THE SYSTEM OF SOIL CLASSIFICATION FOR CANADA

PUBLICATION 1455

CANADA DEPARTMENT OF AGRICULTURE

1974 — REVISED

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Ottawa, 1974

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THE NATIONAL SOIL SURVEY COMMITTEE OF CANADA

The National Soil Survey Committee was formed by the National Advisory Committee on Agricultural Services at the suggestion of Dr. E. S. Archibald, Director of the Experimental Farms Service. A committee consisting of Dr. A. Leahey, Professor G. N. Ruhnke, and Professor C. L. Wrenshall was appointed on November 15, 1939, to prepare an outline of the organization and duties of the proposed National Soil Survey Committee. The outline was adopted by the National Advisory Committee, and the National Soil Survey Committee was established in May of 1940. Dr. A. Leahey was selected as chairman and Dr. P. C. Stobbe as secretary. To these two men goes most of the credit for the achievement of the objectives set forth in the terms of reference that follow. By approval of the members, some functions have been modified from those originally established. National meetings were held in 1945, 1948, 1955, 1960, 1963, 1965, 1968, and 1970.

Terms of Reference

To act as a coordinating body among the soil survey organizations in Canada supported by the Canada Department of Agriculture, provincial departments of agriculture, research councils, and departments of soil science at universities. Its functions include:

1) Improvement of the taxonomic classification system for Canadian soils and revision of this system because of new information.
2) Improvement of the identification of physical features and soil characteristics used in the description and mapping of soils.
3) Review of methods, techniques, and nomenclature used in soil surveys and recommending changes necessary for a greater measure of uniformity or for their improvement.
4) Recommending investigations of problems affecting soil classification, soil formation, and the interpretation of soil survey information.
5) Recommending and supporting investigations on interpretations of soil survey information for soil ratings, crop yield assessments, soil mechanics, and other purposes.
6) Cooperating with specialists in soil fertility, agronomy, agrometeorology, and other disciplines in assessing interrelated problems.

Dr. A. Leahey was chairman of the N.S.S.C. from 1940 until his retirement in 1966, when he was replaced by Dr. W. A. Ehrlich.

On July 4, 1969, the name of this committee became the Canada Soil Survey Committee.

SOIL CLASSIFICATION

W. A. Ehrlich, Chairman, N.S.S.C.

Dr. Charles E. Kellogg (1) stated, "As any science grows, some plan or system of classification must be devised if the facts are to be remembered, their relationship to one another understood, and their application to practical problems made possible." It is apparent that in any science a system of classification is necessary if proper use is to be made of the facts.

No one classification fulfills all the requirements in any field; often several systems are needed. Many classifications can be developed along the same lines. What is sought is the most fundamental and natural type and one that is logical and sufficiently flexible to permit changes as knowledge increases.

A classification is an orderly arrangement of objects or ideas placed into categories according to their relationship to each other. All objects are arranged in such a way that they succeed or accompany each other and thus provide us with groupings from a high level with broad generalizations to succeeding series of lower levels, each level in descending order being more specifically defined.

The classification system presented here is taxonomic in that it is based on the study of soils in their natural relationships. Many systems have been developed in the past in various countries. A few examples are given here to illustrate the development of soil classification beginning about the middle of the nineteenth century.

Although the birth of pedology, the science that deals with soils, is generally credited to the Russian school of soil science that began under V. V. Dokuchaev (2) in 1870, it was actually two decades earlier that E. W. Hilgard (2) had the first insight of soil as a natural object having a definite organization and morphology. In his description of soils he stressed profile features regardless of agronomic considerations. Throughout his career Hilgard defended his concept of natural soil layers, which he described as surface soil, subsoil, and under-subsoil, later designated (assumed to be by the Russians in 1870) as A, B, and C horizons. Hilgard was aware of the mode of formation of soils and the processes occurring in them. In an 1860 report he discussed the oxidation and reduction of iron in relation to air and moisture in the soil. He stated that reduction of iron in soils "is an unfailing symptom of a want of proper drainage." In a later report dated 1880 he imparted a corollary: "if a well-drained soil contains bog-ore spots or grains – that is, mottling – this proves that at some time it was subject to long continued submergence or at least to drenching with water." Hilgard also described a podzolized soil and demonstrated analytically that the color difference between the surface and subsurface layers was related to iron translocation.

The concept, intimated by Hilgard, that soils are individual natural bodies each with its own morphology, was developed by Dokuchaev and his pupils. Through their classical researches, pedology was established as a scientific discipline. Because of the language barrier, the results of research in soils in Russia were not available to the western world until 1914, when K. D. Glinka (3) published a textbook in German. At that time in the USA, C. F. Marbut (3) was in charge of soil survey under M. Whitney (3). He read and translated Glinka's book. He grasped the significance of the new concept and he set forth to personally study the soils of the country and to teach others. From this concept began a new and orderly system of classification, soil research, and the interpretation of results to make them applicable to individual soils everywhere.

The first soil survey in the USA started in 1899 when T. H. Means (3) under Whitney studied 720,000 acres in Montana. The report so impressed the Secretary of Agriculture and President McKinley that a Bureau of Soils was established. By the end of 1903 about 40 million acres had been surveyed. Considerable criticism was directed at the subsequent reports and maps, particularly because of the doubtful benefits of this work. The surveys continued, however, and when Marbut took charge in 1914 the image of soil survey and its value began an ascent that has continued and spread throughout the world.

During the formative period of the U.S. soil survey a system was developed mainly for land use. The system was based on the soil type (texture) as the fundamental unit of classification, and the series to embrace the features of color, texture, drainage, and geologic origin of the soil material. When Marbut became acquainted with the Russian concept, he shifted, as did soil workers in western Europe, from the old geological basis of definition to the climatic basis. This concept, first introduced by Dokuchaev as normal, transitional, and abnormal divisions and later developed by Sibirtzev (4) in 1895 as zonal, intrazonal, and azonal soils, was accepted by Marbut in principle. In 1927 Marbut published a classification system in which the uppermost category was divided into Pedalfers and Pedocals and the lower categories were indicative (although not specified) of zonal and intrazonal soils. This scheme was modified in 1938 and revised in 1949 to a system of six categories listed as order, suborder, great group, family, series, and type. The order included groupings of zonal, intrazonal, and azonal soils; the suborder provided separations of soils that reflected in various degrees the effect of climate, vegetation, drainage, soil color, development, and composition; and the great group brought together soils of similar genetic origin. Not being satisfied with their classification, the U.S. soil scientists began in 1951 to develop a system in the hope that it could be used internationally. A category, called a subgroup, was added to this system to accommodate generally those soils called intergrades. Initially this system had seven categories, but the removal of the type as a category reduced the number to six.

The present U.S. system, although incomplete in some aspects, provides the most precise definitions and is by far the most universal scheme developed to the present time. Although it has been tested rigorously since 1965, it has not been published because of additions and changes that have been made. It is expected to be officially published in 1973.

