horizon.

Haplic Cryohumods

CCDG. Other Cryohumods.

Typic Cryohumods

Fragihumods

These are the Humods that have a fragipan below the spodic horizon and do not have a placic horizon. They are not known to occur in the United States, and the classification of subgroups has not been developed.

Haplohumods

Key to subgroups

CCEA. Haplohumods that have a lithic contact within 50 cm of the soil surface.

Lithic Haplohumods

CCEB. Other Haplohumods that:

1. Have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 75 and 125 cm below the soil surface; *and*

2. Have an argillic or kandic horizon below the spodic horizon.

Arenic Ultic Haplohumods

CCEC. Other Haplohumods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 75 and 125 cm below the soil surface.

Arenic Haplohumods

CCED. Other Haplohumods that:

1. Have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 125 and 200 cm below the soil surface; *and*

2. Have both:

a. A spodic horizon that has a weighted average of less than 0.6 percent organic carbon in the matrix of the upper 30 cm of the spodic horizon or below any Ap horizon; *and*

b. Any black upper subhorizon of the spodic horizon that has 3 percent or more organic carbon in the upper 2 cm is present in 90 percent or less of the area of each pedon.

Grossarenic Entic Haplohumods

CCEE. Other Haplohumods that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haplohumods

CCEF. Other Haplohumods that have the following combination of characteristics:

1. A spodic horizon that has a weighted average of less than 0.6 percent organic carbon in the matrix of the

upper 30 cm of the spodic horizon or below any Ap horizon; *and*

2. Any black upper subhorizon of the spodic horizon that has 3 percent or more organic carbon in the upper 2 cm is present in 90 percent or less of the area of each pedon.

Entic Haplohumods

CCEG. Other Haplohumods that have a layer starting at the mineral soil surface that has a sandy particle-size class throughout and extends to at least the upper boundary of the spodic horizon, and the upper boundary of the spodic horizon is between 125 and 200 cm below the soil surface.

Grossarenic Haplohumods

CCEH. Other Haplohumods that have 5 percent or more by volume of iron-cemented nodules, 2.5 to 30 cm in diameter, throughout the spodic horizon.

Ferrudalfic Haplohumods

CCEI. Other Haplohumods that have a surface horizon more than 30 cm thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Haplohumods

CCEJ. Other Haplohumods that have an argillic or kandic horizon below the spodic horizon.

Ultic Haplohumods

CCEK. Other Haplohumods that have less than 3 percent organic carbon in the upper 2 cm of the spodic horizon, or any black upper subhorizon of the spodic horizon that has 3 percent or more organic carbon in the upper 2 cm is present in less than 90 percent of the area of each pedon.

Orthic Haplohumods

CCEL. Other Haplohumods that have a xeric moisture regime.

Xeric Haplohumods

CCEM. Other Haplohumods.

Typic Haplohumods

Placohumods

Key to subgroups

CCAA. Placohumods that have a cryic or colder temperature regime.

Cryic Placohumods

CCAB. Other Placohumods.

Typic Placohumods

Tropohumods

Tropohumods are the Humods that have an isomesic or a warmer *iso* temperature regime.

ORTHODS

Key to great groups

CDA. Orthods that have a placic horizon in the spodic horizon.

Placorthods, p. 371

CDB. Other Orthods that have a fragipan below the spodic horizon.

Fragiorthods, p. 368

CDC. Other Orthods that have a cryic or pergelic temperature regime.

Cryorthods, p. 367

CDD. Other Orthods that have an isomesic or warmer iso temperature regime.

Troporthods, p. 371

CDE. Other Orthods.

Haplorthods, p. 369

Cryorthods

Key to subgroups

CDCA. Cryorthods that:

1. Have more than 6 percent organic carbon in the upper 10 cm of the spodic horizon; *and*

2. Have a lithic contact within 50 cm of the soil surface.

Humic Lithic Cryorthods

CDCB. Other Cryorthods that have a lithic contact within 50 cm of the soil surface.

Lithic Cryorthods

CDCC. Other Cryorthods that have a mean annual soil temperature of 0°C or less.

Pergelic Cryorthods

CDCD. Other Cryorthods that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Cryorthods

CDCE. Other Cryorthods that have an argillic or kandic horizon below the spodic horizon.

Boralfic Cryorthods

CDCE. Other Cryorthods that do not have a cemented or indurated spodic horizon and have less than 1.2 percent organic carbon in the upper 10 cm of the spodic horizon.

Entic Cryorthods

CDCF. Other Cryorthods that have more than 6 percent organic carbon in the upper 10 cm of the spodic horizon.

Humic Cryorthods

CDCG. Other Cryorthods.

Typic Cryorthods

Fragiorthods

Key to subgroups

CDBA. Fragiorthods that have a cryic or pergelic temperature regime.

Cryic Fragiorthods

CDBB. Other Fragiorthods that:

1. Have distinct or prominent mottles in the spodic horizon; *and*

2. Have a spodic horizon that does *not* have any of the following:

   a. A continuous horizon that is at least 2.5 cm thick and is very firm or extremely firm when moist (ortstein); *nor*

   b. A texture of very fine sand or finer, and a thickness of more than 10 cm and at least 1.2 percent organic carbon (weighted average) in the upper 10 cm; *nor*

   c. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma of 3 or less in at least the upper 7.5 cm.

Aquentic Fragiorthods

CDBC. Other Fragiorthods that have distinct or prominent mottles in the spodic horizon.

Aquic Fragiorthods

CDBD. Other Fragiorthods that have a surface horizon more than 30 cm thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Fragiorthods

CDBE. Other Fragiorthods that have an argillic or kandic horizon below the spodic horizon and have base saturation of 35 percent or more in some part of the argillic or kandic horizon or have a mean annual soil temperature of less than 8°C.

Alfic Fragiorthods

CDBF. Other Fragiorthods that have an argillic or kandic horizon below the spodic horizon.

Ultic Fragiorthods

CDBG. Other Fragiorthods that have a spodic horizon that does *not* have any of the following:

1. A continuous horizon that is at least 2.5 cm thick and is very firm or extremely firm when moist (ortstein); *nor*

2. A texture of very fine sand or finer, and a thickness of more than 10 cm and at least 1.2 percent organic carbon (weighted average) in the upper 10 cm; *nor*

3. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma of 3 or less in at least the upper 7.5 cm.

Entic Fragiorthods

CDBH. Other Fragiorthods.

Typic Fragiorthods

Haplorthods

Key to subgroups

CDEA. Haplorthods that:

1. Have a spodic horizon that does *not* have any of the following:

a. A continuous horizon at least 2.5 cm thick that is very firm or extremely firm when moist (ortstein); *nor*

b. A texture of very fine sand or finer, and a thickness of more than 10 cm and a weighted average of at least 1.2 percent organic carbon in the upper 10 cm; *nor*

c. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma, moist, of 3 or less in at least the upper 7.5 cm of the spodic horizon; *and*

2. Have a lithic contact within 50 cm of the surface.

Entic Lithic Haplorthods

CDEB. Other Haplorthods that have a lithic contact within 50 cm of the surface.

Lithic Haplorthods

CDEC. Other Haplorthods that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haplorthods

CDED. Other Haplorthods that have a horizon 15 cm or more thick below the spodic horizon and within 100 cm of the surface that has a brittle matrix when wet or contains some durinodes.

Duric Haplorthods

CDEE. Other Haplorthods that:

1. Have distinct or prominent mottles of approximate spherical shape in the spodic horizon and the variability in color is not associated with differences in consistence in such a manner that the redder or darker parts are extremely firm or very firm, and, if

the color is due to uncoated sand grains, have a water table within 100 cm of the soil surface for 60 days or more, cumulative, in most years; *or*

2. Have chroma of 2 or less if mottled, or chroma less than 2 if not mottled, that is dominant in the matrix within 15 cm below the base of the spodic horizon and within 100 cm of the surface of the soil; *and*

3. Have an argillic or kandic horizon below the spodic horizon, and the argillic or kandic horizon either has base saturation of 35 percent or more in some part or has a mean annual soil temperature lower than 8°C.

