Criteria for Soil Classification in the Higher Categories of the U.S. System

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CRITERIA FOR SOIL CLASSIFICATION IN THE HIGHER CATEGORIES OF THE U.S. SYSTEM

Ellis G. Knox
Professor of Soil Science

INTRODUCTION

This paper presents the higher categories of the soil classification system of the National Cooperative Soil Survey (Soil Survey Staff, 1960, 1967, 1968, 1970, 1973) in tabular form. Eleven tables and fifty-six criteria, some of them compound, are used to present the complete definitions of the 10 orders, 47 suborders, and 224 great groups of the system. The paper is intended to be faithful to the 1973 version, although definitions have been recast and shortened.

The system operates by division, starting at the highest category. It is necessary to identify the order, suborder, and great group, in that sequence. Table 1 presents the criteria for separation of orders. Criteria for separation of suborders and great groups within each of the orders are presented in Tables 2 through 11. This paper does not deal with the definitions of subgroups nor of families.

The tables specify for each class the criteria that are required for that class (R or A), the criteria that are not permitted for that class (O), and the criteria that are not critical in the definition of the class (N or I). The symbol A indicates that two or more criteria are alternatives and that at least one of the alternatives is required. The symbol I indicates a criterion that is permitted but is not probable. For example, in Table 1, the order Aridisol requires at least one of the criteria 8, 9, 12, 13, 15, 17, and 18, indicated by the symbol A. It also requires criterion 33, indicated by the symbol R. Criteria 1, 2, 3, 4, 7, 10, 11, 20, 21, 25, 44, and 49, indicated by the symbol O, are all prohibited. Criteria 19, 24, and 32, indicated by symbols I and N, are permitted but are not required. Because of the interrelationships of criteria, criteria 19 and 24 (symbol I) are very improbable.

Definitions for most of the diagnostic horizons used in the system are given, each with the criterion to which it is most closely related. (The epipedons are simply diagnostic horizons at or near the soil surface.) In these definitions, horizon should be understood to refer to a set of subhorizons. Unless specified otherwise, depth references are to the top of the horizon in question. For example, in criterion 13, "calcic horizon within a depth of 100 cm" refers to a calcic horizon that has its upper boundary at a depth of 100 cm or less from the soil surface.

The pedon is the smallest body of soil considered in the system. A pedon is defined as a body of soil at least 1 m^2 in area ranging up to 10 m^2 as necessary to include a half cycle of any roughly cyclical, small-scale pattern of soil variation.

The terms lithic contact and paralithic contact are defined in the system as the upper boundary of "continuous, coherent underlying material" that is not a cemented soil horizon. "The underlying material must be continuous within the limits of a pedon except for cracks produced in place without

significant differential displacement of the pieces relative to each other." It must be sufficiently coherent that roots do not enter except in cracks with spacing of 10 cm or more between cracks. A paralithic contact is a boundary with material that can be dug with difficulty with a spade when moist and that can be more or less completely dispersed when gravel-size chunks are shaken end-over-end for 15 hours in water or sodium hexametaphosphate solution. A lithic contact is a boundary with more completely consolidated material. In this paper, bedrock is used to refer to material below lithic or paralithic contact and hard bedrock is used to refer to material below lithic contact.

The approach used in this paper was developed as a teaching device at Oregon State University in 1967. Criteria for a needle-sorting system were developed from an advance copy of the 1967 Supplement (Soil Survey Staff, 1967) before copies were available to students. A version in Spanish (Knox, 1971) was used in teaching in 1970 during an FAO assignment to the Inter-american Institute of Agricultural Sciences, Turrialba, Costa Rica. A later, English version was tested at Oregon State University in 1971 and 1972.

CRITERIA

Horizons buried by recent deposits are not considered unless the deposit is less than 30 cm thick; or less than 50 cm thick and less than half the thickness of the buried horizons.

1. Organic soil materials (1) that constitute 40 cm or more of accumulative thickness (60 cm or more if the content of moss fibers is 3/4 or more by volume or the bulk density is less than 0.1 g/cc) within a depth of 80 cm, or (2) that extend to fragmental mineral material coarser than 2 mm and penetrate the interstices, or (3) that extend to bedrock or to within 10 cm of bedrock if the thickness of organic materials is more than double the thickness of mineral materials.

Organic soil materials (1) have an organic carbon content of 20% or more and rest on bedrock or penetrate into the interstices of fragmental material or (2) are saturated with water for long periods or artificially drained and, excluding live roots, contain 18% or more of organic carbon if the mineral fraction has 50% or more clay, 12% or more of organic carbon if the mineral fraction has no clay, and intermediate amounts of organic carbon if the clay content is intermediate.

2. Clay content of 30% or more throughout the soil to a depth of 50 cm after the upper 18 cm are mixed; when not irrigated, with vertical cracks during some period of most years that are 1 cm or more in width to a depth of 50 cm; mean annual soil temperature of 8° C or more; and (1) gilgai microrelief or (2) at some depth between 25 and 100 cm, slickensides that intersect or wedge-shaped structural aggregates that have their major axes tilted from 10 to 60 degrees from the horizontal.

3. Mollic epipedon (or surface layer mixed to 18 cm and upper part of an argillic or natric horizon, separated by an albic horizon, that individually meet all requirements of the mollic epipedon except thickness and together meet the thickness requirement) lacking criterion 47 and (1) with base

saturation (CEC by NH_4OAc at pH 7) of 50% or more throughout the profile to a depth of 180 cm or to bedrock or to a depth of 125 cm below the upper boundary of an argillic or natric horizon, and (2) if the mean annual soil temperature is 8° C or more and the difference between mean summer and mean winter soil temperature at 50 cm depth is less than 5° C, (a) the epipedon rests on a horizon with calcium carbonate equivalent of 40% or more or (b) subhorizons with more than 35% clay and montmorillonitic mineralogy total less than 50 cm in thickness (less than 25 cm if depth to bedrock is less than 50 cm).

A mollic epipedon is a mineral horizon excluding plaggen epipedon, that has, after the upper 18 cm are mixed, excluding shallower bedrock, (1) both before and after crushing, moist color value and chroma less than 3.5 and dry color value less than 5.5; or with more than 40% of finely dispersed carbonates, moist color value 5 or less, and with more than 2.5% of organic carbon, (2) organic carbon content of 0.6% or more, (3) darker moist and dry colors by 1 unit of value or 2 units of chroma or more organic carbon by 0.6% of C than any C or other underlying horizon, (4) if the soil is sometimes dry, structure (before mixing, peds finer than 30 cm) or dry consistence that is slightly hard or softer, (5) base saturation (CEC by NH_4OAc at pH 7.0) of 50% or more, (6) thickness greater than 25 cm (10 cm if the epipedon rests on bedrock, petrocalcic horizon, or duripan) or, if the epipedon is finer than loamy fine sand in some part and if there is an underlying diagnostic horizon or the decrease in organic matter is regular with depth below the epipedon, thickness greater than 18 cm and greater than 1/3 of the depth to secondary carbonates, duripan, or fragipan or to the base of a cambic, argillic, natric, oxic, or spodic horizon, (7) content of P_2O_5 soluble in 1% citric acid less than 250 ppm or less than in underlying horizons; and moist in some part without irrigation for three months (accumulative) or more when the temperature at 50 cm of depth is 5° C or higher, (8) n value (see criterion 44) less than 0.7, and (9) a position at the surface of the soil or under organic soil material or under a recent deposit.