In Canada, the establishment of soil surveys occurred over a period of 28 years, beginning in Saskatchewan and Alberta in 1921, and following in Manitoba and Ontario in 1927 (although some work had been carried out earlier in these two provinces), British Columbia in 1931, Quebec and Nova Scotia in 1934, New Brunswick in 1938, Prince Edward Island in 1943, Northwest Territories in 1944, and Newfoundland in 1949. The first surveys were started by teachers and professors of soils in colleges and universities, who had little or no field experience. The first enterprises in 1921 were sponsored by the provincial governments; this sponsorship continued until 1929. From 1929 to 1932 support was provided by the federal government. For the next 2 years only limited funds were available because of the economic depression. In 1935 the federal government provided sufficient assistance to permit some surveys to get under way, especially in the drought areas of Western Canada. At this time, however, the number of trained soil survey personnel in Canada was small, and several years elapsed before sufficiently experienced persons were available to map soils. Up to 1936 about 25 million acres were surveyed, mainly in Saskatchewan and Alberta.

Before 1955 a variety of classification systems were used, particularly in Western Canada. At first, both Saskatchewan and Alberta emphasized texture as the main criterion, and this aspect was followed until 1926 when the zonal concept was recognized and included in the definition of the major soil groups.

Since 1948 a soil zone has represented a land area in which a zonal great soil group forms a natural land pattern with other soils that exhibit the zonal characteristics only weakly or not at all. The soil zone is not a taxonomic unit, but may be used as a cartographic unit.

From 1948 to 1955, taxonomic classification in Canada placed the great soil group at the highest level, and the soil series and soil type at lower levels. The great soil group represented major kinds of soil profiles. Its adoption did much to firm up our classification, but further work was needed to bridge the gap between the great soil group and the soil series, and to bring together in a higher category those great groups with similar characteristics. In 1955 in Canada, a system similar to the one being developed in the USA was proposed and accepted for use in 1960. This scheme consisted of order, great group, subgroup, family, series, and type, similar to the arrangement proposed by the USA except for one less category. This category, called suborder in the U.S. system, was not considered necessary in the scheme developed here, but it has been found on occasion that an additional category would provide more discriminatory separations at the intermediate levels. At present many intergrades must be included with nontransitional soils, especially in the subgroup, because no separate category is available for either one or the other (for example, grumic, calcareous, and bisequa).

Since the adoption of the classification in 1960, the system has been subjected to a number of changes based on decisions made at the national meetings held in 1963, 1965, 1968, and 1970. These changes, brought about by research and field testing, were definite improvements, but caused a great deal of inconvenience to soil workers and teachers. The alterations were deemed necessary by the National Committee and were to be continued until a rather stable system was established. This state of stability of the Canadian system appears to have been achieved and it is the intention of the committee to avoid major changes for the next 5 years. Consequently, the committee has prepared this handbook on the system of soil classification for Canada.

The present classification, through the splitting of the Podzolic order and the acceptance of the upper four categories of the Organic order, increased the number of classes in the scheme. There are 8 orders, 23 great groups, 165 subgroups, 800 to 1,000 families, about 3,000 series, and about 4,000 types.

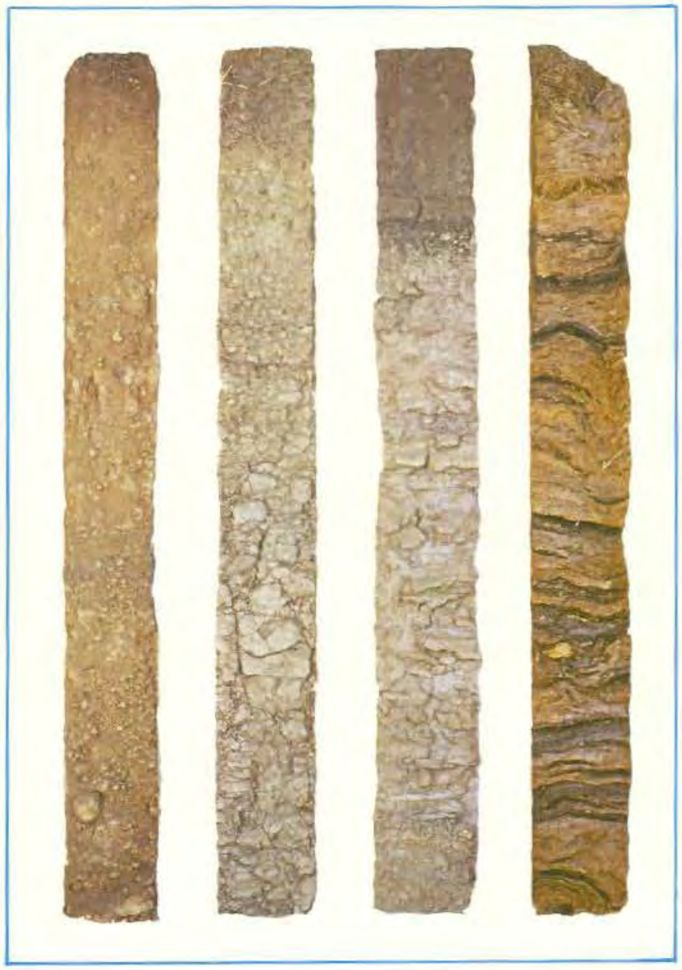
Minor modifications in the system will undoubtedly be necessary. Some definitions need strengthening and some additions to the organic soil classification will be made. Research on soil genesis through the efforts of soil survey units, soil units at research stations, the Soil Research Institute, and soil science departments at universities has contributed much. This type of research has been intensified in recent years and is expected to continue in the future.

References

1. Charles E. Kellogg. 1941. The Soils that Support Us. p. 309. The Macmillan Company, New York.
2. Jenny, Hans. 1961. E.W. Hilgard and the Birth of Modern Science. Collana Della Rivista "Agrochimica", Pisa.
3. U.S. Department of Agriculture. 1957. Soil. USDA Yearbook of Agriculture.
4. U.S. Department of Agriculture. 1960. Soil Classification (7th Approximation).