Aqualfic Haplorthods

CDEF. Other Haplorthods that:

1. Have distinct or prominent mottles of approximate spherical shape in the spodic horizon and the variability in color is not associated with differences in consistence in such a manner that the redder or darker parts are extremely firm or very firm, and, if the color is due to uncoated sand grains, have a water table within 100 cm of the soil surface for 60 days or more, cumulative, in most years; *and*

2. Have a spodic horizon that does *not* have any of the following:

a. A continuous horizon at least 2.5 cm thick that is very firm or extremely firm when moist (ortstein); *nor*

b. A texture of very fine sand or finer, and a thickness of more than 10 cm and a weighted average of at least 1.2 percent organic carbon in the upper 10 cm; *nor*

c. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma, moist, of 3 or less in at least the upper 7.5 cm of the spodic horizon.

Aquentic Haplorthods

CDEG. Other Haplorthods that:

1. Have distinct or prominent mottles of approximate spherical shape in the spodic horizon and the variability in color is not associated with differences in consistence in such a manner that the redder or darker parts are extremely firm or very firm, and, if the color is due to uncoated sand grains, have a water table within 100 cm of the soil surface for 60 days or more, cumulative, in most years; *or*

2. Have chroma of 2 or less if mottled, or chroma less than 2 if not mottled, that is dominant in the matrix within 15 cm below the base of the spodic horizon and within 100 cm of the surface of the soil.

Aquic Haplorthods

CDEH. Other Haplorthods that have an argillic or kandic horizon below the spodic horizon, and the argillic or kandic horizon either has base saturation of 35 percent or more in some part or has a mean annual soil temperature lower than 8°C.

Alfic Haplorthods

CDEI. Other Haplorthods that have an argillic or kandic horizon below the spodic horizon.

Ultic Haplorthods

CDEJ. Other Haplorthods that:

1. Have a black intermittent upper subhorizon that has a ratio of free iron (elemental) to carbon that is less than 0.2; *or*

2. Have 6 percent or more organic carbon in the upper 10 cm of the spodic horizon.

Humic Haplorthods

CDEK. Other Haplorthods that have a spodic horizon that does *not* have any of the following:

1. A continuous horizon at least 2.5 cm thick that is very firm or extremely firm when moist (ortstein); *nor*

2. A texture of very fine sand or finer, and a thickness of more than 10 cm and a weighted average of at least 1.2 percent organic carbon in the upper 10 cm; *nor*

3. A coarse-loamy, loamy-skeletal, sandy-skeletal, or sandy particle-size class and color value and chroma, moist, of 3 or less in at least the upper 7.5 cm of the spodic horizon.

Entic Haplorthods

CDEL. Other Haplorthods.

Typic Haplorthods

Placorthods

These are the orthods that have a placic horizon in the spodic horizon. They are not known to occur in the United States, and they are thought to be rare elsewhere in the world. Subgroups have not been defined.

Troporthods

These are the Orthods that have an isomesic or warmer *iso* temperature regime. They are not known to occur in the United States, but the group is provided for use elsewhere. Subgroups have not been defined.

Chapter 14

Ultisols

KEY TO SUBORDERS

GA. Ultisols, either saturated with water at some time of year or artificially drained, that have characteristics associated with wetness, namely, mottles, iron-manganese concretions more than 2 mm in diameter, or chroma, moist, of 2 or less immediately below any Ap or A horizon that has a value, moist, of 3 or less when rubbed; and also *one or more* of the following:

1. Dominant chroma, moist, of 2 or less in coatings on the surface of peds and mottles within the peds, or dominant chroma of 2 or less in the matrix of the argillic or kandic horizon and mottles of higher chroma (if the hue is redder than 10YR because of parent materials that remain red after citrate-dithionite extraction, the requirement for low chroma is waived); *or*

2. Chroma, moist, of 1 or less on surfaces of peds or in the matrix of the argillic or kandic horizon; *or*

3. Dominant hue of 2.5Y or 5Y in the matrix of the argillic or kandic horizon and distinct or prominent mottles and also a thermic or isothermic or warmer soil temperature regime.

Aquults, p. 373

GB. Other Ultisols that have *either or both* of the following characteristics:

1. Have 0.9 percent or more organic carbon in the upper 15 cm of the argillic or kandic horizon; *or*

2. Have 12 kg or more organic carbon in the soil per square meter to a depth of 100 cm below the top of the mineral soil surface, exclusive of any O horizon that may be present.

Humults, p. 379

GC. Other Ultisols that have a udic moisture regime.

Udults, p. 384

GD. Other Ultisols that have an ustic moisture regime.

Ustults, p. 397

GE. Other Ultisols that have a xeric moisture regime.

Xerults, p. 403

AQUULTS

Key to great groups

GAA. Aquults that have plinthite that forms a continuous phase or constitutes more than half the matrix of some subhorizon within 150 cm of the soil surface.

Plinthaquults, p. 378

GAB. Other Aquults that have a fragipan and, if there is 5 percent or more by volume of plinthite in some subhorizon, the upper boundary of the fragipan is within 100 cm of the surface of the soil.

Fragiaquults, p. 375

GAC. Other Aquults that have an abrupt textural change between the ochric epipedon or the albic horizon and the argillic or kandic horizon, and have slow hydraulic conductivity in the argillic or kandic horizon.

Albaquults, p. 375

GAD. Other Aquults that

1. Have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm; *and*

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

3. Have a clay distribution such that the percentage of clay does not decrease from its maximum by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Kandiaquults, p. 376

GAE. Other Aquults that have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhaplaquults, p. 377

GAF. Other Aquults that do not have a lithic, paralithic, or petroferric contact within 150 cm of the soil surface and have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Paleaquults, p. 378

GAG. Other Aquults that have an ochric epipedon.

Ochraquults, p. 377

GAH. Other Aquults that have an umbric or a mollic epipedon.

Umbraquults, p. 379

Albaquults

Key to subgroups

GACA. Albaquults that:

1. Have *one or more* of the following characteristics in more than 40 percent of the matrix between the Ap horizon and a depth of 75 cm:

a Dominant chroma, moist, of 3 or more if mottles of higher chroma are present; *or*

b. Chroma, moist, of 2 or more if mottles are absent; *or*

c. Dominant hue of 10YR or redder if distinct or prominent mottles are present and there is also a thermic, isothermic, or warmer soil temperature regime; *or*

2. Have an ochric epipedon that has higher chroma or redder hue, or both, than the underlying argillic or kandic horizon.

Aeric Albaquults

GACB. Other Albaquults.

Typic Albaquults

Fragiaquults

Key to subgroups

GABA. Fragiaquults that:

1. Either do not have mottles or have dominant chroma of 3 or more in some subhorizon between the A or Ap horizon and the fragipan; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthudic Fragiaquults

GABB. Other Fragiaquults that either do not have mottles or have dominant chroma of 3 or more in some subhorizon between the A or Ap horizon and the fragipan.

Aeric Fragiaquults

GABC. Other Fragiaquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the 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 (sum of bases plus 1N KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons to a depth of 150 cm below the soil surface.

Acric Kandiaquults

GADB. Other Kandiaquults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthic Kandiaquults

GADC. Other Kandiaquults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Do not have an ochric epipedon.

Arenic Umbric Kandiaquults

GADD. Other Kandiaquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiaquults

GADE. Other Kandiaquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface.

Grossarenic Kandiaquults

GADF. Other Kandiaquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiaquults

GADG. Other Kandiaquults that have a subhorizon that has dominant chroma of 3 or more within 75 cm of the soil surface.

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 a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Aquandic Kanhaplaquults

GAEB. Other Kanhaplaquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kanhaplaquults

GAEC. Other Kanhaplaquults that:

1. Have a subhorizon that has dominant chroma of 3 or more within 75 cm of the soil surface; *and*

2. Have a mollic or histic epipedon.

Aeric Umbric Kanhaplaquults

GAED. Other Kanhaplaquults that have a subhorizon that has dominant chroma of 3 or more within 75 cm of the soil surface.

Aeric Kanhaplaquults

GAEE. Other Kanhaplaquults that have a mollic or histic epipedon.

Umbric Kanhaplaquults

GAEF. Other Kanhaplaquults.