4. Umbric epipedon (or mollic epipedon excluded from criterion 3).

At suborder level in Inceptisol: Umbric (or mollic) epipedon, thicker than 25 cm or with mean annual soil temperature less than 8° C, or anthropic epipedon thicker than 25 cm.

In Aquept and Aquox: Umbric (or mollic) epipedon or histic epipedon.

In Orthox: Umbric epipedon or organic carbon content greater than 1% throughout the profile to a depth of 75 cm.

An umbric epipedon has all of the requirements for mollic epipedon with the exception that the base saturation is less than 50%.

5. Anthropic epipedon.

An anthropic epipedon has all of the requirements for mollic or umbric epipedon except for the requirement regarding P_2O_5 and soil moisture.

6. Histic epipedon.

A histic epipedon is a horizon at or near the surface, saturated with water for at least 30 consecutive days in most years or with artificial drainage, that does not meet the requirements for criterion 1. It is (1) a plow layer, or an organic horizon that when the soil is mixed to a depth of 20 cm produces a layer, with 16% or more of organic carbon if the mineral fraction has 50% or more of clay, with 8% or more of organic carbon if there is no clay, and with proportional content of organic carbon if the clay content is intermediate or (2) a layer of organic soil materials 20 cm thick or thicker with less than 40 cm of overlying mineral material.

7. Plaggen epipedon.

A plaggen epipedon is a horizon thicker than 50 cm formed by additions of mineral material in manure resulting from the use of sod for bedding. The evidence for plaggen epipedon includes artifacts, mixtures of different materials, and spade marks within the epipedon and distribution in rectangular geographic bodies. Any horizon below a plaggen epipedon is considered to be buried.

8. Argillic horizon (excluding natric horizon) or fragipan with clay skins thicker than 1 mm.

An argillic horizon is a horizon of illuvial accumulation of clay. It must be at least 7.5 cm thick and, up to 15 cm, at least 1/10 the thickness of the overlying horizons. In sandy soils, it may consist of lamellae at least 1 cm thick that total 15 cm or more in thickness. If there is an overlying eluvial horizon formed from the same parent material, then, in a vertical distance of 30 cm or less, the increment in clay content from the eluvial horizon to the argillic horizon is at least 8% clay or at least 20% of the clay content of the eluvial horizon but not less than 3% clay. The ratio of fine clay (finer than 0.2 microns) to total clay is greater than in the overlying or underlying horizon by about one-third or more. In addition, an argillic horizon has (1) if there are no peds, clay skins in pores and, in sandy soils, bridging the sand grains, or (2) if there are peds, in at least the lower part of the horizon, clay skins in pores and on vertical and horizontal ped surfaces, or (3) optically-oriented clay in 1% or more of the cross-section, or (4) silt and sand grains free of coatings in the overlying horizon if expanding clay is dominant, the clay content is greater than 40%, and slickensides or wavy horizon boundaries indicate that clay skins have been destroyed by pressure.

9. Natric horizon.

A natric horizon meets all the requirements of argillic horizon and in addition has (1) prismatic or columnar structure, or blocky structure if tongues of an eluvial horizon with uncoated silt or sand grains extend more than 2.5 cm into the horizon and (2) within 40 cm of the upper boundary, (a) exchangeable sodium saturation of 15% or more or (b) if within 2 m of the surface the exchangeable sodium saturation is 15% or more, saturation with magnesium plus sodium greater than saturation with calcium plus exchange acidity (measured at pH 8.2).

10. Spodic horizon within a depth of 2 m (or a placic horizon that overlies a fragipan and meets all the requirements of spodic horizon except thickness).

A spodic horizon is a horizon of accumulation of amorphous material that consists of organic matter and aluminum with or without iron. It underlies an O, A1, A2, or Ap horizon or has been exposed by erosion. The upper part of the horizon, below any subhorizon with moist color value of 2 or less, has the reddest hue and the highest chroma and, unless the horizon overlies bedrock at shallower depth, the hue becomes less red or the chroma decreases with depth within 50 cm of the top of the horizon. Below 12.5 cm and below any Ap horizon or at any depth if the temperature satisfies criterion 39, there is (1) a continuous subhorizon thicker than 2.5 cm cemented by organic matter with aluminum or iron, or (2) amorphous and optically isotropic material that forms cracked coatings on sand grains or dark colored pellets from 20 to 50 microns in diameter, or (3) in some subhorizon (a) an amount of Fe plus Al (elemental basis; C plus Al if extractable Fe is less than 0.1%) extracted by sodium pyrophosphate at pH 10 greater than 0.2 times the amount of clay, and (b) an amount of Fe plus Al extracted by pyrophosphate greater than 0.5 times the amount extracted by dithionite-citrate, and (c) an index of accumulation of amorphous material greater than 65. The index is the product of thickness (cm) times the cation exchange capacity that can be attributed to the amorphous material. The figure used is the CEC of the whole soil (meq/100 g, determined at pH 8.2) minus half the percentage of clay.

11. Oxic horizon, with no argillic or natric horizon overlying the oxic horizon.

An oxic horizon is a horizon of accumulation of resistant minerals and weathering products that does not meet the requirements for argillic or natric horizon. It is at least 30 cm thick and extends no deeper than 2 m unless there is a thick epipedon that satisfies all requirements of the oxic horizon except for the limits on cation exchange capacity (by NH_4OAc at pH 7.0) and water-dispersible clay in which case it may extend 30 cm deeper than the base of the epipedon. It has (1) retention of ammonium from unbuffered 1 N NH_4Cl or a sum of KCl-exchangeable Al and exchangeable bases no greater than 10 meq/100 g of clay (values for the whole soil divided by the percent of clay determined by conventional particle-size analysis or calculated as 2.5 times the 15-bar water retention), (2) CEC (by NH_4OAc at pH 7.0) no greater than 16 meq/100 g of clay (CEC of the whole soil divided by the percent of clay as above), (3) content of weatherable silicates such as feldspars, glass and ferromagnesian minerals in the 20 to 200 micron fraction less than 3% and content of muscovite less than 6%, (4) in some subhorizon, less than 5% of the total clay dispersible in water, (5) more than 15% clay, (6) gradual or diffuse boundaries between subhorizons except for plinthite, gibbsite layers, or different deposits, and (7) less than 5% by volume of remnants of rock structure unless they are coated and cemented with iron oxides or gibbsite.