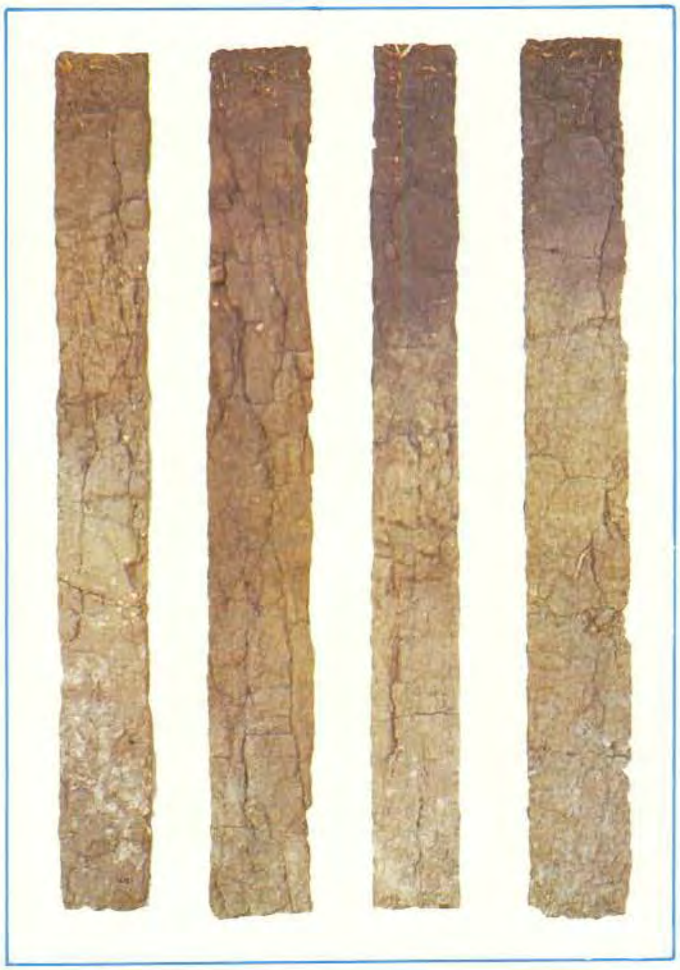
A B C D

Fig. 1. Soil monoliths representative of the (a) Chernozemic, (b) Solonetzic, (c) Luvisolic, and (d) Podzolic orders.



A B C D

Fig. 2. Soil monoliths representative of the (a) Brunisolic, (b) Regosolic, (c) Gleysolic, and (d) Organic orders.



A B C D

Fig. 3. Soil monoliths representative of certain Chernozemic soils: (a) Orthic Brown, (b) Orthic Dark Brown, (c) Orthic Black, and (d) Orthic Dark Gray.

OUTLINE OF THE SYSTEM OF SOIL CLASSIFICATION FOR CANADA

The system of soil classification at the order, great group, and subgroup levels is listed below in numerical sequence for the purposes of identification and coding.

Use the subgroups shown with a hyphen after the first two numbers and a virgule before the last number in combination with other subgroups of the same great group not numbered in this manner. The hyphen indicates a missing subgroup number. For example, a Carbonated Rego Black would be numbered 1.32/6 and a Gleyed Calcareous Black would be 1.33/8.

Soils with distinctive peaty horizons, but of insufficient depth to qualify as organic soils, are defined as peaty phases.

Horizon designations of profile types in the classification system make use of the following conventions:

Diagnostic horizons are underlined.

Nondiagnostic horizons that may be present are in parentheses.

Order	*Great Group*	*Subgroup*	
1. Chernozemic	1.1 Brown	1.11	Orthic Brown
		1.12	Rego Brown
		1.13	Calcareous Brown
		1.14	Eluviated Brown
		1.11-2.11	Solonetzic Brown
		1.14-2.21	Solodic Brown
		1.1-/5	Saline Brown
		1.1-/6	Carbonated Brown
		1.1-/7	Grumic Brown
		1.1-/8	Gleyed Brown
		1.1-/9	Lithic Brown
	1.2 Dark Brown	1.21	Orthic Dark Brown
		1.22	Rego Dark Brown
		1.23	Calcareous Dark Brown
		1.24	Eluviated Dark Brown
		1.21-2.11	Solonetzic Dark Brown
		1.24-2.21	Solodic Dark Brown
		1.2-/5	Saline Dark Brown
		1.2-/6	Carbonated Dark Brown
		1.2-/7	Grumic Dark Brown
		1.2-/8	Gleyed Dark Brown
		1.2-/9	Lithic Dark Brown
	1.3 Black	1.31	Orthic Black
		1.32	Rego Black
		1.33	Calcareous Black
		1.34	Eluviated Black

Order	Great Group	Subgroup	
		1.31-2.12	Solonetzic Black
		1.34-2.22	Solodic Black
		1.3-/5	Saline Black
		1.3-/6	Carbonated Black
		1.3-/7	Grumic Black
		1.3-/8	Gleyed Black
		1.3-/9	Lithic Black
	1.4 Dark Gray	1.41	Orthic Dark Gray
		1.42	Rego Dark Gray
		1.43	Calcareous Dark Gray
		1.41-2.12	Solonetzic Dark Gray
		1.41-2.22	Solodic Dark Gray
		1.4-/5	Saline Dark Gray
		1.4-/6	Carbonated Dark Gray
		1.4-/7	Grumic Dark Gray
		1.4-/8	Gleyed Dark Gray
		1.4-/9	Lithic Dark Gray
2. Solonetzic	2.1 Solonetz	2.11	Brown Solonetz
		2.12	Black Solonetz
		2.13	Gray Solonetz
		2.14	Alkaline Solonetz
		2.1-/8	Gleyed Solonetz
		2.1-/9	Lithic Solonetz
	2.2 Solod	2.21	Brown Solod
		2.22	Black Solod
		2.23	Gray Solod
		2.2-/8	Gleyed Solod
		2.2-/9	Lithic Solod
3. Luvisolic	3.1 Gray Brown Luvisol	3.11	Orthic Gray Brown Luvisol
		3.12	Brunisolic Gray Brown Luvisol
		3.13	Bisequa Gray Brown Luvisol
		3.1-/8	Gleyed Gray Brown Luvisol
		3.1-/9	Lithic Gray Brown Luvisol
	3.2 Gray Luvisol	3.21	Orthic Gray Luvisol
		3.22	Dark Gray Luvisol
		3.2-/3	Brunisolic Gray Luvisol
		3.2-/4	Bisequa Gray Luvisol
		3.21-2.23	Solodic Orthic Gray Luvisol
		3.22-2.23	Solodic Dark Gray Luvisol
		3.2-/8	Gleyed Gray Luvisol
		3.2-/9	Lithic Gray Luvisol
4. Podzolic	4.1 Humic Podzol	4.11	Orthic Humic Podzol