Typic Kanhaplaquults

Ochraquults

Key to subgroups

GAGA. Ochraquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Ochraquults

GAGB. Other Ochraquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Ochraquults

GAGC. Other Ochraquults that have dominant chroma of 3 or more in one or more subhorizons between the A or Ap horizon and a depth of 75 cm.

Aeric Ochraquults

GAGD. Other Ochraquults.

Typic Ochraquults

Paleaquults

Key to subgroups

GAFA. Paleaquults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Arenic Plinthic Paleaquults

GAFB. Other Paleaquults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. Do not have an ochric epipedon.
Arenic Umbric Paleaquults

GAFC. Other Paleaquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.
Arenic Paleaquults

GAFD. Other Paleaquults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.
Grossarenic Paleaquults

GAFE. Other Paleaquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Plinthic Paleaquults

GAFF. Other Paleaquults that have a subhorizon that has dominant chroma of 3 or more within 75 cm of the soil surface.
Aeric Paleaquults

GAFG. Other Paleaquults that do not have an ochric epipedon.
Umbric Paleaquults

GAFH. Other Paleaquults.
Typic Paleaquults

Plinthaquults

Key to subgroups

GAAA. Plinthaquults that have a CEC of less than 24 cmol(+) per kg of clay (by 1N NH_4OAc pH 7) in the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kandic Plinthaquults

GAAB. Other Plinthaquults.

Typic Plinthaquults

Umbraquults

Key to subgroups

GAHA. Umbraquults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Umbraquults

GAHB. Other Umbraquults.

Typic Umbraquults

HUMULTS

Key to great groups

GBA. Humults that have a sombric horizon within 100 cm of the soil surface.

Sombrihumults, p. 384

GBB. Other Humults that have plinthite that forms a continuous phase or constitutes more than 50 percent of the volume of some subhorizon within 150 cm of the soil surface.

Plinthohumults, p. 384

GBC. Other Humults that

1. Have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm; *and*

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

3. Have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Kandihumults, p. 381

GBD. Other Humults that have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhaplohumults, p. 382

GBE. Other Humults that have a clay distribution such that the percentage of clay does not decrease from its maximum amount by 20 percent or more within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Palehumults, p. 383

GBF. Other Humults.

Haplohumults, p. 380

Haplohumults

Key to subgroups

GBEA. Haplohumults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplohumults

GBEB. Other Haplohumults that have the following combination of characteristics in the upper 25 cm or more of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or more or they are artificially drained.

Aquic Haplohumults

GBEC. Other Haplohumults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haplohumults

GBED. Other Haplohumults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Haplohumults

GBEE. Other Haplohumults that have an ustic soil moisture regime.

Ustic Haplohumults

GBEF. Other Haplohumults that have a xeric soil moisture regime.

Xeric Haplohumults

GBEG. Other Haplohumults.

Typic Haplohumults

Kandihumults

Definition

Key to subgroups

GBCA. Kandihumults that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. Have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Andic Epiaquic Kandihumults

GBCB. Other Kandihumults that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. Have an ustic soil moisture regime.

Ustandic Kandihumults

GBCC. Other Kandihumults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kandihumults

GBCD. Other Kandihumults that have the following combination of characteristics in the upper 25 cm or more of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more, and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or more or there is artificial drainage.

Aquic Kandihumults

GBCE. Other Kandihumults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Kandihumults

GBCF. Other Kandihumults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandihumults

GBCG. Other Kandihumults that have an ustic soil moisture regime.

Ustic Kandihumults

GBCH. Other Kandihumults that have a xeric soil 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

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. Have an ustic soil moisture regime.

Ustandic Kanhaplohumults

GBDC. Other Kanhaplohumults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kanhaplohumults

GBDD. Other Kanhaplohumults that have the following combination of characteristics in the upper 25 cm or more of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of the year when the soil temperature in that zone is 5°C or higher or there is artificial drainage.

Aquic Kanhaplohumults

GBDE. Other Kanhaplohumults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Kanhaplohumults

GBDF. Other Kanhaplohumults that have an ustic soil moisture regime.

Ustic Kanhaplohumults

GBDG. Other Kanhaplohumults that have a xeric soil moisture regime.

Xeric Kanhaplohumults

GBDH. Other Kanhaplohumults that have an anthropic epipedon.

Anthropic Kanhaplohumults

GBDI. Other Kanhaplohumults.

Typic Kanhaplohumults

Palehumults

Key to subgroups

GBEA. Other Palehumults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Palehumults

GBEB. Palehumults that have the following combination of characteristics in the upper 25 cm or more of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more, and chroma, moist, of 2 of less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or more or there is artificial drainage.

Aquic Palehumults

GBEC. Other Palehumults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the 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

These are the Humults that have plinthite that forms a continuous phase or that constitutes more than half the volume of some subhorizon within 125 cm of the soil surface. They are not known to occur in the United States, but the great group has been proposed for other countries (Sys 1969). Subgroups have not been developed.

Sombrihumults

These are the Humults that have a sombric horizon whose upper boundary is within 100 cm of the soil surface. They are not known to occur in the United States, but the great group is provided for use elsewhere. Humoxic and orthoxic subgroups have been proposed (Sys 1969) for the soils that have low CEC, that is, less than 24 cmol(+) per kg clay. The humoxic subgroup is proposed for soils that have an isothermic or cooler temperature regime and the orthoxic subgroup for soils that have an isohyperthermic temperature regime.

UDULTS

Key to great groups

GCA. Udults that have plinthite that forms a continuous phase or constitutes more than half the volume in some subhorizon within 150 cm of the soil surface.

Plinthudults, p. 397

GCB. Other Udults that have a fragipan in or below the argillic or kandic horizon.

Fragiudults, p. 385

GCC. Other Udults that

1. Have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm; *and*

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

3. Have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Kandiudults, p. 388

GCD. Other Udults that have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhapludults, p. 391

GCE. Other Udults that do not have a lithic or paralithic contact within 150 cm of the mineral soil surface and that have a clay distribution such that the percentage of clay does not decrease from its maximum amount by more than 20 percent within 150 cm of the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Paleudults, p. 393

GCF. Other Udults that have

1. An epipedon that has a color value, moist, of 3 or less in all parts; *and*

2. An argillic horizon that has a color value, dry, of less than 5 and not more than 1 unit higher than the value, moist.

Rhodudults, p. 397

GCG. Other Udults.

Hapludults, p. 387

Fragiudults

Key to subgroups

GCBA. Fragiudults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Fragiudults

GCBB. Other Fragiudults that:

1. Meet *either* of the following:

a. Do not have an argillic or kandic horizon above the fragipan that has some clay skins on both vertical and horizontal surfaces of some structural aggregates; *or*

b. Have an intervening horizon (one or more) between the argillic or kandic horizon and the fragipan that has dominant chroma of 3 or less and that has as much as 3 percent less clay (absolute) than both the overlying argillic or kandic horizon and the underlying fragipan; *and*

2. Have mottles that have chroma of 2 or less within 40 cm of the soil surface; *and*

3. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthaquic Fragiudults

GCBC. Other Fragiudults that:

1. Meet *either* of the following:

a. Do not have an argillic or kandic horizon above the fragipan that has some clay skins on both vertical and horizontal surfaces of some structural aggregates; *or*

b. Have an intervening horizon (one or more) between the argillic or kandic horizon and the fragipan that has dominant chroma of 3 or less and that has as much as 3 percent less clay (absolute) than both the overlying argillic or kandic horizon and the underlying fragipan; *and*

2. Have mottles that have chroma of 2 or less within 40 cm of the soil surface.

Glossaquic Fragiudults

GCBD. Other Fragiudults that have mottles that have chroma of 2 or less above the top of the fragipan and within the upper 25 cm of the argillic or kandic horizon.

Aquic Fragiudults

GCBE. Other Fragiudults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Fragiudults

GCBF. Other Fragiudults that meet *either* of the following:

1. Do not have an argillic or kandic horizon above the fragipan that has some clay skins on both vertical and horizontal surfaces of some structural aggregates; *or*

2. Have an intervening horizon (one or more) between the argillic or kandic horizon and the fragipan that has dominant chroma of 3 or less and that has as much as 3 percent less clay (absolute) than both the overlying argillic or kandic horizon and the underlying fragipan.