12. Cambic horizon (within a depth of 100 cm at the order level).

A cambic horizon is an altered horizon that does not meet the requirements for any other diagnostic horizon (or epipedon). It does not include transitional horizons above or below argillic, natric, spodic, or oxic horizons. It has (1) texture finer than loamy fine sand, (2) absence of rock structure (including fine (less than 5mm) stratification of sediments and small-scale orientation of grains, including pseudomorphs) in place in at

least half of the volume, (3) evidence of alteration: (a) evidence for the removal or concentration of iron (chroma less than 1, or chroma of 1 or less with value of 4 or more, or mottles with chroma of 2 or less; and hue no bluer than 10Y if the hue changes on exposure to the air) in soils that have a regular decrease in organic carbon with depth and have less than 0.2% organic carbon at a depth of 125 cm or in soils that are churned (with cracks that are at least 1 cm wide at a depth of 50 cm and that open and close most years or with permafrost) or in soils that have umbric, or mollic, or histic epipedon, (b) higher chroma, or redder hue, or higher clay content than in the underlying horizon, (c) evidence of removal of carbonates, or (d) in the absence of carbonates, soil structure, and (4) sufficient thickness that it extends to a depth of at least 25 cm or temperature according to criterion 39.

13. Calcic horizon (or petrocalcic or gypsic horizon) within a depth of:

Order level: 100 cm.

Suborder level and within Aquoll: 40 cm and saturation with water during some season when the soil temperature is greater than 5^{o} C (or artificially drained).

Great group level except within Aquoll: 100 cm (150 cm within Xeroll and in the case of petrocalcic horizon within Ustoll), with no overlying argillic or natric horizon, and calcareous throughout all overlying horizons after the upper 18 cm are mixed unless textures are coarser than loamy very fine sand.

A calcic horizon is a horizon of illuvial accumulation of carbonates. It has thickness greater than 15 cm, calcium carbonate equivalent greater than 15%, and (a) an excess of at least 5% of calcium carbonate equivalent relative to the underlying horizons or (b) more than 5% by volume of identifiable secondary lime in pendants on pebbles, concretions, or soft powdery forms.

14. Petrocalcic horizon, without an overlying duripan, within a depth of 100 cm (150 cm in Alfisol and Mollisol).

A petrocalcic horizon is a continuous calcic horizon cemented or indurated by carbonates to the point that dry fragments do not slake in water. It cannot be penetrated by spade or auger when dry. A thin, laminar horizon, cemented by carbonates and resting on bedrock, is considered a petrocalcic horizon if it is 2.5 cm or more thick and the product of thickness (cm) multiplied by the calcium carbonate equivalent (%) is 200 or more.

15. Gypsic horizon (or petrogypsic horizon) within a depth of 1 m.

A gypsic horizon is a horizon of secondary accumulation of gypsum. It has thickness greater than 15 cm, an excess of at least 5% of gypsum relative to the C or other underlying layer, and a product of thickness (cm) multiplied by the content of gypsum (%) of 150 or more.

16. Petrogypsic horizon.

A petrogypsic horizon is a gypsic horizon cemented with gypsum to the point that dry fragments do not slake in water and roots are not able to penetrate it.

17. Salic horizon within a depth of 75 cm; saturation with water within a depth of 100 cm for a month or more in some years or with artificial drainage.

A salic horizon is a horizon of accumulation of salts more soluble than gypsum. It has thickness of 15 cm or more, soluble salt content of at least 2%, and a product of thickness (cm) multiplied by the salt content (%) of 60 or more.

18. Duripan within a depth of 100 cm without an overlying petrocalcic horizon (or, in Spodosol, duripan within the albic horizon and saturation with water, or with artificial drainage).

A duripan is a horizon cemented by silica. Cementation is strong enough that dry fragments do not slake in water and remain brittle even with prolonged wetting. There are coatings and deposits of silica which are not soluble in acid (1N HCl) but are soluble in hot, concentrated alkali (KOH) or alternating alkali and acid. Soaking in acid destroys the cementation in less than half of some continuous subhorizon. Cementation in such a horizon is completely destroyed by alkali or alternating alkali and acid treatment. If fractured, the average lateral spacing of fractures is 10 cm or more.

19. Fragipan (within a depth of 100 cm at the order level and, if there is more than 5% of plinthite by volume in some subhorizon, within Aquult).

A fragipan is a loamy (uncommonly loamy sand) subsurface horizon (below an eluvial horizon unless the soil has been truncated) that is hard to extremely hard and seemingly cemented when dry and brittle when moist. Dry fragments slake in water. It has high bulk density relative to the overlying horizons. The permeability is low and roots are scarce and largely restricted to cracks between prisms. Within the brittle matrix of prisms, roots are not present at intervals less than 10 cm. Commonly, the horizon has few or many, bleached, mottled, roughly vertical streaks that are faces of coarse or very coarse prisms. Some fragipans also qualify for argillic horizon.

20. Order and suborder level: Continuous plinthite and saturation with water in some season in most years, both within a depth of 30 cm.

Great group level: Plinthite within a depth of 125 cm. The plinthite must be continuous in Oxisol. It must constitute more than half of the volume of some subhorizon in Alfisol, Inceptisol, and Ultisol.

Plinthite is iron-rich, reddish, unconsolidated material that hardens irreversibly to form ironstone with repeated wetting and drying. It ranges from isolated mottles or aggregates within a less reddish matrix that does not harden irreversibly to a continuous matrix with inclusions of less reddish, non-hardening material. It is soft enough to be cut with a spade. Material that has become indurated is no longer considered to be plinthite.

21. Order level and within Inceptisol: Placic horizon within a depth of 100 cm in half or more of each pedon.

Suborder level and within Aquod: Placic horizon that is over a spodic horizon or a fragipan but is not within a spodic horizon; saturation with water during some seasons.

Humod and Orthod: Placic horizon within a spodic horizon.

A placic horizon is a thin, black to dark reddish pan cemented by iron, with or without manganese. It contains some organic matter which may contribute to the cementation. Its thickness generally ranges from 2 to 10 mm, with extremes from 1 to 40 mm. It is not necessarily related to stratification of the parent material nor does it occur in multiple sheets. It is a single pan, rarely bifurcated, with a pronounced wavy or even involute form, roughly parallel to the soil surface and most commonly within the upper 50 cm of the mineral soil. It is a barrier to water and roots.

22. Agric horizon.

An agric horizon is an illuvial horizon formed under cultivation. It is directly below the plow layer. The illuvial material, silt, clay and humus washed out of the plow layer, has moist color value of 4 or less and moist chroma of 2 or less. The illuvial material forms coatings at least 2 mm thick in earthworm holes that constitute 5% or more of the volume of the horizon or forms lamellae at least 5 mm thick that constitute 5% or more of the volume of a horizon at least 10 cm thick.

23. Mollisol: Albic horizon and underlying argillic or natric horizon, both with mottles or iron-manganese concretions larger than 2 mm.

Alfisol and Ultisol: (1) Albic horizon or ochric epipedon (a surface horizon that does not qualify for any of the epipedons described in criteria 3 through 7) over an argillic horizon with slow or very slow permeability and with clay content in some part at least double that of the overlying horizon; within a vertical distance of 7.5 cm at the upper boundary of the argillic horizon, clay content that doubles or an increment of 20% of clay. (2) Albic horizon tonguing into an argillic horizon. Requirement (1) applies to Albaqualf and Aquult; requirement (2) to Glossaqualf, and Udalf.

An albic horizon is a horizon from which clay and free iron oxides have been been removed or in which the oxides have been segregated so that the color is determined by the sand and silt particles rather than by coatings on these particles. Except in cases of uncommon mineral composition, the chroma is 2 or less with moist value of 4 or more or dry value of 5 or more, or the chroma is 3 or less with moist value of 6 or more or dry value of 7 or more. An albic horizon overlies an argillic, natric, or spodic horizon, a fragipan, or a relatively impervious layer that can produce a perched water table, or in sandy soils it may overlie a B horizon too weakly developed to qualify for argillic or spodic horizon.