Order	*Great Group*	*Subgroup*	
		4.12	Placic Humic Podzol
		4.1-/8	Gleyed Humic Podzol
		4.1-/9	Lithic Humic Podzol
	4.2 Ferro-Humic Podzol	4.21	Orthic Ferro-Humic Podzol
		4.22	Mini Ferro-Humic Podzol
		4.23	Sombric Ferro-Humic Podzol
		4.2-/4	Placic Ferro-Humic Podzol
		4.2-/8	Gleyed Ferro-Humic Podzol
		4.2-/9	Lithic Ferro-Humic Podzol
	4.3 Humo-Ferric Podzol	4.31	Orthic Humo-Ferric Podzol
		4.32	Mini Humo-Ferric Podzol
		4.33	Sombric Humo-Ferric Podzol
		4.3-/4	Placic Humo-Ferric Podzol
		4.3-/5	Bisequa Humo-Ferric Podzol
		4.3-/7	Cryic Humo-Ferric Podzol
		4.3-/8	Gleyed Humo-Ferric Podzol
		4.3-/9	Lithic Humo-Ferric Podzol
5. Brunisolic	5.1 Melanic Brunisol	5.11	Orthic Melanic Brunisol
		5.12	Degraded Melanic Brunisol
		5.1-/8	Gleyed Melanic Brunisol
		5.1-/9	Lithic Melanic Brunisol
	5.2 Eutric Brunisol	5.21	Orthic Eutric Brunisol
		5.22	Degraded Eutric Brunisol
		5.23	Alpine Eutric Brunisol
		5.2-/7	Cryic Eutric Brunisol
		5.2-/8	Gleyed Eutric Brunisol
		5.2-/9	Lithic Eutric Brunisol
	5.3 Sombric Brunisol	5.31	Orthic Sombric Brunisol
		5.31/8	Gleyed Sombric Brunisol
		5.31/9	Lithic Sombric Brunisol
	5.4 Dystric Brunisol	5.41	Orthic Dystric Brunisol
		5.42	Degraded Dystric Brunisol
		5.43	Alpine Dystric Brunisol
		5.4-/7	Cryic Dystric Brunisol
		5.4-/8	Gleyed Dystric Brunisol
		5.4-/9	Lithic Dystric Brunisol

Order	*Great Group*	*Subgroup*	
6. Regosolic	6.1 Regosol	6.11	Orthic Regosol
		6.12	Cumulic Regosol
		6.1-/5	Saline Regosol
		6.1-/7	Cryic Regosol
		6.1-/8	Gleyed Regosol
		6.1-/9	Lithic Regosol
7. Gleysolic	7.1 Humic Gleysol	7.11	Orthic Humic Gleysol
		7.12	Rego Humic Gleysol
		7.13	Fera Humic Gleysol
		7.1-/5	Saline Humic Gleysol
		7.1-/6	Carbonated Humic Gleysol
		7.1-/7	Cryic Humic Gleysol
		7.1-/9	Lithic Humic Gleysol
	7.2 Gleysol	7.21	Orthic Gleysol
		7.22	Rego Gleysol
		7.23	Fera Gleysol
		7.2-/5	Saline Gleysol
		7.2-/6	Carbonated Gleysol
		7.2-/7	Cryic Gleysol
		7.2-/9	Lithic Gleysol
	7.3 Eluviated Gleysol	7.31	Humic Eluviated Gleysol
		7.32	Low Humic Eluviated Gleysol
		7.33	Fera Eluviated Gleysol
		7.3-/9	Lithic Eluviated Gleysol
8. Organic	8.1 Fibrisol	8.1-1a	Fenno-Fibrisol
		8.1-1b	Silvo-Fibrisol
		8.1-1c	Sphagno-Fibrisol
		8.1-2	Mesic Fibrisol
		8.1-3	Humic Fibrisol
		8.1-4	Limno Fibrisol
		8.1-5	Cumulo Fibrisol
		8.1-6	Terric Fibrisol
		8.1-7	Terric Mesic Fibrisol
		8.1-8	Terric Humic Fibrisol
		8.1-9	Cryic Fibrisol
		8.1-10	Hydric Fibrisol
		8.1-11	Lithic Fibrisol
	8.2 Mesisol	8.2-1	Typic Mesisol
		8.2-2	Fibric Mesisol
		8.2-3	Humic Mesisol
		8.2-4	Limno Mesisol
		8.2-5	Cumulo Mesisol
		8.2-6	Terric Mesisol
		8.2-7	Terric Fibric Mesisol
		8.2-8	Terric Humic Mesisol
		8.2-9	Cryic Mesisol
		8.2-10	Hydric Mesisol
		8.2-11	Lithic Mesisol

Order	*Great Group*	*Subgroup*	
	8.3 Humisol	8.3-1	Typic Humisol
		8.3-2	Fibric Humisol
		8.3-3	Mesic Humisol
		8.3-4	Limno Humisol
		8.3-5	Cumulo Humisol
		8.3-6	Terric Humisol
		8.3-7	Terric Fibric Humisol
		8.3-8	Terric Mesic Humisol
		8.3-9	Cryic Humisol
		8.3-10	Hydric Humisol
		8.3-11	Lithic Humisol
	8.4 Folisol	8.4-1	Typic Folisol
		8.4-11	Lithic Folisol

CRITERIA FOR IDENTIFICATION OF HORIZONS AND LAYERS

The scope of soil horizons in the system of soil classification for Canada is based on the definition of soil as "any unconsolidated mineral or organic layer thicker than 4 inches (10 cm), occurring naturally on the earth's surface."[1] Surface layers that do not meet these requirements are not soil and are designated as rockland, ice, or water.

In this system, an important change from the one used in 1965 is the distinction by definition of organic horizons developed under wet conditions (Of, Om, Oh) and those formed under imperfect or better drainage conditions (L, F, H). Modifications were also made on the definitions of m and R. Another change recommended was the removal of the suffix "j" from the horizon originally designated as Bfj. The intergrade between Bf and Bm was considered unnecessary.

CONVENTIONS CONCERNING THE USE OF DESIGNATIONS

The capital letters A and B may not be used singly in profile descriptions, but must be accompanied by the lowercase suffix (for example, Ah, Bf, or Bt) indicating the estimated modification from the parent material. The capital letter C may be used alone except when the material is affected by reducing conditions, or has the properties of a fragipan.

Unless otherwise specified, additional lowercase suffixes indicate a secondary or subordinate feature or features, in addition to those characteristic of the defined main horizon. The symbol Btg, for example, indicates that in addition to the dominance of illuvial clay in the B horizon, there is also evidence of strong gleying. Some combinations are redundant or impractical in the light of present knowledge and definitions, and their use should be avoided, for example, Bmj. In some cases, such as Bgf, Bfh, and Bhf, the combination of suffixes has a specific meaning which differs from that of the sum of the two suffixes used singly.

All horizons except AB, A and B, AC, and B and A may be vertically subdivided by consecutive arabic numbers placed after the letter designations. The assigned arabic numeral has no meaning except that

[1] A minimum thickness limit of 4 inches of organic or unconsolidated mineral material on the immediate surface of the earth is applied to the definition of soil presented in the "Glossary of Terms in Soil Science," CDA publication 1459, 1972.

of vertical subdivision. For example, a profile may be described as having the following: Ae1, Ae2, Bt1, Bt2, Bt3, Bt4, C1, and C2.

Roman numerals are prefixed to horizon designations to indicate unconsolidated lithologic discontinuities in the profile. Roman numeral I is understood for the uppermost material and, generally, is not written. Subsequent contrasting materials are numbered consecutively in the order in which they are encountered downward, that is, II, III, and so on.