Glossic Fragiudults

GCBG. Other Fragiudults that have an Ap horizon that has a color value, moist, of 3 or less and has a value, dry, of 5 or less when crushed and smoothed (smoothed with a knife to eliminate shadows), or the A horizon is 15 cm or more thick and its color value, moist, is 3 or less.

Humic Fragiudults

GCBH. Other Fragiudults.

Typic Fragiudults

Hapludults

Key to subgroups

GCGA. Hapludults that:

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

2. Have a discontinuous argillic horizon in each pedon that is interrupted by ledges of bedrock.

Ruptic-Lithic-Entic Hapludults

GCGB. Other Hapludults that have a lithic contact within 50 cm of the surface of the mineral soil.

Lithic Hapludults

GCGC. Other Hapludults that have the following combination of characteristics:

1. Cracks at some period in most years that are 1 cm or more wide at a depth of 50 cm, that are at least 30 cm long in some part, and that extend upward to the soil surface, to the base of an Ap horizon, or to a depth within 25 cm of the soil surface; *and*

2. A coefficient of linear extensibility (COLE) of 0.09 or more in a horizon or horizons at least 50 cm thick, and a potential linear extensibility of 6 cm or more in the upper 100 cm of the soil or in the whole soil if a lithic or paralithic contact is deeper than 50 cm but shallower than 100 cm; *and*

3. More than 35 percent clay in horizons that total more than 50 cm in thickness.

Vertic Hapludults

GCGD. Other Hapludults that have a texture that is loamy fine sand or coarser throughout the argillic horizon or have an argillic horizon that has lamellae within the upper 25 cm.

Psammentic Hapludults

GCGE. Other Hapludults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Hapludults

GCGF. Other Hapludults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Hapludults

GCGG. Other Hapludults that have the following combination of characteristics in the upper 60 cm of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less, and also mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or artificial drainage.

Aquic Hapludults

GCGH. Other Hapludults that have an Ap horizon that has a color value, moist, of 3 or less and has a value, dry, of 5 or less when crushed and smoothed; or the A horizon is 15 cm or thicker and its color value, moist, is 3 or less.

Humic Hapludults

GCGI. Other Hapludults that have an argillic horizon 25 cm or less thick.

Ochreptic Hapludults

GCGJ. Other Hapludults.

Typic Hapludults

Kandiudults

Key to subgroups

GCCA. Kandiudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

   a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

   b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

3. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthaquic Kandiudults

GCCB. Other Kandiudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

   a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Aquic Arenic Kandiudults

GCCC. Other Kandiudults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthic Kandiudults

GCCD. Other Kandiudults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have, throughout the argillic or kandic horizon, colors with a hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, that is 1 unit or less higher than the value, moist.

Arenic Rhodic Kandiudults

GCCE. Other Kandiudults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiudults

GCCF. Other Kandiudults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Grossarenic Plinthic Kandiudults

GCCG. Other Kandiudults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is more than 100 cm below the soil surface.

Grossarenic Kandiudults

GCCH. Other Kandiudults that:

1. Have an ECEC (sum of bases plus 1N KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one

or more subhorizons within a depth of 150 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Acrudoxic Plinthic Kandiudults

GCCI. Other Kandiudults that have an ECEC (sum of bases plus 1N KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons within a depth of 150 cm below the soil surface.
Acrudoxic Kandiudults

GCCJ. Other Kandiudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Plinthaquic Kandiudults

GCCK. Other Kandiudults that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage.
Aquandic Kandiudults

GCCL. Other Kandiudults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kandiudults

GCCM. Other Kandiudults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage.

Aquic Kandiudults

GCCN. Other Kandiudults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiudults

GCCO. Other Kandiudults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Kandiudults

GCCP. Other Kandiudults that have a sombric horizon within 150 cm of the soil surface.

Sombric Kandiudults

GCCQ. Other Kandiudults that have, throughout the argillic or kandic horizon, colors with a hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, that is 1 unit or less higher than the value, moist.

Rhodic Kandiudults

GCCR. Other Kandiudults.

Typic Kandiudults

Kanhapludults

Key to subgroups

GCDA. Kanhapludults that have a lithic contact within 50 cm of the soil surface.

Lithic Kanhapludults

GCDB. Other Kanhapludults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the

top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Arenic Plinthic Kanhapludults

GCDC. Other Kanhapludults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.
Arenic Kanhapludults

GCDD. Other Kanhapludults that have an ECEC (sum of bases plus 1N KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons within a depth of 150 cm below the soil surface.
Acrudoxic Kanhapludults

GCDE. Other Kanhapludults that:

1. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface; *and*

2. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher or there is artificial drainage.
Plinthaquic Kanhapludults

GCDF. Other Kanhapludults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.
Andic Kanhapludults

GCDG. Other Kanhapludults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher or there is artificial drainage.

Aquic Kanhapludults

GCDH. Other Kanhapludults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kanhapludults

GCDI. Other Kanhapludults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Kanhapludults

GCDJ. Other Kanhapludults that have, throughout the argillic or kandic horizon, colors with a hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, that is one unit or less higher than the value, moist.

Rhodic Kanhapludults

GCDK. Other Kanhapludults.

Typic Kanhapludults

Paleudults

Key to subgroups

GCEA. Paleudults that have a horizon that is above the argillic horizon whose lower boundary is deeper than 18 cm and that meets all requirements for a spodic horizon except that the horizon is intermittent.

Spodic Paleudults

GCEB. Other Paleudults that:

1. Have texture that is loamy fine sand or coarser in all parts of the argillic horizon, or the argillic horizon has lamellae in some or all parts of the upper 100 cm; *and*

2. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage.

Psammaquentic Paleudults

GCEC. Other Paleudults that have texture that is loamy fine sand or coarser in all parts of the argillic horizon, or the argillic horizon has lamellae in some or all parts of the upper 100 cm.

Psammentic Paleudults

GCED. Other Paleudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

3. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthaquic Paleudults

GCEE. Other Paleudults that:

1. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage; *and*

2. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Aquic Arenic Paleudults

GCEF. Other Paleudults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Arenic Plinthic Paleudults

GCEG. Other Paleudults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have an argillic horizon that has a color value, moist, of 3 or less and do not have mottles of 3 or more within 100 cm of the top of the argillic horizon, and have a color value, dry, 1 unit or less higher than the value, moist, throughout the soil within that depth.
Arenic Rhodic Paleudults

GCEH. Other Paleudults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.
Arenic Paleudults

GCEI. Other Paleudults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.
Grossarenic Plinthic Paleudults

GCEJ. Other Paleudults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.
Grossarenic Paleudults

GCEK. Other Paleudults that:

1. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface; *and*

2. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or they are artificially drained.
Plinthaquic Paleudults

GCEL. Other Paleudults that:

1. Have at least one subhorizon in the argillic horizon and within 125 cm of the soil surface that has all the properties of a fragipan except that it is brittle in 40 to 60 percent of the volume; *and*

2. Have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

a. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

b. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or artificial drainage.

Fragiaquic Paleudults

GCEM. Other Paleudults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or artificial drainage.

Aquic Paleudults

GCEN. Other Paleudults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Paleudults

GCEO. Other Paleudults that have at least one subhorizon in the argillic horizon and within 125 cm of the soil surface that has all the properties of a fragipan except that it is brittle in 40 to 60 percent of the volume.

Fragic Paleudults

GCEP. Other Paleudults that have, throughout the upper 100 cm of the argillic horizon, a color value, moist, of 3 or less and a color value, dry, 1 unit or less higher than the value, moist, and do not have mottles with chroma of 3 or more.

Rhodic Paleudults

GCEQ. Other Paleudults.

Typic Paleudults

Plinthudults

Plinthudults are the Udults that have plinthite that forms a continuous phase or constitutes more than half the matrix of some subhorizon in the upper 150 cm of the soil.

Rhodudults

Key to subgroups

GCFA. Rhodudults that have a lithic contact within 50 cm of the soil surface.

Lithic Rhodudults

GCFB. Other Rhodudults that have texture that is 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 plinthite that forms a continuous phase or that constitutes more than half the volume of some subhorizon within 150 cm of the soil surface.