24. Sulfuric horizon within a depth of 50 cm; artificial drainage or saturation with water at some season of the year when the soil temperature at a depth of 50 cm is more than 5° C.

A sulfuric horizon is a mineral or an organic horizon with pH (1:1 in water) less than 3.5 and with straw-colored mottles (hue of 2.5Y or yellower and chroma of 6 or more) due to accumulation of jarosite produced by the oxidation of sulfides.

25. Sulfidic materials within a depth of 50 cm (100 cm in Histosol).

Sulfidic materials are waterlogged mineral or organic soil materials that have 0.75% or more sulfur (elemental, dry weight basis), mostly in the form of sulfides, and more sulfur than 1/3 of the $CaCO_3$ equivalent. They form by the biological reduction of sulfates under permanently saturated conditions, mostly in brackish water. They have the potential of forming a sulfuric horizon with drainage and oxidation of the sulfides.

26. Fibric soil material dominant over hemic and sapric soil materials in the section between 30 and 90 cm depths or between the surface and the shallowest of (1) bedrock, (2) a mineral layer thicker than 40 cm, or (3) 25 cm below the upper boundary of frozen material 2 months after the summer solstice if any of these are at a depth less than 90 cm.

Fibric soil material is an organic soil material (1) in which fibers of plant tissues large enough to be retained on a 100 mesh sieve (0.15 mm openings), excluding live roots and wood fragments more than 2 cm across that cannot be crushed and shredded in the fingers, constitute 2/3 or more of the organic volume and after rubbing between the fingers about 10 times constitute 4/10 or more of the organic volume, and (2) which yields a sodium pyrophosphate extract with value and chroma of 7/1, 7/2, 8/1, 8/2, or 8/3 when absorbed on white chromatographic paper.

27. Hemic soil materials dominant over fibric and sapric soil materials in the section between the depths of 30 and 90 cm or between the surface and (1) bedrock, (2) a mineral layer thicker than 40 cm, or (3) 25 cm below the upper boundary of frozen material 2 months after the summer solstice if any of these are at a depth less than 90 cm.

Hemic soil material is an organic soil material intermediate between fibric and sapric soil material.

28. Sapric soil material is an organic soil material (1) in which fibers constitute less than 1/3 of the organic volume or after rubbing constitute less than 1/6 of the organic volume, and (2) which yields a sodium pyrophosphate extract with value less or chroma greater than 5/1, 6/2, or 7/3 when absorbed on white chromatographic paper.

29. Fibric soil material with 3/4 or more of the fiber volume derived from species of Sphagnum throughout the organic section to a depth of 90 cm or to a lesser depth 25 cm below the upper boundary of frozen material 2 months after the summer solstice.

30. Humilluvic material that constitutes half or more of a horizon 2 cm or more thick.

Humilluvic material is illuvial humus within an organic soil, recognized by a radiocarbon age younger than that of the overlying organic materials. It is found in some acid organic soils that have been drained and cultivated.

31. (Not used.)

32. Relatively high base saturation (cation exchange capacity by NH_4OAc at pH 7.0 except at the order level and within Boralf):

Order level (CEC by sum of cations at pH 8.2): Mean annual soil temperature less than 8° C; or with less than 10% weatherable minerals in the 20 to 200 micron fraction and with tongues of material like that of an albic horizon which penetrate at least 50 cm into the argillic horizon; or base saturation of 35% or more at a depth of (1) in soils without fragipan, 180 cm below the soil surface or 125 cm below the upper boundary of the argillic horizon, (2) in soils with fragipan, 75 cm below the upper boundary of the fragipan, or (3) immediately above shallower bedrock. In (1), use the greater depth if the argillic horizon throughout has color hue redder than 5YR, moist color value less than 4, and dry color value no more than 1 unit higher than moist value, or if the epipedon is sandy throughout and more than 50 cm thick. Otherwise, use the lesser depth.

Boralf (CEC by sum of cations at pH 8.2): Base saturation of 60% or more throughout the argillic horizon and with a horizon that is dry sometime during the year in most years.

Andept: Base saturation of 50% or more in some subhorizon between the depths of 25 and 75 cm.

Ochrept: (1) Base saturation of 60% or more in some subhorizon between the depths of 25 and 75 cm or (2) with carbonates.

Tropept: Base saturation of 50% or more throughout the section between 25 cm and 100 cm or shallower bedrock.

Orthox: Base saturation of 35% or more throughout to a depth of 125 cm; without anthropic epipedon.

Ustox: Base saturation of 50% or more (35% or more if there is less than 35% clay) and with umbric or mollic epipedon darker than the oxic horizon by one unit of chroma or value when moist.

33. In most years except when irrigated:

Fluvent, Psamment, and Oxisol: Dry (moisture tension of 15 bars or more) throughout the moisture control section more than half the time that the temperature at a depth of 50 cm is greater than 5° C; and moist in some part of the moisture control section less than 90 consecutive days when the temperature at a depth of 50 cm is continuously above 8° C.

The moisture control section has its upper boundary at the depth to which dry soil (15 bars tension) will be moistened by 25 mm of water within 24 hours and its lower boundary at the depth to which dry soil will be moistened by 75 mm of water within 48 hours or, in both cases, at the upper boundary of shallower bedrock or any shallower cemented horizon. If the upper boundary of the control section is at the contact with bedrock or a cemented horizon, the contact itself serves as control. Approximately, the moisture control section is between 10 and 30 cm depths if there is more than 18%

clay or less than 15% coarser than very fine sand; between 20 and 60 cm depths if the texture is intermediate; and between 30 and 90 cm depths if the texture is coarser than loamy very fine sand.

Order level and Orthent: With an argillic or natric horizon, moisture regime indicated above and a surface horizon that is not both massive and hard (or harder) when dry. Without an argillic or natric horizon, moisture regime indicated above or (1) salic horizon within a depth of 75 cm and saturation with water for one month or more in most years within a depth of 100 cm or (2) moisture regime according to criterion 34 or 35, and with conductivity of the saturation extract at 25° C that is 2 mmhos per cm or more in some part above bedrock, petrocalcic horizon, or duripan and within a depth of 125 cm if the soil is sandy, 90 cm if the soil is loamy, or 70 cm if the soil is clayey (texture between 25 cm and 100 cm or shallower bedrock or cemented horizon).

Vertisol: Cracks that are closed less than 60 consecutive days when the temperature at a depth of 50 cm is continuously more than 8° C.

34. In most years except when irrigated:

Vertisol: Cracks that are open for 90 cumulative days or more.

Other orders: Dry (moisture tension of 15 bars or more) in some part of the moisture control section for 90 cumulative days or more; or, in Alfisol, Tropept, and Mollisol, with calcic or gypsic horizon or concentrations of secondary lime within a depth of 150 cm (or, in Alfisol and Mollisol, within 50 cm of the base of an argillic or cambic horizon).