ORGANIC LAYERS

Organic layers may be found at the surface of the mineral soils, or at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 30% organic matter. Two groups of these layers are recognized:

O – This is an organic layer or layers developed under poorly drained conditions, or under conditions of being saturated most of the year, or on wet soils that have been artificially drained.

- Of – This is the least decomposed layer. It has large amounts of well-preserved fiber whose botanical origin is readily identifiable. This layer, called fibric, has a rubbed fiber content of more than 4/10 of the organic volume, and an unrubbed fiber content of more than 2/3 of the organic volume.
- Om – This is the intermediately decomposed layer. It has intermediate amounts of physically and biochemically altered fiber. This layer, called mesic, has (i) a rubbed fiber content between 1/10 and 4/10 of the organic volume, and (ii) an unrubbed fiber content of more than 1/3 of the organic volume.
- Oh – This is the most highly decomposed layer. It has the least amount of plant fiber, the highest bulk density, and the lowest water-holding capacity. This layer, called humic, (i) has a rubbed fiber content of less than 1/10 of the organic volume, and (ii) usually yields a pyrophosphate extract that is lower in value and higher in chroma than 10YR 7/3.

LFH These are organic layers developed under imperfectly to well-drained conditions.

- L – This is an organic layer characterized by an accumulation of organic matter in which the original structures are easily discernible.
- F – This is an organic layer characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The layer may be partly

comminuted by soil fauna, as in moder,[2] or it may be a partly decomposed mat permeated by fungal hyphae, as in mor.[2]

H – This is an organic layer characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F layer by its greater humification chiefly through the action of organisms. This layer is a zoogenous humus form consisting mainly of spherical or cylindrical droppings of microarthropods. It is frequently intermixed with mineral grains, especially near the junction with a mineral layer.

MASTER MINERAL HORIZONS AND LAYERS

Mineral horizons are those that contain less organic matter than that specified for organic horizons.

A – This is a mineral horizon or horizons formed at or near the surface in the zone of the removal of materials in solution and suspension, or a maximum in situ accumulation of organic matter, or both. Included are:

1) Horizons in which organic matter has accumulated as a result of biological activity (Ah).
2) Horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of these (Ae).
3) Horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B).
4) Horizons markedly disturbed by cultivation or pasture (Ap).

B – This is a mineral horizon or horizons characterized by one or more of the following:

1) An enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt, Bf, Bfh, Bhf, and Bh).
2) A prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amounts of exchangeable Na (Bn).
3) An alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and so does not meet the requirements of 1) and 2) above (Bm, Bg).

C – This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca, Csa, Cg, and C).

[2] Bernier, B. 1968. Soils under forest, p. 145 and 147. Proceedings of the Seventh Meeting of the National Soil Survey Committee of Canada.

R – This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist, and that does not meet the requirements of a C horizon. The boundary between the R layer and any overlying unconsolidated material is called a lithic contact.

LOWERCASE SUFFIXES

b – A buried soil horizon.

c – A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, a layer cemented by Ca, and a duripan are examples.

ca – A horizon of secondary carbonate enrichment in which the concentration of lime exceeds that in the unenriched parent material. It is more than 4 inches (10 cm) thick, and if it has a $CaCO_3$ equivalent of less than 15%, it should have at least 5% more $CaCO_3$ equivalent than the parent material (IC). If it has more than 15% $CaCO_3$ equivalent, it should have 1/3 more $CaCO_3$ equivalent than IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5% (by volume) of secondary carbonates in concretions or in soft, powdery forms.

cc – Cemented (irreversible) pedogenic concretions.

e – A horizon characterized by the removal of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f – A horizon enriched with hydrated iron. It usually has a chroma of 3 or more. It is used with B alone (Bf), with B and h (Bfh and Bhf), with B and g (Bfg), and with others. The criteria for an f horizon (excepting Bgf) are that the oxalate-extractable Fe + Al exceed that of the IC horizon by 0.8% or more (Δ Fe + Δ Al > 0.8%), and that the ratio of organic matter to oxalate-extractable Fe be less than 20. These horizons are differentiated on the basis of organic matter content into:

Bf – less than 5% organic matter
Bfh – 5 to 10% organic matter
Bhf – more than 10% organic matter

g – A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bfhg and Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg – This horizon must meet the definitions of A, e, and g.

Bg – This horizon cannot be defined precisely at present. It includes those horizons occurring between A and C horizons in which the main features are (i) colors of low chroma and a change in structure from that of the C, or (ii) matrix colors of low chroma accompanied by mottles more prominent or more abundant, or both, than those in the C, but not satisfying the requirements for Bgf horizons. Bg horizons occur in some Orthic Humic Gleysols and in some Orthic Gleysols. These horizons are somewhat similar to the Bm horizons of soils that are not strongly gleyed.

Bfg, Bfhg, Bhfg, Btg, and others – When used in any of these combinations the horizons must be within the limits set for f, fh, hf, t, and others.

Bgf – The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more, and the dithionite-extractable Al does not exceed that of the IC by more than 0.5%. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg horizons of gleyed Podzols. It is distinguished from the Bfg horizon of Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The FeO formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag – When g is used with C alone, or with C and one of the lowercase suffixes k, ca, s, or sa, it must meet the definition for C and for the particular suffix.

h – A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bfh, Bhf).

Ah – When used with A alone, it refers to the accumulation of organic matter and must contain less than 30% organic matter. It must show one Munsell unit of value darker than the layer just below, or have 1% more organic matter than IC.

Ahe – When used with A and e it refers to an Ah horizon that has been degraded as evidenced, under natural conditions, by streaks and splotches and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh – This horizon contains more than 2% organic matter and the ratio of organic matter to oxalate-extractable Fe is 20 or more. In general, this horizon has a color with value and chroma of less than 3 when moist. Usually the Δ (Fe + Al) is less than 0.8%, but in some cases ΔAl is great enough to exceed this value.

j – Used as a modifier of suffixes e, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right of and adjacent to the suffix it modifies.

Aej – When used with A and e it denotes an eluvial horizon that is thin, discontinuous, or slightly discernible.

Btj – When used with B and t it is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj – When used with g it refers to horizons that are mottled but do not show the neutral colors of intense reduction.

Bnjt – j may be used with n when secondary enrichment of Na is present but does not meet the limits for n.

k– Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. It may be used with any master horizon or combination of master horizon and lowercase suffix. Most often it is used with B and m (Bmk) or C (Ck).

m[3] – A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1) Soil structure rather than rock structure comprising more than half the volume of all subhorizons.
2) Some weatherable minerals.
3) Evidence of alteration in one of the following forms:
   a) Stronger chromas and redder hues than the underlying horizons.
   b) Evidence of the removal of carbonates.
4) Illuviation, if evident, is too slight to meet the requirements of a textural B or a podzolic B.
5) No cementation or induration and lacks a brittle consistence when moist.