Plinthustults, p. 403

GDB. Other Ustults that

1. Have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm; *and*

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

3. Have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent within a depth of 150 cm from the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Kandiustults, p. 399

GDC. Other Ustults that have a CEC of 16 cmol(+) or less per kg clay (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 the major part of the argillic or kandic horizon, or the major part of the upper 100 cm of the argillic or kandic horizon if these horizons are thicker than 100 cm.

Kanhaplustults, p. 401

GDD. Other Ustults that have a clay distribution such that the percentage of clay does not decrease from its maximum amount by as much as 20 percent of that maximum within 150 cm of the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

Paleustults, p. 403

GDE. Other Ustults that have:

1. An epipedon that has a color value, moist, of 3 or less in all parts; *and*

2. An argillic horizon that has a color value, dry, of less than 5 and not more than 1 unit higher than the value, moist.

Rhodustults, p. 403

GDF. Other Ustults.

Haplustults, p. 398

Haplustults

<u>Key to subgroups</u>

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 soil surface.

Petroferric Haplustults

GDFC. Other Haplustults that have the following combination of characteristics in the upper 75 cm of the soil and in the upper 12.5 cm of the argillic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less and mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or there is artificial drainage.

Aquic Haplustults

GDFD. Other Haplustults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Haplustults

GDFE. Other Haplustults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Haplustults

GDFF. Other Haplustults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Haplustults

GDFG. Other Haplustults that have CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in the major part of the argillic horizon, or the major part of the upper 100 cm of the argillic horizon if the argillic horizon is thicker than 100 cm.

Kanhaplic Haplustults

GDFH. Other Haplustults.

Typic Haplustults

Kandiustults

Key to subgroups

GDBA. Kandiustults that have an ECEC (sum of bases plus KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons within a depth of 150 cm below the soil surface.

Acrustoxic Kandiustults

GDBB. Other Kandiustults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher or there is artificial drainage.

Aquic Kandiustults

GDBC. Other Kandiustults that:

1. Have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface; *and*

2. Have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Arenic Plinthic Kandiustults

GDBD. Other Kandiustults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kandiustults

GDBE. Other Kandiustults that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for 135 cumulative days or less in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udandic Kandiustults

GDBF. Other Kandiustults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kandiustults

GDBG. Other Kandiustults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kandiustults

GDBH. Other Kandiustults that when neither irrigated nor fallowed to store moisture have *either*:

1. If the soil temperature regime is mesic or thermic, are moist six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 180 days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Kandiustults

GDBI. Other Kandiustults that when neither irrigated nor fallowed to store moisture have *either*:

1. If the soil temperature regime is mesic or thermic, are dry for 135 cumulative days or less in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less

during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Kandiustults

GDBJ. Other Kandiustults that have, throughout the argillic or kandic horizon, colors with a hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, that is one unit or less 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 (sum of bases plus KCl-extractable Al) of 1.5 cmol(+) or less per kg clay in one or more subhorizons within a depth of 150 cm below the soil surface.

Acrustoxic Kanhaplustults

GDCC. Other Kanhaplustults that have the following combination of characteristics in the upper 75 cm of the soil if the chroma in all or part of the upper 75 cm is not controlled by uncoated sand grains; or if the chroma throughout the upper 75 cm is controlled by uncoated sand grains, have the following combination of characteristics throughout the upper 12.5 cm of the argillic or kandic horizon:

1. Mottles that have a color value, moist, of 4 or more and chroma, moist, of 2 or less accompanied by mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher or there is artificial drainage.

Aquic Kanhaplustults

GDCD. Other Kanhaplustults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic or kandic horizon that is 50 to 100 cm below the soil surface.

Arenic Kanhaplustults

GDCE. Other Kanhaplustults that:

1. Have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent; *and*

2. When neither irrigated nor fallowed to store moisture:

a. If the soil temperature regime is mesic or thermic, are dry for 135 cumulative days or less in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

b. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udandic Kanhaplustults

GDCF. Other Kanhaplustults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Kanhaplustults

GDCG. Other Kanhaplustults that have 5 percent or more plinthite (by volume) in one or more subhorizons within 150 cm of the soil surface.

Plinthic Kanhaplustults

GDCH. Other Kanhaplustults that have, in the upper 75 cm of the soil, a hue of 10YR or yellower in one or more subhorizons that have a color value, moist, of 4 or more and mottles with chroma of 3 or more and the hue becomes redder with depth within 100 cm of the soil surface.

Epiaquic Kanhaplustults

GDCI. Other Kanhaplustults that when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are moist six-tenths or less of the time in half or more years in some part of the moisture control section (not necessarily the same part) when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, are moist in most years in some or all parts of the moisture control section for less than 180 days during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Aridic Kanhaplustults

GDCJ. Other Kanhaplustults that when neither irrigated nor fallowed to store moisture:

1. If the soil temperature regime is mesic or thermic, are dry for 135 cumulative days or less in some part of the moisture control section when the soil temperature at a depth of 50 cm exceeds 5°C; *or*

2. If the soil temperature regime is hyperthermic, isomesic, or warmer, the soils are dry in some or all parts of the moisture control section for 90 days or less during a period when the soil temperature at a depth of 50 cm exceeds 8°C.

Udic Kanhaplustults

GDCK. Other Kanhaplustults that have, throughout the argillic or kandic horizon, colors with a hue of 2.5YR or redder, a value, moist, of 3 or less, and a value, dry, that is one unit or less higher than the value, moist.
Rhodic Kanhaplustults

GDCL. Other Kanhaplustults.
Typic Kanhaplustults

Paleustults

Paleustults are the Ustults that

1. Have a clay distribution such that the percentage of clay does not decrease from its maximum amount by more than 20 percent of that maximum within 150 cm of the soil surface, or the layer in which the clay percentage decreases by more than 20 percent has at least 5 percent of the volume consisting of skeletans on faces of peds and there is at least 3 percent (absolute) increase in clay below the layer.

2. Do not have plinthite that forms a continuous phase or constitutes more than half the matrix in any subhorizon within 150 cm of the soil surface; and

3. Do not have a fragipan or kandic horizon.

Plinthustults

Plinthustults are the Ustults that have plinthite that forms a continuous phase or constitutes more than half the matrix within some subhorizon in the upper 150 cm of the soil.

Rhodustults

Key to subgroups

GDEA. Rhodustults that have a lithic contact within 50 cm of the soil surface.
Lithic Rhodustults

GDEB. Other Rhodustults that have texture that is loamy fine sand or coarser in all parts of the argillic horizon.
Psammentic Rhodustults

GDEC. Other Rhodustults.
Typic Rhodustults

XERULTS

Key to great groups

GEA. Xerults that have an argillic horizon that has less than 10 percent weatherable minerals in the 20- to 200-micron fraction in its upper 50 cm and have a clay distribution such that the percentage of clay does not decrease from its maximum amount by more than 20 percent within 150 cm of the soil surface, or the layer in which the percentage of clay is less than the maximum has skeletans on ped faces or has 5 percent or more plinthite by volume.

Palexerults, p. 405

GEB. Other Xerults.

Haploxerults, p. 404

Haploxerults

Key to subgroups

GEBA. Haploxerults that:

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

2. Have a discontinuous argillic horizon in each pedon that is interrupted by ledges of bedrock.

Ruptic-Lithic-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 the following combination of characteristics in the upper 25 cm or more of the argillic horizon:

1. Mottles that have a color value, moist, or 4 or more and chroma, moist, of 2 or less and also mottles of higher chroma that are due to segregation of iron; *and*

2. Saturation with water in the mottled zone at some time of year when the soil temperature in that zone is 5°C or higher, or the soil is artificially drained.

Aquic Haploxerults

GEBD. Other Haploxerults that have texture that is loamy fine sand or coarser in all parts of the argillic horizon, or have an argillic horizon that has lamellae in the upper 25 cm.

Psammentic Haploxerults

GEBE. Other Haploxerults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is 50 to 100 cm below the soil surface.

Arenic Haploxerults

GEBF. Other Haploxerults that have a layer, starting at the mineral soil surface, that has a sandy particle-size class and extends to the top of an argillic horizon that is more than 100 cm below the soil surface.