35. Mean annual soil temperature less than 22° C and mean summer and mean winter soil temperatures that differ by 5° C or more at a depth of 50 cm or immediately above shallower bedrock; and in most years except when irrigated:

Vertisol: Cracks that open and close once each year and that remain open for 60 consecutive days or more between the summer solstice and the following equinox and remain closed for 60 consecutive days between the winter solstice and the following equinox.

Other orders: Dry (moisture tension of 15 bars or more) throughout the moisture control section for 45 consecutive days or more within the four months that follow the summer solstice and moist throughout the moisture control section for 45 consecutive days within the four months that follow the winter solstice; and, in Alfisol and Mollisol, temperature regime warmer than that specified in criterion 39.

36. Saturation with water, or with artificial drainage, during some period of the year when the soil temperature at a depth of 50 cm is more than 5° C; and: (Color specifications are for the soil when moist. Chroma requirements do not apply if hues are redder than 10YR because of red parent materials that remain red after citrate-dithionite extraction.)

Alfisol and Ultisol: (1) Mottles, iron-manganese concretions larger than 2 mm, or chromas of 2 or less immediately below any Ap horizon or any A1 horizon with value darker than 3.5 when rubbed and (2) in the argillic

or natric horizon (a) dominant chroma on ped surfaces or within peds of 1 or less or, if there are mottles, of 2 or less or (b) in Ultisol if the mean annual soil temperature is 15° C or more, distinct or prominent mottles and dominant hues of 2.5Y or 5Y.

Entisol: In all horizons below 25 cm, color hue bluer than 10Y or colors of 0 chroma that change on exposure to air; or within a depth of 50 cm (1) chroma less than 1 (1 or less if the value if 4 or more) or with mottles and chroma of 2 or less or (2) if the texture is loamy fine sand or coarser in all subhorizons, (a) hue yellower than 10YR and either chroma of 1 or less or distinct or prominent mottles and chroma of 3 or less or (b) hue bluer than 10Y or (c) colors determined by uncoated sand grains.

Histosol: Saturation with water, or with artificial drainage, for 6 months or more during the year. (The Folist suborder permits saturation with water for only a few days following heavy rains and requires, within a depth of 100 cm, bedrock or fragmental materials with the interstices at least partially filled with organic materials.)

Inceptisol: Histic epipedon or, within a depth of 50 cm, dominant chroma of 1 or less or, if there are mottles, or 2 or less.

Mollisol: (1) Histic epipedon or (2) sodium saturation greater than 15% in the upper part of the mollic epipedon and decreasing with depth below 50 cm or (3) chroma of 2 or less and distinct or prominent mottles in the lower part of the mollic epipedon or (4) chroma of 2 or less but more than 1 in the lower part of the mollic epipedon and, immediately below the mollic epipedon, value of 4 and chroma less than 2 or mottles of chroma less than 2 (2 or less if the value is 5 or higher) or (5) chroma of 1 or less in the lower part of the mollic epipedon and, immediately below the mollic epipedon or within a depth of 75 cm if a calcic horizon immediately underlies the mollic epipedon, (a) chroma less than 1 (1 or less if the hue is 2.5Y or yellower) or (b) mottles of chroma less than 1.5 (2 or less if the hue is 2.5Y; 3 or less if the hue is 5Y or yellower) or (c) hue bluer than 10Y or (d) colors determined by uncoated sand grains.

Oxisol: (1) Histic epipedon or (2) chroma of 2 or less immediately below any A horizon of value darker than 3.5 or (3) within a depth of 50 cm, distinct or prominent mottles and dominant chroma of 3 or less.

Spodosol: (1) Histic epipedon or (2) mottles in the albic horizon or in the upper part of the spodic horizon or (3) color values less than 4 in the upper part of the spodic horizon and fine or medium mottles of iron and manganese in the materials immediately below the spodic horizon or (4) absence of iron oxide coatings on silt and sand grains wherever the color value is 4 or more, and with a transition between albic and spodic horizons at least 1 cm thick unless an Ap horizon rests directly on the spodic horizon.

37. Mean annual soil temperature of 8° C or more and less than 5° C of difference between mean summer and mean winter soil temperature at a depth of 50 cm (30 cm in Histosol) or immediately above shallower bedrock.

38. Mean annual soil temperature less than 8° C.

39. Mean annual soil temperature less than 8^{o} C and:

Histosol: (1) Frozen in some layer 2 months after the summer solstice within a depth of 130 cm (160 cm if in the upper 60 cm moss fibers constitute 3/4 or more of the volume or the bulk density is less than 0.1 g/cc) and above bedrock or (2) not frozen below 5 cm.

Other orders: Mean summer soil temperature less than 8^{o} C (less than 6^{o} if saturated with water) or less than 15^{o} if there is no O horizon (less than 13^{o} if saturated with water).

40. Inceptisol and Ultisol: Organic carbon content of 12 kg or more per square meter to a depth of 1 m below any O horizon or, in Ultisol, organic carbon content of 0.9% or more in the upper 15 cm of the argillic horizon.

Oxisol: Organic carbon content of 16 kg or more per m^2 to a depth of 1 m below any O horizon; and base saturation less than 35% (CEC by NH_4OAc at pH 7) in the oxic horizon; and mean annual soil temperature less than 22^{o} C.

Spodosol: Fe/C ratio less than 0.2 (elemental ratio of free iron, extractible with citrate-dithionite, and carbon) in some subhorizon of the spodic horizon in at least half of each pedon.

41. Disordered fragments of one or more diagnostic horizons between 25 and 100 cm depths (resulting from deep plowing or other disturbance).

42. Organic carbon content irregular with depth or greater than 0.2% at a depth of 125 cm; slopes less than 25%; and mean annual soil temperature greater than 0^{o} C.

43. Throughout the section from 25 cm (or the base of the Ap horizon if it is deeper) to 100 cm (or shallower bedrock), content of coarse fragments less than 35% by volume and texture of loamy fine sand or coarser. (Lamellae with sandy loam texture that are too thin individually or in aggregate to meet the requirements of argillic horizon are permitted.)

44. Order level and Entisol: Clay content of 8% or more and n value greater than 0.7 throughout the section from 20 to 50 cm; and mean annual soil temperature warmer than 0^{o} C. The n value is the field moisture percentage minus 2/10 of the percentage of silt plus sand divided by the clay percentage plus 3 times the organic matter percentage.

n = (field moisture - 0.2 silt plus sand) / (clay + 3 organic matter). If the n value is greater than 0.7, the strength of the soil is so low that a mass of soil squeezed in the hand can flow between the fingers, leaving the hand empty.

Inceptisol: Clays that dehydrate irreversibly into aggregates including some coarser than 2 mm.

45. More than 95% of quartz (or other normally insoluble minerals that do not weather to liberate iron or aluminum) in the sand fraction.

46. Dominant moist chroma less than 1.5 to a depth of 30 cm in more than half of each pedon.

47. To a depth of 35 cm or more, or to bedrock, exchange complex dominated by amorphous material or, in the silt, sand, and gravel fractions, 60% or more of vitric volcanic ash or other pyroclastic material (glass and particles coated with glass).