This suffix can be used as Bm, Bmgj, Bmk, and Bms.

[3] The Bm is similar to the cambic horizon described in the U.S. and World soil classification systems except for the following:

1) It may occur under a Bf or Bt horizon.

2) Its lower boundary must be 2 inches (5 cm) or more from the surface compared with 10 inches (25 cm) in the other systems.

n – A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. When used with B it must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry.

p – A layer disturbed by man's activities, that is, by cultivation, or pasturing, or both. It is to be used only with A.

s – A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by distressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any master horizon or combination of master horizon and lowercase suffix.

sa – A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, where the concentration of salts exceeds that present in the unenriched parent material. The horizon is 4 inches (10 cm) or more thick. The conductivity of the saturation extract must be at least 4 mmhos/cm and must exceed that of the C horizon by at least one-third.

t – A horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), and with others.

Bt – A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1) If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizon, as follows:

   a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction, the Bt horizon must contain at least 3% more clay, e.g., Ae 10% clay – Bt minimum 13% clay.

   b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

   c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon.

2) A Bt horizon must be at least 2 inches (5 cm) thick. In some sandy soils where clay accumulation occurs in the lamellae,

the total thickness of the lamellae should be more than 4 inches (10 cm) in the upper 60 inches (150 cm) of the profile.

3) In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.
4) If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of cross section.
5) If a soil shows a lithologic discontinuity between the eluvial horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

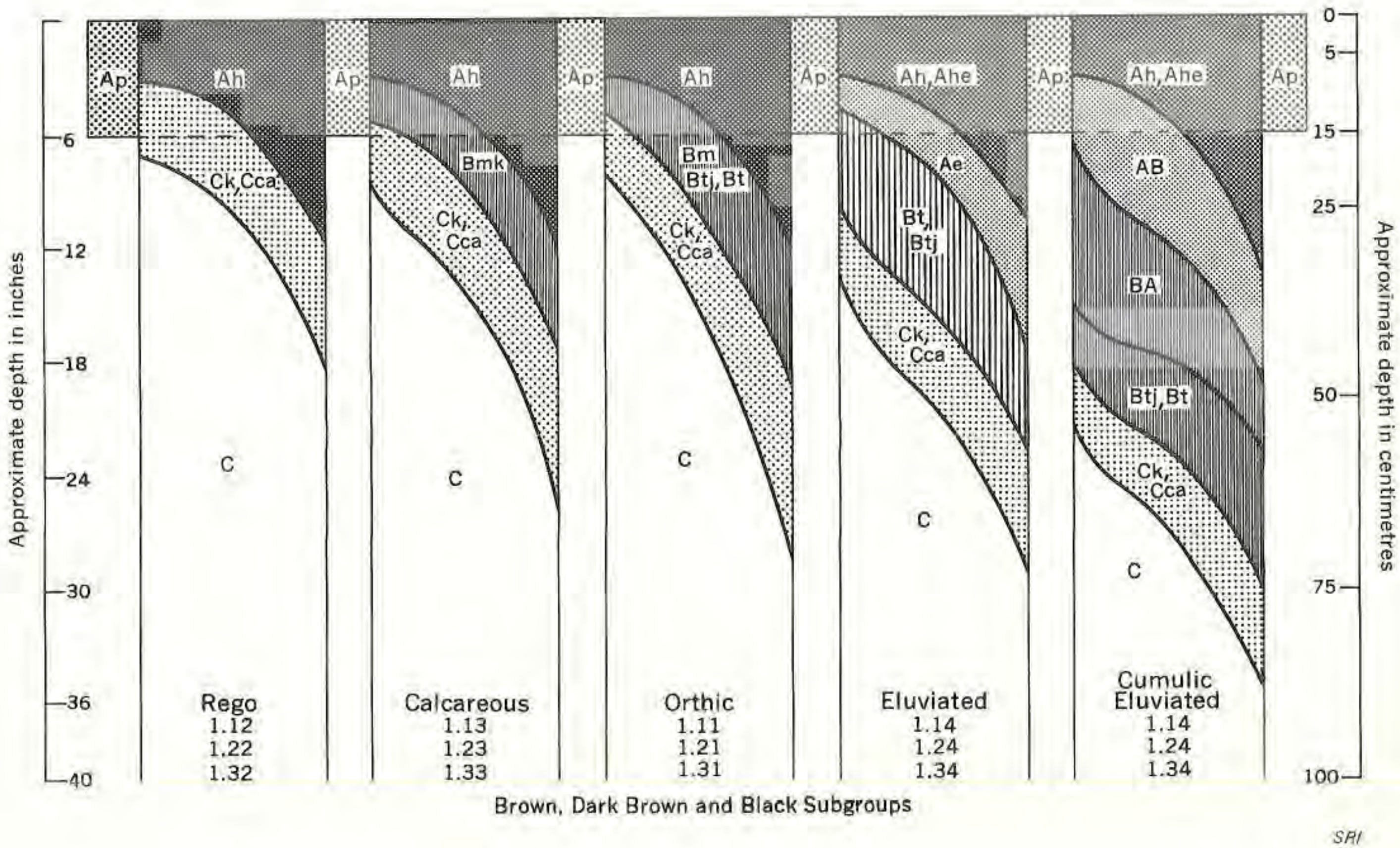
Btj and Btg are defined under j and g.

x – A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density. It is very low in organic matter and when dry it has a hard consistence and is seemingly cemented. When moist, it has a moderate to weak brittleness. It has few or many bleached fracture planes and has an overlying friable B horizon.

z – A permanently frozen layer.

Notes

1) Transitional horizons need capitals only:
   a) If the transition is gradual, use, e.g., AB or BC.
   b) If the transition is interfingered, use, e.g., A and B, or B and C.
   c) If desired, dominance can be shown by order, e.g., AB and BA.
2) The designations for diagnostic horizons must be given in the same sequence as shown for the definition, e.g., Ahe not Aeh.
3) Although definitions have been given to all diagnostic horizons, all possible combinations of horizon designations have not been covered. It is still necessary to write profile descriptions.