Grossarenic Haploxerults

GEBG. Other Haploxerults that have, throughout a cumulative thickness of 18 cm or more and within a depth of 75 cm, bulk density of the less than 2.0 mm fraction, measured at 33 kPa water retention, of 1.0 g cm^{-3} or less and acid-oxalate-extractable aluminum plus 1/2 acid-oxalate-extractable iron of more than 1.0 percent.

Andic Haploxerults

GEBH. Other Haploxerults.

Typic Haploxerults

Palexerults

Palexerults are the Xerults that

1. Have *both* the following characteristics:

   a. An argillic horizon that in its upper 50 cm has less than 10 percent weatherable minerals in the 20- to 200-micron fraction; *and*

   b. A clay distribution such that the percentage of clay does not decrease from its maximum amount by more than 20 percent within 150 cm of the soil surface, or the layer in which the percentage of clay is less than the maximum has skeletans on ped faces or has 5 percent or more plinthite by volume; *and*

2. Have a color value, moist, of 4 or more in some part of the epipedon or have an argillic horizon that has a color value, dry, of 5 or more in some subhorizon or a color value, moist, of 4 or more; *and*

3. Do not have plinthite that forms a continuous phase or constitutes more than half the matrix in any subhorizon within 125 cm of the soil surface; *and*

4. Do not have a fragipan.

LITERATURE CITED

Sys, C. 1969. The soils of central Africa in the American Classification - 7th Approximation. African Soils. XIV:25-44.

Chapter 15

Vertisols

KEY TO SUBORDERS

EA. Vertisols that have a thermic, mesic, or frigid soil temperature regime and, unless irrigated, have cracks that open and close once each year and remain open for 60 consecutive days or more in the 90 days following the summer solstice in more than 7 out of 10 years but that are closed for 60 consecutive days or more during the 90 days following the winter solstice.

Xererts, p. 410

EB. Other Vertisols that, unless irrigated, have in most years cracks that either remain open throughout the year or are closed for less than 60 consecutive days at a period when the soil temperature at a depth of 50 cm is continuously higher than 8°C.

Torrerts, p. 407

EC. Other Vertisols that have cracks that open and close one or more times during the year in most years but do not remain open for as many as 90 cumulative days in most years.

Uderts, p. 408

ED. Other Vertisols.

Usterts, p. 409

TORRERTS

Key to subgroups

EBAA. Torrerts that:

1. Have a surface horizon 30 cm or more thick with a color value of 3 or less, moist, in half or more of each pedon; *and*

2. Have prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix within 100 cm of the soil surface.

Paleustollic Torrerts

EBAB. Other Torrerts that have a surface horizon 30 cm or more thick with a color value of 3 or less, moist, in half or more of each pedon.

Mollic Torrerts

EBAC. Other Torrerts that have prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix within 100 cm of the soil surface.

Argidic Torrerts

EBAD. Other Torrerts.

Typic Torrerts

UDERTS

Key to great groups

ECA. Uderts that have a chroma, moist, of 2 or more dominant in the matrix of some subhorizon in the upper 30 cm in more than half of each pedon.

Chromuderts, p. 408

ECB. Other Uderts.

Pelluderts, p. 408

Chromuderts

Key to subgroups

ECAA. Chromuderts that:

1. Have distinct or prominent mottles within 50 cm of the soil surface in more than half of each pedon (the terms refer to contrast, not to size of the mottles); *and*

2. Have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Aquentic Chromuderts

ECAB. Other Chromuderts that have distinct or prominent mottles within 50 cm of the soil surface in more than half of each pedon (the terms refer to contrast, not to size of the mottles).

Aquic Chromuderts

ECAC. Other Chromuderts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon or the horizon with color value or 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Chromuderts

ECAD. Other Chromuderts.

Typic Chromuderts

Pelluderts

Key to subgroups

ECBA. Pelluderts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Pelluderts

ECBB. Other Pelluderts.

Typic Pelluderts

USTERTS

Key to great groups

EDA. Usterts that have a chroma, moist, of 2 or more in some part of the matrix of the upper 30 cm in more than half of each pedon.

Chromusterts, p. 409

EDB. Other Usterts.

Pellusterts, p. 409

Chromusterts

Key to subgroups

EDAA. Chromusterts that

1. Have cracks that remain open from 90 to 150 cumulative days in most years and have a mean annual soil temperature that is less than 15°C; *and*

2. Have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Udorthentic Chromusterts

EDAB. Other Chromusterts that have cracks that remain open from 90 to 150 cumulative days in most years, and have a mean annual soil temperature that is less than 15°C.

Udic Chromusterts

EDAC. Other Chromusterts that have, within 100 cm of the soil surface, prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix.

Paleustollic Chromusterts

EDAD. Other Chromusterts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Chromusterts

EDAE. Other Chromusterts.

Typic Chromusterts

Pellusterts

Key to subgroups

EDBA. Pellusterts that

1. Have cracks that remain open for 150 or less cumulative days during each year or have a mean annual soil temperature that is less than 15°C; *and*

2. Have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon

with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Udorthentic Pellusterts

EDBB. Other Pellusterts that have cracks that remain open for 150 or less cumulative days during each year, or have a mean annual soil temperature that is less than 15°C.

Udic Pellusterts

EDBC. Other Pellusterts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Pellusterts

EDBD. Other Pellusterts that have within 100 cm of the soil surface prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix.

Paleustollic Pellusterts

EDBE. Other Pellusterts.

Typic Pellusterts

XERERTS

Key to great groups

EAA. Xererts that have a dominant chroma, moist, of 2 or more in the matrix of some subhorizon in the upper 30 cm in more than half of each pedon.

Chromoxererts, p. 410

EAB. Other Xererts.

Pelloxererts, p. 411

Chromoxererts

Key to subgroups

EAAA. Chromoxererts that have distinct or prominent mottles (these terms refer to contrast, not size) within 50 cm of the soil surface in more than half of each pedon.

Aquic Chromoxererts

EAAB. Other Chromoxererts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Chromoxererts

EAAC. Other Chromoxererts that have, within 100 cm of the soil surface, prismatic or blocky structure accompanied by clay skins on ped faces that have a color value lower than that in the matrix.

Palexerollic Chromoxererts

EAAD. Other Chromoxererts.

Typic Chromoxererts

Pelloxererts

<u>Key to subgroups</u>

EABA. Pelloxererts that have in one or more subhorizons within a depth of 100 cm a chroma, either dry or moist, of 2 or more, or have between 30 cm and 100 cm neither distinct or prominent mottles, nor concretions that are due to segregated iron or manganese.

Chromic Pelloxererts

EABB. Other Pelloxererts that have a color value, moist, of 4 or more or a value, dry, of 6 or more in the surface horizon, or the horizon with color value of 3 or less, moist, and 5 or less, dry, is less than 30 cm thick in half or more of each pedon.

Entic Pelloxererts

EABC. Other Pelloxererts.

Typic Pelloxererts

SI Units Conversion Table

CEC and ECEC:

1 meq/100 g soil = 1 cmol(+) per kg soil

Conductivity:

1 mmho/cm = 1 dS per m

Pressure:

15-bar water = 1500 kPa water retention

1/3-bar water = 33 kPa water retention

Designations for Horizons and Layers

Genetic horizons are not the equivalent of the diagnostic horizons of *Soil Taxonomy*. Designations of genetic horizons express a qualitative judgment about the kind of changes that are believed to have taken place. Diagnostic horizons are quantitatively defined features used to differentiate between taxa. The diagnostic horizons may encompass several genetic horizons, and changes implied by genetic horizon designations may not be large enough to justify recognizing different diagnostic criteria.

MASTER HORIZONS AND LAYERS

The capital letters **O**, **A**, **E**, **B**, **C**, and **R** represent the master horizons and layers of soils. The 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 are organic materials that were deposited under saturated conditions and that were decomposed to varying stages. The mineral fraction of such material is only a small percentage of the volume of the material and generally is much less than half of the weight. Some soils consist entirely of material designated as O horizons or layers.

An O layer may be on the surface of a mineral soil or at any depth beneath the surface if it is buried. A horizon formed by illuviation of organic material into a mineral subsoil is not an O horizon, though some horizons formed in this manner contain much organic matter.