Domination of the exchange complex by amorphous material (amorphous to X-ray diffraction) is indicated by (1) a relation of cation exchange capacity measured at pH 8.2 to the clay content by conventional methods of more than 150 meq/100 g of clay, (2) pH of 1 g of soil in 50 ml of 1 N NaF greater than 9.4 after 2 minutes if there is sufficient clay for 20% or more 15-bar water retention, (3) ratio of 15-bar water retention to measured clay greater than 1, (4) organic matter content greater than 1%, (5) a low temperature endotherm in differential thermal analysis, and (6) in the fraction finer than 2 mm, bulk density less than 0.85 g/cc at one-third bar tension.

48. In the section between 25 cm and 100 cm or shallower bedrock, (1) not thixotrophic in any part and (2) average (weighted by horizon thickness) 15-bar water retention of the fraction finer than 2 mm of less than 20%.

49. Sodium saturation greater than 15% in half or more of the upper 50 cm and decreasing with depth below 50 cm; and saturation with water within a depth of 100 cm at some period of the year.

50. In the fractions finer than 7.5 cm, $CaCO_3$ equivalent of 40% or more in or immediately below a mollic epipedon no more than 50 cm thick; no argillic horizon and no calcic horizon.

51. Volume of worm casts, worm holes, and filled animal burrows 50% or more in the mollic epipedon below any Ap horizon and (unless the mollic epipedon rests on bedrock) 25% or more in the transition to the underlying horizon.

52. Alfisol: Discontinuous argillic horizon (with broken upper boundary) without a continuous overlying albic horizon; in the argillic horizon, discrete nodules from 2.5 to 5 up to about 30 cm in diameter that are enriched in iron in the exterior portion so that this portion is weakly cemented to indurated and redder in hue or higher in chroma than the interior portion.

Spodosol: Fe/C ratio greater than 6 (elemental ratio of free iron, extractible with citrate-dithionite, and carbon) in all subhorizons of the spodic horizon.

53. Alfisol: In all parts of the argillic horizon, color hue redder than 5YR, moist color value less than 4, and dry color value no more than 1 unit higher than moist value. (Rhodudalfs may have criterion 57 in combination with criterion 37.)

Ultisol: Moist color value less than 4 in all parts of the epipedon; argillic horizon with dry color value less than 5 and no more than 1 unit higher than moist value.

54. Within a depth of 100 cm (125 cm in Orthox), gibbsite content of 30% or more either in cemented sheets or in gravel-size aggregates that constitute 20% or more by volume of some subhorizon; no plinthite that forms a continuous phase within 30 cm of the surface.

55. Retention of ammonium from unbuffered 1 N NH_4Cl or a sum of KCl-exchangeable Al and exchangeable bases no greater than 1.5 meq/100 g of clay (values for the whole soil divided by the percentage of clay determined by conventional particle-size analysis or calculated as 2.5 times the 15-bar water retention) in some subhorizon of the oxic horizon; and, in Orthox, without structure in the oxic horizon.

56. Sombric horizon, a subsurface horizon with illuvial humus and with darker color (lower value or lower chroma) than the overlying horizon.

57. Boralf and Boroll: Depth from the mineral surface to the argillic horizon greater than 60 cm and (1) in Boroll, texture finer than loamy fine sand throughout this depth or (2) in Boralf, texture finer than loamy fine sand in some subhorizon above the argillic horizon and peds in the upper 5 cm of the argillic horizon separated more than 2 mm by clean silt or sand grains on vertical faces.

Other suborders: (1) Depth to bedrock greater than 50 cm; argillic horizon with more than 35% clay in the upper part and an increment at the upper boundary of:
(a) 10% of clay or more if the boundary is between an Ap horizon and the argillic horizon.
(b) 15% of clay or more in a vertical distance of 2.5 cm.
(c) 20% of clay or more in a vertical distance of 7.5 cm.
(2) Argillic horizon in which, to a depth of 150 cm, the clay content does not decrease to a value of 80% or less of the maximum value (or, in Alfisol and Ultisol, any layer in which the clay content decreases to a lower value shows evidence of clay eluviation or has more than 5% by volume of plinthite) and in which:
(a) at least the lower part has hue redder than 10YR and chroma more than 4.
(b) there are common coarse mottles with hue of 7.5YR or redder (*redder than 7.5YR) or chroma of more than 5.
(c) the major part has hue of 7.5YR (*2.5YR) or redder, moist value less than 4, and dry value less than 5.
(d) the upper 50 cm has less than 10% of weatherable minerals in the 20 to 200 micron fraction.

These requirements are applied as follows:
Argid: 1a or 1b.
Udalf: 2a, 2b*, or 2c*.
Ustalf: 1b, 1c, 2a, 2b, or 2c.
Xeralf: 1b, 1c, 2a, or 2b.
Udoll: 2a or 2b*.
Ustoll: 1b, 1c, 2a, or 2b.
Xeroll: 1b, 1c, 2a, or 2b.
Suborders of Ultisol: 2d.

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Table 1. Criteria for orders.

Order	Criteria																						
	organic	clay	mollic	umbric	plaggen	argillic	natric	spodic	oxic	cambic	calcic	gypsic	salic	duripan	fragipan	plinthite	placic	sulfuric	sulfidic	high base	aridic	water	sodium
	1	2	3	4	7	8	9	10	11	12	13	15	17	18	19	20	21	24	25	32	33	44	49
Histosol	R																						
Spodosol	O	I	I	N	O	N	I	R	I	I	I	I	I	N	N	I	N	I	O	N	I	O	I
Oxisol	O	I	N	N	O	O	O	O	A	I	I	I	I	I	I	A	I	I	O	N	N	O	I
Vertisol	O	R	N	N	I	N	N	O	O	N	N	N	I	I	I	O	O	I	O	N	N	O	I
Aridisol	O	O	O	O	O	A	A	O	O	A	A	A	A	A	I	O	O	I	O	N	R	O	O
Ultisol	O	O	O	N	O	R	I	O	O	I	I	I	I	I	N	O	I	I	O	O	O	O	O
Mollisol	O	O	R	O	O	N	N	O	O	N	N	N	N	N	I	O	I	O	O	N	N	O	I
Alfisol	O	O	O	N	O	A	A	O	O	I	N	N	I	N	N	O	I	I	O	R	O	O	I
Inceptisol	O	O	O	A	A	O	O	O	O	A	A	O	O	A	A	O	A	A	O	N	O	O	A
Entisol	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	N	N	N	N	O

R = Required criterion.
A = Alternative criterion. (One of the alternatives is required).
N = Neutral criterion, permitted but not required.
I = Improbably criterion, permitted but very improbable.
O = Prohibited criterion or one impossible by definition.

Table 2. Criteria for suborders and great groups of Alfisol.