Approximate depth in inches
6
12
18
24
30
36
40
Approximate depth in centimetres
0
5
15
25
50
75
100
Ap
Ah
Ck,Cca
C
Rego
1.12
1.22
1.32
Ah
Bmk
Ck,
Cca
C
Calcareous
1.13
1.23
1.33
Ah
Bm
Btj,Bt
Ck,
Cca
C
Orthic
1.11
1.21
1.31
Ah,Ahe
Ae
Bt,
Btj
Ck,
Cca
C
Eluviated
1.14
1.24
1.34
Ah,Ahe
AB
BA
Btj,Bt
Ck,
Cca
C
Cumulic
Eluviated
1.14
1.24
1.34
Brown, Dark Brown and Black Subgroups
SRI

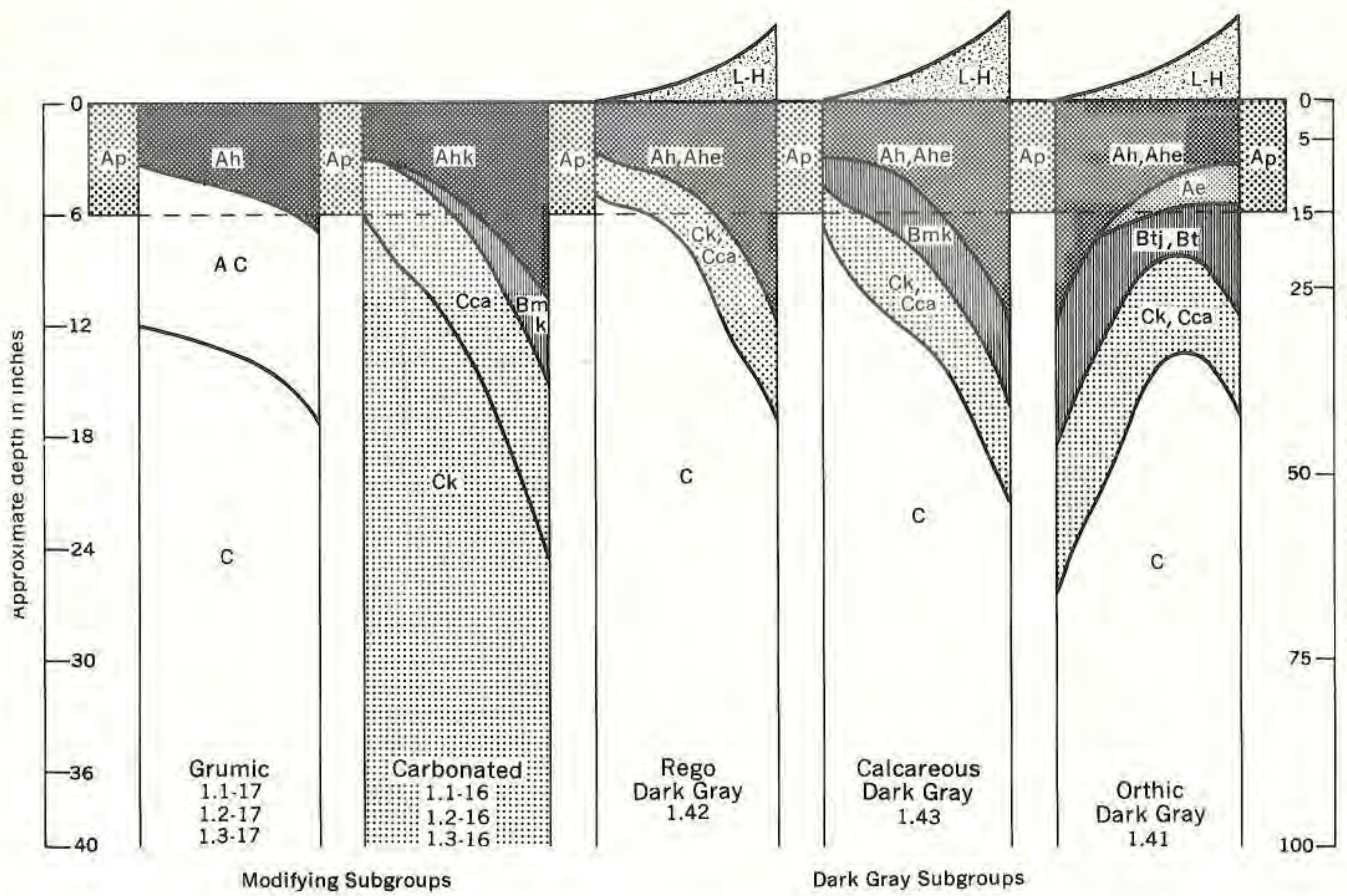


Fig. 4. A diagrammatic horizon pattern of representative Chernozemic profiles.

SRI

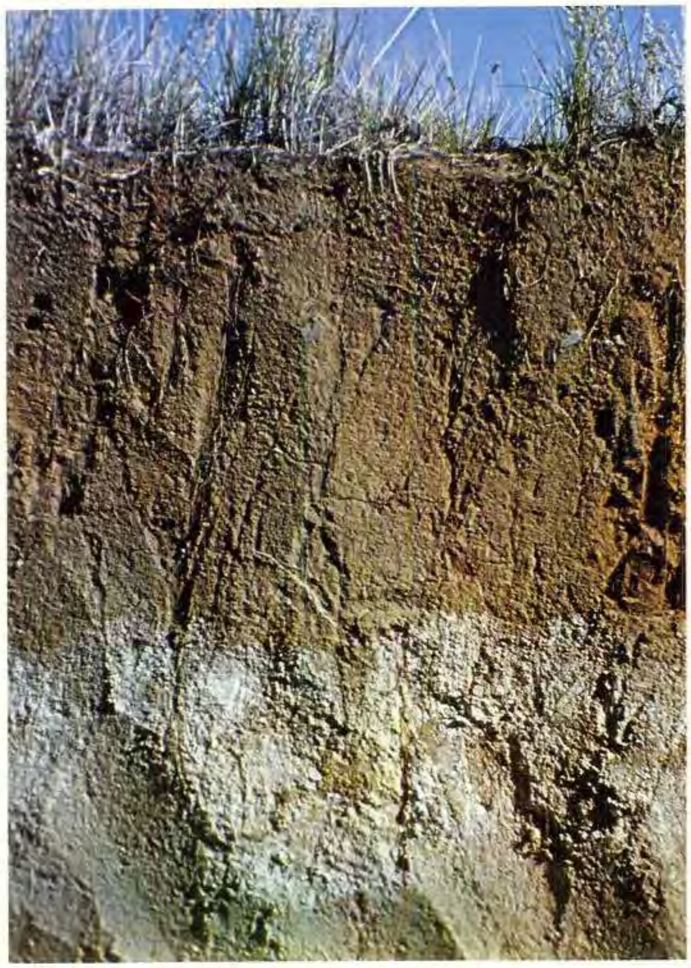


Fig. 5. An Orthic Brown soil.

Fig. 6. An Orthic Black soil.