A horizons: *Mineral horizons that formed at the surface or below an O horizon, that exhibit obliteration of all or much of the original rock structure*[1] *and show one or more of the following:*

(1) *are characterized by an accumulation of humified organic matter intimately mixed with the mineral fraction and are not dominated by properties characteristic of E or B horizons (defined below)* or

(2) *have properties resulting from cultivation, pasturing, or similar kinds of disturbance.*

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[1] Rock structure includes fine stratification in unconsolidated or weakly consolidated sediment or pseudomorphs of weathered minerals retaining their positions relative to each other and to unweathered minerals in saprolite from consolidated rocks.

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, though 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 an A horizon unless cultivated.

E horizons: *Mineral horizons in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these, leaving a concentration of sand and silt particles and exhibiting obliteration of all or much of the original rock structure*[2].

An E horizon is usually, but not necessarily, lighter in color than an underlying B horizon. In some soils the color 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 and it generally has less organic matter than the A horizon. An E horizon is most commonly differentiated from an underlying B horizon in the same sequum by color of higher value or lower chroma or both, by coarser texture, or by a combination of these properties. 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 within or between parts of the B horizon or that extend to depths greater than normal observation if the horizon has resulted from soil genesis.

B horizons: *Horizons that formed below an A, E, or O horizon and that are dominated by obliteration of all or much of the original rock structure*[3] *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*;
(4) *coatings of sesquioxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons without apparent illuviation of iron*;
(5) *alteration that forms silicate clay or liberates oxides or both and that forms granular, blocky, or*

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2 Rock structure includes fine stratification in unconsolidated sediment or pseudomorphs of weathered minerals retaining their positions relative to each other and to unweathered minerals in saprolite from consolidated rocks.

3 Rock structure includes fine stratification in unconsolidated sediment or pseudomorphs of weathered minerals retaining their positions relative to each other and to unweathered minerals in saprolite from consolidated rocks.

prismatic structure if volume changes accompany changes in moisture content; or
(6) *brittleness*.

All kinds of B horizons are subsurface horizons or were originally. Included as B horizons where contiguous to another genetic horizon are layers of illuvial concentration of carbonates, gypsum, or silica that are the result of pedogenic processes (these layers may or may not be cemented) and brittle layers that have 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 coat rock fragments or are on finely stratified unconsolidated sediments, 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 properties of O, A, E, or B horizons. Most are mineral layers. The material of C layers may be either like or unlike that from which the solum presumably formed. A C horizon may have been modified even if there is no evidence of pedogenesis.*

Included as C layers are sediments, saprolite, and unconsolidated bedrock and other geologic materials that commonly will slake within 24 hours when air-dry or drier chunks are placed in water and that, when moist, can be dug with a spade. Some soils form in material that is already highly weathered, and such material that does not meet the requirements of A, E, or B horizons is designated C. Changes not considered pedogenic are those not related to overlying horizons. Layers having accumulations of silica, carbonates, or gypsum or more soluble salts are included in C horizons, even if indurated, unless these layers are obviously affected by pedogenic processes; then they are a B horizon.

R layers: *Hard bedrock*.

Granite, basalt, quartzite and indurated limestone or sandstone are examples of bedrock that are designated R. Air-dry or drier chunks of an R layer when placed in water will not slake within 24 hours. 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 few enough and small enough that few roots can penetrate. The cracks may be coated or filled with clay or other material.

Transitional horizons

There are two kinds of transitional horizons. In one, the properties of an underlying or overlying horizon are superimposed on properties of the other horizon throughout the transition zone. In the other, parts that are characteristic of an overlying or underlying horizon are enclosed by parts that are characteristic of the other horizon. Special conventions are used to designate these kinds of horizons.

Horizons dominated by properties of one master horizon but having subordinate properties of another. Two capital letter symbols are used, as AB, EB, BE, BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. An AB horizon, for example, has characteristics of both an overlying A horizon and an underlying B horizon, but 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 is apparently transitional 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 in 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 material.

Horizons in which distinct parts have recognizable properties of the two kinds of master horizons indicated by the capital letters. The two capital letters are separated by a virgule (/), as E/B, B/E, B/C. Most of the individual parts of one of the components are surrounded by the other.

The designation may be used even though horizons similar to one or both of the components are not present, if the separate components can be recognized in the transitional horizon. The first symbol is that of the horizon that makes up the greater volume.

SUBORDINATE DISTINCTIONS WITHIN MASTER HORIZONS AND LAYERS

Lower case letters are used as suffixes to designate specific kinds of master horizons and layers. The word "accumulation" is used in many of the definitions in the sense that the horizon must have more of the material in question than is presumed to have been present in the parent material. The symbols and their meanings are as follows:

a *Highly decomposed organic material*

This symbol is used with "O" to indicate the most highly decomposed of the organic materials. The rubbed fiber content is less than about 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 formed 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. The symbol is not used in organic soils or to separate an organic layer from a mineral layer.

c *Concretions or nodules*

This symbol is used to indicate a significant accumulation of concretions or of nodules. Cementation is required. The cementing agent is not specified except it cannot be silica. This symbol is not used if concretions or nodules are dolomite or calcite or more soluble salts, but it is used if the nodules or concretions are enriched in minerals that contain iron, aluminum, manganese, or titanium. Their consistence is specified in the horizon description.

d *Dense unconsolidated sediments or materials*

This symbol is used to indicate naturally occurring or manmade, unconsolidated sediments or materials with high bulk density, such as dense basal till, plow pans and other mechanically compacted zones. The layer is root restrictive and roots do not enter except along fracture planes.

e *Organic material of intermediate decomposition*

This symbol is used with "O" to indicate organic materials of intermediate decomposition. Rubbed fiber content is 17 to 40 percent of the volume. Usually occurs in soils saturated for prolonged periods; however, can occur in soils not saturated for prolonged periods.

f *Frozen soil*

This symbol is used to indicate that the horizon or layer contains permanent ice. Symbol is not used for seasonally frozen layers or for "dry permafrost" (material that is colder than 0°C but does not contain ice).

g *Strong gleying*

This symbol is used to indicate either that iron has been reduced and removed during soil formation or that saturation with stagnant water has preserved a reduced state. Most of the affected layers have low chroma and many are mottled. The low chroma can be the color of reduced iron or the color of uncoated sand and silt particles from which iron has been removed. Symbol "g" is not used for soil materials of low chroma, such as some shales or E horizons, unless they have a history of wetness. If "g" is used with "B," pedogenic change in addition to gleying is implied. If no other pedogenic change in addition to 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 organosesquioxide material coats sand and silt particles. In some horizons, 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 value and chroma of the horizon are approximately 3 or less.

i *Slightly decomposed organic material*

This symbol is used with "O" to indicate the least decomposed of the organic materials. Rubbed fiber content is more than about 40 percent of the volume. Usually occurs in soils not saturated for prolonged periods.

k *Accumulation of carbonates*

This symbol is used to indicate accumulation of alkaline earth carbonates, commonly calcium carbonate.

m *Cementation or induration*

This symbol is used to indicate continuous or nearly continuous cementation. Symbol is used only for horizons that are more than 90 percent cemented, though they may be fractured. The layer is root restrictive and roots do not enter except along fracture planes. The single predominant or codominant cementing agent may be indicated using defined letter suffixes singly or in pairs. If the horizon is cemented by carbonates, "km" is used; by silica, "qm"; by iron, "sm"; by gypsum, "ym"; by both lime and silica, "kqm"; by salts more soluble than gypsum, "zm".

n *Accumulation of sodium*

This symbol is used to indicate accumulation of exchangeable sodium.

o *Residual accumulation of sesquioxides*

This symbol is used to indicate residual accumulation of sesquioxides. It differs from the use of symbol "s" which indicates illuvial accumulation of organic matter and sesquioxide complexes.

p *Tillage or other disturbance*

This symbol is used to indicate disturbance of the surface layer by mechanical means, pasturing, or similar uses. A disturbed organic horizon is designated Op. A disturbed mineral horizon, even though clearly once a E, B, or C horizon, is designated Ap.

q *Accumulation of silica*

This symbol is used to indicate accumulation of secondary silica. If silica cements the layer and cementation is continuous or nearly continuous, "qm" is used.