Suborder and great group	Criteria																		
	umbric	natric	petrocalcic	duripan	fragipan	plinthite	agric	albic	high base	ustic	xeric	wet	tropic	frigid	cryic	iron	red	old
	4	9	14	18	19	20	22	23	32	34	35	36	37	38	39	52	53	57
Aqualf										N	N	R		N				
Boralf										N	O	O		R				
Udalf										O	O	O		O				
Ustalf										R	O	O		O				
Xeralf										N	R	O		N				
Albaqualf	N	O		O	O	O		R					O					
Duraqualf	N	N		R	I	O		N					N					
Fragiaqualf	N	O		O	R	O		N					O					
Glossaqualf	N	O		O	O	O		R					O					
Natraqualf	N	R		O	I	O		O					N					
Ochraqualf	O	O		O	O	O		O					O					
Plinthaqualf	N	I		I	I	R		N					N					
Tropaqualf	N	O		O	N	O		N					R					
Umbraqualf	R	O		O	O	O		O					O					
Cryoboralf		O			O				N						R			O
Eutroboralf		O			O				R						O			O
Fragiboralf		O			R				I						N			O
Glossoboralf		O			O				O						O			O
Natriboralf		R			O				O						N			O
Paleboralf		O			N				N						N			R
Agrudalf		I			I		R	I					I			I	N	I
Ferrudalf		O			N		O	N					O			R	I	N
Fragiudalf		O			R		O	O					I			O	N	N
Fraglossudalf		O			R		O	R					O			O	N	N
Glossudalf		O			O		O	R					O			O	N	N
Hapludalf		O			O		O	O					O			O	O	O
Natrudalf		R			I		O	O					N			O	O	O
Paleudalf		O			O		O	O					O			O	N	R
Rhodudalf		O			O		O	O					N			O	R	O
Tropudalf		O			O		O	I					R			O	O	N
Durustalf	N		O	R		O											N	N
Haplustalf	O		O	O		O											O	O
Natrustalf	R		N	O		O											O	O
Paleustalf	O		A	O		O											N	A
Plinthustalf	I		I	O		R											N	N
Rhodustalf	O		O	O		O											R	O

Table 2. (cont.) Criteria for suborders and great groups of Alfisol.

Suborder and great group	Criteria																	
	umbric	natric	petrocalcic	duripan	fragipan	plinthite	agric	albic	high base	ustic	xeric	wet	tropic	frigid	cryic	iron	red	old
	4	9	14	18	19	20	22	23	32	34	35	36	37	38	39	52	53	57
Durixeralf		N	O	R		O											N	N
Haploxeralf		O	O	O		O											O	O
Natrixeralf		R	N	O		O											O	O
Palexeralf		O	A	O		O											O	A
Plinthoxeralf		I	I	O		R											N	N
Rhodoxeralf		O	N	O		O											R	N

Table 3. Criteria for suborders and great groups of Aridisol.

Suborder and great group	Criteria							
	argillic	natric	calcic	petrocalcic	gypsic	salic	duripan	old
	8	9	13	14	15	17	18	57
Argid	A	A						
Orthid	O	O						
Durargid		O		O			R	N
Haplargid		O		O			O	O
Nadurargid		R		O			R	O
Natrargid		R		O			O	O
Paleargid		N		A			O	A
Calciorthid			R	O	O	O	O	
Camborthid			O	O	O	O	O	
Durorthid			N	O	N	I	R	
Gypsiorthid			N	O	R	O	O	
Paleorthid			N	R	N	O	O	
Salorthid			N	I	N	R	O	

Table 4. Criteria for suborders and great groups of Entisol.

Suborder and great group	Criteria											
	sulfidic	aridic	ustic	xeric	wet	tropic	cryic	fragments	alluvial	sandy	water	quartz
	25	33	34	35	36	37	39	41	42	43	44	45
Aquent	A				A			N	N	N		
Arent	O				O			R	N	N		
Fluvent	O				O			O	R	O		
Orthent	O				O			O	O	O		
Psamment	O				O			O	N	R		
Cryaquent	O					O	R		N	N	O	
Fluvaquent	O					N	O		R	O	O	
Haplaquent	O					O	O		O	O	O	
Hydraquent	O					N	N		N	O	R	
Psammaquent	O					O	O		N	R	I	
Sulfaquent	R					N	N		N	N	N	
Tropaquent	O					R	O		O	N	O	
Cryofluvent		N	N	N		O	R					
Torrifluvent		R	N	N		N	O					
Tropofluvent		O	O	O		R	O					
Udifluvent		O	O	O		O	O					
Ustifluvent		O	R	O		N	O					
Xerofluvent		O	N	R		O	O					
Cryorthent		N	N	N		O	R					
Torriorthent		R	N	N		N	O					
Troporthent		O	O	O		R	O					
Udorthent		O	O	O		O	O					
Ustorthent		O	R	O		N	O					
Xerorthent		O	N	R		O	O					
Cryopsamment		N	N	N		O	R					N
Quartzipsamment		O	N	N		N	O					R
Torripsamment		R	N	N		N	O					N
Tropopsamment		O	O	O		R	O					O
Udipsamment		O	O	O		O	O					O
Ustipsamment		O	R	O		N	O					O
Xeropsamment		O	N	R		O	O					O

Table 5. Criteria for suborders and great groups of Histosol.

Suborder and great group	Criteria									
	sulfuric	sulfidic	fibric	hemic	sphagnum	humilluvic	wet	tropic	frigid	cryic
	24	25	26	27	29	30	36	37	38	39
Fibrist	O	O	A	O	A		R			
Folist	O	O	N	N	O		O			
Hemist	A	A	N	A	N		R			
Saprist	O	O	O	O	O		R			
Borofibrist					O	O		O	R	O
Cryofibrist					O	O		O	N	R
Luvifibrist					I	R		N	N	I
Medifibrist					O	O		O	O	O
Sphagnofibrist					R	O		N	N	N
Tropofibrist					O	O		R	O	O
Borofolist								O	R	O
Cryofolist								O	N	R
Tropofolist								R	O	O
Borohemist	O	O				O		O	R	O
Cryohemist	O	O				O		O	N	R
Luvihemist	O	O				R		N	N	N
Medihemist	O	O				O		O	O	O
Sulfihemist	O	R				I		N	N	N
Sulfohemist	R	N				I		N	N	N
Tropohemist	O	O				O		R	O	O
Borosaprist								O	R	O
Cryosaprist								O	N	R
Medisaprist								O	O	O
Troposaprist								R	O	O

Table 6. Criteria for suborders and great groups of Inceptisol.

Suborder and great group	Criteria																		
	umbric 4	plaggen 7	duripan 18	fragipan 19	plinthite 20	placic 21	sulfuric 24	high base 32	ustic 34	xeric 35	wet 36	tropic 37	cryic 39	humus 40	water 44	ash 47	glass 48	sodium 49	sombric 56
Andept	N	N					O				O	N				R		O	
Aquept	N	N					A				A	N				N		A	
Ochrept	O	O					O				O	O				O		O	
Plaggept	O	R					O				O	N				O		O	
Tropept	N	O					O				O	R				O		O	
Umbrept	R	O					O				O	O				O		O	
Cryandept			N			N		N					R		N		N		
Durandept			R			I		N					O		I		N		
Dystrandept			O			O		O					O		O		O		
Eutrandept			O			O		R					O		O		O		
Hydrandept			O			O		N					O		R		I		
Placandept			O			R		N					O		O		N		
Vitrandept			O			O		N					O		O		R		
Andaquept	N			O	O	O	O					N	O			R		O	
Cryaquept	N			O	I	O	O					O	R			N		N	
Fragiaquept	N			R	I	O	O					N	N			N		I	
Halaquept	N			O	O	O	O					N	O			N		R	
Haplaquept	O			O	O	O	O					O	O			O		O	
Humaquept	R			O	O	O	O					N	N			N		I	
Placaquept	N			N	I	R	O					N	O			I		I	
Plinthaquept	N			O	R	O	O					N	N			N		I	
Sulfaquept	N			I	I	I	R					R	O			O		O	
Tropaquept	N			O	O	O	O												
Cryochrept			O	O				N	N	N			R						
Durochrept			R	O				N	N	N			N						
Dystrochrept			O	O				O	O	O			O						
Eutrochrept			O	O				R	O	O			N						
Fragiochrept			O	R				I	I	N			O						
Ustochrept			O	O				N	R	O			N						
Xerochrept			O	O				N	N	R			O						
Dystropept								O	N					O					O
Eutropept								R	O					N					O
Humitropept								O	N					R					O
Sombritropept								N	N					N					R
Ustropept								R	R										O
Cryumbrept				O						N			R						
Fragiumbrept				R						N			N						
Haplumbrept				O						O			O						
Xerumbrept				O						R			O						