r *Weathered or soft bedrock*

This symbol is used with "C" to indicate layers of soft bedrock or saprolite, such as weathered igneous rock, partly consolidated soft sandstone, siltstone, and shale. Roots cannot enter except along fracture planes. The material can be dug with a spade.

s *Illuvial accumulation of sesquioxides and organic matter*

This symbol is used with "B" to indicate the accumulation of illuvial, amorphous, dispersible organic matter-sesquioxide complexes if both the organic matter and sesquioxide components are significant and the value and chroma of the horizon is more than 3. The symbol is also used in combination with "h" as "Bhs" if both the organic matter and sesquioxide components are significant and the value and chroma are approximately 3 or less.

ss *Presence of slickensides*

This symbol is used to indicate the presence of slickensides. Slickensides result directly from swelling of clay minerals and shear failure, commonly at angles of 20 to 60° 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 is used to indicate an accumulation of silicate clay either by illuviation into the horizon or by formation and subsequent translocation within the horizon, or both. The clay can be in the form of coatings on ped surfaces or in pores, lamellae, or bridges between mineral grains.

v *Plinthite*

This symbol is used to indicate the presence of iron-rich, humus-poor, reddish material that is firm or very firm when moist and that hardens irreversibly when exposed to the atmosphere and to repeated wetting and drying. These properties are characteristic of plinthite.

w. *Development of color or structure*

This symbol is used with "B" to indicate 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 is used to indicate genetically developed firmness, brittleness, or high bulk density. These features are characteristic of fragipans, but some horizons designated "x" do not have all the properties of a fragipan.

y *Accumulation of gypsum*

This symbol is used to indicate accumulation of gypsum.

z *Accumulation of salts more soluble than gypsum*

This symbol is used to indicate accumulation of salts more soluble than gypsum.

CONVENTIONS FOR USING LETTER SUFFIXES

Many master horizons and layers that are symbolized by a single capital letter will have one or more lower case letter suffixes. The following rules apply:

Letter suffixes should immediately follow the capital letter.

Seldom are more than three suffixes used.

If a surface horizon is disturbed, only "p" is used, except where there are surface accumulations of calcium carbonate, calcium sulfate or more soluble salts (Calciaquolls, for example).

When 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 for Bhs or Crt[4] horizons, 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, these 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. Suffix "b" is used only for buried mineral soils.

A B horizon that has significant accumulation of clay and also shows evidence of 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 that has accumulations of carbonates, sodium, silica, gypsum, salts more soluble than gypsum, or residual accumulation 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.

Suffixes "h", "s", and "w" are not used with g, k, n, q, y, z, or o, unless needed for explanatory purposes.

Unless otherwise given, suffixes are listed alphabetically.

VERTICAL SUBDIVISION

Commonly a horizon or layer designated by a single combination of letters needs to be subdivided. The

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[4] Indicating weathered bedrock or saprolite in which clay films are present.

Arabic numerals used for this purpose always follow all letters. Within a C, for example, successive layers could be C1, C2, C3, etc.; or if the lower part is gleyed and the upper part is not, the designations could be C1-C2-Cg1-Cg2 or C-Cg1-Cg2-R.

These conventions apply whatever the purpose of subdivision. In many soils, horizons that would be identified by one unique set of letters are subdivided on the basis of evident morphological features, such as structure, color, or texture. These divisions are numbered consecutively. The numbering starts with 1 at whatever level in the profile any element of the letter symbol changes. Thus Bt1-Bt2-Btk1-Btk2 is used, 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: Bs1-Bs2- 2Bs3-2Bs4 is used, not Bs1-Bs2-2Bs1-2Bs2.

Sometimes, thick layers are subdivided during sampling for laboratory analyses even though differences in morphology are not evident in the field. These layers need to be identified, and this is done simply by numbering each subdivision consecutively within a layer having a unique symbol, starting at the top. For example, four layers of a Bt horizon sampled by 10-cm increments would be designated Bt1, Bt2, Bt3, and Bt4.

DISCONTINUITIES

In mineral soils Arabic numerals are used as prefixes to indicate discontinuities. Wherever needed, they are used preceding A,E,B,C, and R. These prefixes are distinct from Arabic numerals used as suffixes to denote vertical subdivisions.

A discontinuity is a significant change in particle-size distribution or mineralogy that indicates a difference in the material from which the horizons 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 will contribute substantially to the reader's understanding of relationships among horizons. Stratification common to soils formed in alluvium is not designated as discontinuities unless particle size distribution differs markedly (strongly contrasting particle-size class as defined in *Soil Taxonomy*) from layer to layer even though genetic horizons have formed in the contrasting layers.

Where a soil has formed entirely in one kind of material, a prefix is omitted from the symbol; the whole profile is material 1. Similarly, the uppermost material in a profile having 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 though a layer below material 2 is similar to material 1, it is designated "3" in the sequence. The numbers indicate a change in the material, not the type of material. Where two or more consecutive horizons formed in one kind of material, the same prefix number is applied to all of the horizon designations in that material: Ap-E-Bt1-2Bt2-2Bt3-2BC. The number of suffixes designating subdivisions of the Bt horizon continue in consecutive order across the discontinuity.

If an R layer is below a soil that formed in residuum and the material of the R layer is judged to be like that from which the material of the soil weathered, the Arabic number prefix is not used. If the R layer would not produce material like that in the solum, the number prefix is used, as in A-Bt-C-2R or A-Bt-2R. If part of the solum formed in residuum, "R" is given the appropriate prefix: Ap-Bt1-2Bt2-2Bt3-2C1-2C2-2R.

Buried horizons (designated "b") are special problems. A buried horizon is obviously not in the same deposit as horizons in the overlying deposit. Some buried horizons, however, formed in material lithologically like that of the overlying deposit. A prefix is not used to distinguish material of such buried horizons. If the material in which a horizon of a buried soil formed is lithologically unlike that of the overlying material, the discontinuity is designated by number prefixes and the symbol for a buried horizon is used as well: Ap-Bt1-Bt2-BC-C-2ABb-2Btb1-2Btb2-2C.

In organic soils, discontinuities between different kinds of layers are not identified. In most cases the differences are shown by the letter suffix designations, if the different layers are organic, or by the master symbol if the different layers are mineral.

USE OF THE PRIME

Identical letter and numeral designations may be appropriate for two or more horizons separated by at least one horizon or layer of a different kind in the same pedon. The sequence A-E-Bt-E-Btx-C is an example: the soil has two E horizons. To make communication easier, the prime is used with the master horizon symbol of the lower of two horizons having identical designations: A-E-Bt-E'-Btx-C. The prime is applied to the capital letter designation, and any lower case symbols follow it: B't. The prime is not used unless all designations of two different layers are identical. Rarely, three layers have identical symbols; a double prime can be used: 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: Oi-C-O'i-C' or Oi-C-Oe-C'. The prime is added to the lower C layer to differentiate it from the upper.

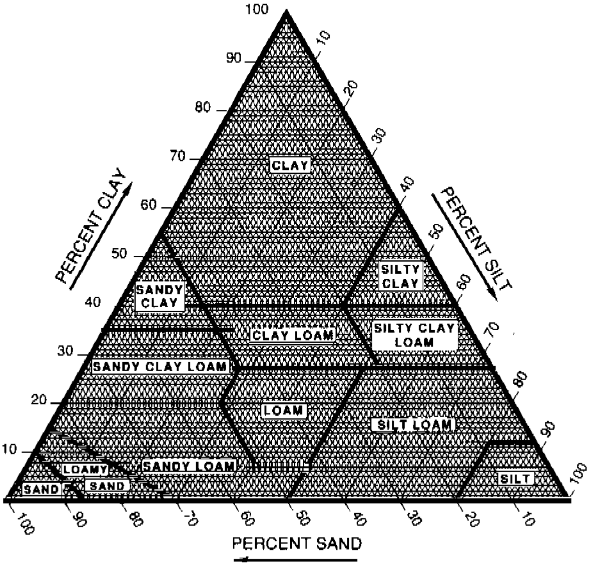

Chart showing the percentages of clay (below 0.002 mm), silt (0.002 to 0.05 mm), and sand (0.05 to 2.0 mm) in the basic soil textural classes.