Table 7. Criteria for suborders and great groups of Mollisol.

Suborder and great group	Criteria														
	argillic 8	natric 9	calcic 13	petrocalcic 14	duripan 18	albic 23	ustic 34	xeric 35	wet 36	frigid 38	cryic 39	carbonate 50	worms 51	cold 57
Alboll			O			R	N	N	N	N		O		
Aquoll			A			O	N	N	A	N		N		
Boroll			O			O	N	O	O	R		O		
Rendoll			O			O	O	O	O	N		R		
Udoll			O			O	O	O	O	O		O		
Ustoll			O			O	R	O	O	O		O		
Xeroll			O			O	N	R	O	N		O		
Argialboll		O												
Natralboll		R												
Argiaquoll	R	O	O		O						O			
Calciaquoll	O	O	R		O						O			
Cryaquoll	N	N	N		N						R			
Duraquoll	N	N	I		R						O			
Haplaquoll	O	O	O		O						O			
Natraquoll	O	R	O		O						O			
Argiboroll	R	O	O								O		O	O
Calciboroll	O	O	R								O		O	O
Cryoboroll	N	N	N								R		N	O
Haploboroll	O	O	O								O		O	O
Natriboroll	O	R	O								O		O	O
Paleboroll	N	O	O								N		O	R
Vermiboroll	O	O	I								O		R	O
Argiudoll	R												O	O
Hapludoll	O												O	O
Paleudoll	N												O	R
Vermudoll	O												R	O
Argiustoll	R	O	O	O	O								O	O
Calciustoll	O	O	R	N	O								I	O
Durustoll	N	N	N	O	R								N	N
Haplustoll	O	O	O	O	O								O	O
Natrustoll	O	R	O	O	O								O	O
Paleustoll	N	O	O	A	O								O	A
Vermustoll	O	O	O	O	O								R	O
Argixeroll	R	O	O	O	O									O
Calcixeroll	O	O	R	N	O									O
Durixeroll	N	N	N	O	R									N
Haploxeroll	O	O	O	O	O									O
Natrixeroll	O	R	O	O	O									O
Palexeroll	N	O	O	A	O									A

Table 8. Criteria for suborders and great groups of Oxisol.

Suborder and great group	Criteria									
	umbric	plinthite	high base	aridic	ustic	wet	humus	gibbsite	end	sombric
	4	20	32	33	34	36	40	54	55	56
Aquox		A		I	N	A	N			
Humox		O		O	N	O	R			
Orthox		O		O	O	O	O			
Torrox		O		R	N	O	I			
Ustox		O		O	R	O	O			
Gibbsiaquox	N	N						R		
Ochraquox	O	O						O		
Plinthaquox	N	R						O		
Umbraquox	R	O						O		
Acrohumox								O	R	O
Gibbsihumox								R	N	O
Haplohumox								O	O	O
Sombrihumox								N	N	R
Acrorthox	N		N					O	R	O
Eutrorthox	N		R					O	O	O
Gibbsiorthox	N		N					R	N	O
Haplorthox	O		O					O	O	O
Sombriorthox	N		N					N	N	R
Umbriorthox	R		O					O	O	O
Acrustox			N						R	O
Eutrustox			R						O	O
Haplustox			O						O	O
Sombriustox			N						N	R

Table 9. Criteria for suborders and great groups of Spodosol.

Suborder and great group	Criteria							
	duripan	fragipan	placic	wet	tropic	cryic	humus	iron
	18	19	21	36	37	39	40	52
Aquod	A		A	A			N	N
Ferrod	O		O	O			O	R
Humod	O		O	O			R	O
Orthod	O		O	O			O	O
Cryaquod	I	O	O		O	R	N	
Duraquod	R	I	I		N	O	N	
Fragiaquod	O	R	O		I	N	N	
Haplaquod	O	O	O		O	O	R	
Placaquod	O	N	R		N	N	I	
Sideraquod	O	O	O		O	O	O	
Tropaquod	O	O	O		R	O	N	
Cryohumod		O	O		O	R		
Fragihumod		R	O		O	N		
Haplohumod		O	O		O	O		
Placohumod		N	R		N	N		
Tropohumod		O	O		R	O		
Cryorthod		O	O		O	R		
Fragiorthod		R	O		O	N		
Haplorthod		O	O		O	O		
Placorthod		N	R		N	N		
Troporthod		O	O		R	O		

Table 10. Criteria for suborders and great groups of Ultisol.

Suborder and great group	Criteria											
	umbric	fragipan	plinthite	albic	ustic	xeric	wet	tropic	humus	red	sombric	old
	4	19	20	23	34	35	36	37	40	53	56	57
Aquult					N	N	R		N			
Humult					N	N	O		R			
Udult					O	O	O		O			
Ustult					R	O	O		O			
Xerult					N	R	O		O			
Albaquult	N	O	O	R				N				N
Fragiaquult	N	R	O	N				N				N
Ochraquult	O	O	O	O				O				O
Paleaquult	N	O	O	O				N				R
Plinthaquult	N	I	R	N				N				N
Tropaquult	N	O	O	O				R				O
Umbraquult	R	O	O	O				O				O
Haplohumult			O					O			O	O
Palehumult			O					N			O	R
Plinthohumult			R					N			O	N
Sombrihumult			N					N			R	N
Tropohumult			O					R			O	O
Fragiudult		R	I					N		N		N
Hapludult		O	O					O		O		O
Paleudult		O	O					N		N		R
Plinthudult		O	R					N		N		N
Rhodudult		O	O					N		R		O
Tropudult		O	O					R		O		O
Haplustult			O							O		O
Paleustult			O							N		R
Plinthustult			R							N		N
Rhodustult			O							R		O
Haploxerult												O
Palexerult												R

Table 11. Criteria for suborders and great groups of Vertisol.

Suborder and great group	Criteria			
	aridic	ustic	xeric	gray
	33	34	35	46
Torrert	R	N	O	
Udert	O	O	O	
Ustert	O	R	O	
Xerert	N	N	R	
Chromudert				O
Pelludert				R
Chromustert				O
Pellustert				R
Chromoxerert				O
Pelloxerert				R