CLASSIFICATION OF SOILS AT THE ORDER, GREAT GROUP, AND SUBGROUP LEVELS

CHERNOZEMIC ORDER

Great Group	*Subgroup*	
1.1 Brown	1.11	Orthic Brown
	1.12	Rego Brown
	1.13	Calcareous Brown
	1.14	Eluviated Brown
	1.11-2.11	Solonetzic Brown
	1.14-2.21	Solodic Brown
	1.1-/5	Saline Brown
	1.1-/6	Carbonated Brown
	1.1-/7	Grumic Brown
	1.1-/8	Gleyed Brown
	1.1-/9	Lithic Brown
1.2 Dark Brown	1.21	Orthic Dark Brown
	Subgroups same as for Brown except for great group name	
1.3 Black	1.31	Orthic Black
	Subgroups same as for Brown except for great group name	
1.4 Dark Gray	1.41	Orthic Dark Gray
	1.42	Rego Dark Gray
	1.43	Calcareous Dark Gray
	1.41-2.12	Solonetzic Dark Gray
	1.41-2.22	Solodic Dark Gray
	1.4-/5	Saline Dark Gray
	1.4-/6	Carbonated Dark Gray
	1.4-/7	Grumic Dark Gray
	1.4-/8	Gleyed Dark Gray
	1.4-/9	Lithic Dark Gray

A diagrammatic representation of the horizon pattern of the main subgroup profiles in the Chernozemic Order is shown in Fig. 4.

1. CHERNOZEMIC ORDER

Chernozemic soils are well to imperfectly drained mineral soils with dark surface Ah, Ahe, or Ap Chernozemic A horizons as defined, and with B or C horizons of high base saturation with divalent cations, calcium usually being dominant. These soils are found in areas with cool (mean annual temperature usually less than 42 F, 5.5 C), semiarid to subhumid continental (boreal) climate. The characteristics of the A horizons are developed and maintained from the accumulation and decomposition of a cyclic growth of xero- or meso-phytic grasses and forbs, representative of grassland communities or of transitional grassland–forest communities with associated shrubs and forbs.

At the order level, the definitions and criteria established for Chernozemic soils are such that they may be closely correlated with the suborder Borolls in the U.S. system[1] and with Kastanozems and Chernozems in the proposed units for the World system.[2] However, a number of other soils with similarly dark-colored surface horizons (Mollic Epipedons or Mollic A horizons) are excluded from the Chernozemic order by definition. These exclusions include:

1) Dark surface soils with distinct solonetzic (Bn) horizons as defined in the Solonetzic order, including soils comparable with Natriborolls in the U.S. system and Humic Solonetz in the World system.

2) Dark surface soils developed under hydrophytic vegetation and exhibiting strongly gleyed characteristics as defined within the Gleysolic order, including soils comparable with Aquolls in the U.S. system and Humic Gleysols in the World system.

3) Dark surface soils developed in areas with cold (cryic) climates and under vegetative communities characteristic of the Subarctic, Arctic, Subalpine, and Alpine regions, and comparable with soils classed as Pergelic Cryoborolls in the U.S. system, with M.A.S.T. (mean annual soil temperature) <32 F (0 C), which is characteristic of cryic climates in the World system.

4) Dark surface soils developed under very dry (xeric) temperate climates with M.A.T. (mean annual temperature) >42 F (5.5 C), comparable with those classified as Ustolls in the U.S. system and Yermosols in the World system.

5) Dark surface soils developed under deciduous or mixed-wood forest vegetation of moist (udic) temperate climates, or under boreal forest vegetaton where prominent Ae horizons >2.5 inches (6 cm) in thickness have developed because of podzolization. These exclusions include Dark Gray Luvisols comparable with U.S. Mollic Cryoboralfs, and some Gray Brown Luvisols and Melanic Brunisols comparable with Mollic Hapludalfs and Typic Hapludolls in the U.S. system and with Brunic Luvisols and Eutric Cambisols in the World system.

[1] U.S. Department of Agriculture. Soil Classification. A Comprehensive System, 7th Approximation (1960) and Supplement (March 1967) and Amendments (July 1968).

[2] FAO/UNESCO. Definitions of Soil Units for the Soil Map of the World. World Soil Resources Reports 33 (1968) and 37 (1969).

DEFINITION

A Chernozemic A horizon should have the following characteristics:

In virgin soils, the Ah horizon should be not less than 3.5 inches (9 cm) thick; its colors should have values darker than 3.5 when moist and 5.5 when dry, and chromas of less than 3.5 when moist. In soils disturbed by man's activities, by cultivation, or pasturing, or both, the Ap horizon should be thick and dark enough to provide 6 inches (15 cm) of surface horizon with the above color criteria. The Ah or Ap, moist or dry, should be at least 1 Munsell unit darker in value than the C horizon and should not be higher in chroma than the B horizon, if present.

The Ah of a virgin soil usually has more than 1.5% organic matter for every 6 inches (15 cm) when mixed or disturbed, and a carbon-to-nitrogen ratio of 17 or less. The organic matter content must not exceed 30%.

An Ap horizon 6 inches (15 cm) thick usually meets the requirement of 1.5% organic matter specified for the Ah horizon. However, where the original Ah was thin or where the present Ap horizon is thin or partly eroded, the surface soil may contain as little as 1% organic matter. If the Ah or Ap horizon rests on consolidated bedrock (R), it must be at least 4 inches (10 cm) thick.

Virgin and cultivated A horizons of Chernozemic soils have peds or clods with well-flocculated, moderate to strong structures that do not become amorphous (massive) on wetting or single-grained on drying.

1.1 BROWN (LIGHT CHESTNUT)

These Chernozemic soils have either Ah horizons with values darker than 3.5 when moist and 5.5 when dry and thick enough to produce 6 inches (15 cm) of mixed surface, or Ap horizons with color values darker than 3.5 moist and 4.5 to 5.5 dry. Chromas are usually greater than 1.5 dry. In virgin Brown Chernozemic soils the surface layers of the Ah horizons are usually as light as or lighter in value than the lower parts of the Ah or the upper B horizons.

Brown soils are associated with and developed from the decomposition of a cyclic growth of mixed xero- to meso-phytic grasses and forbs. They are closely correlated with the concept of Aridic Borolls in the U.S. system and with Kastanozems (borustic-aridic phase — Light Chestnut) in the World system.

1.11 Orthic Brown

Profile type: Ah, Bm, Btj or Bt, C, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by a color or structural Bm, or a weak to moderately textural Btj or Bt. The B horizons are free from primary carbonates and range in reaction from slightly alkaline to slightly acidic.

The B horizons are normally medium to fine prismatic in macrostructure, breaking into medium and fine blocky or into coarse granular aggregates. Coarse prismatic structure is usually associated with coarse-textured fabric. Decreasing size of macroprismatic structure and an increasing tendency to break into fine, blocky, and granular aggregates is apparently associated with increasing clay content in the solum, and particularly with the occurrence of a textural (Bt) horizon. Thin discontinuous coatings on the surface of peds may occur in textural (Bt) horizons. Although these are not readily visible to the naked eye, they may be observed with a hand lens or in a thin section.

The occurrence of distinctive textural B horizons is not common in orthic Chernozemic soils, but may reflect simple gravitational movement and colloidal flow through pores and cleavages, or trends toward minimal development of solonetzic or luvisolic characteristics. A thin weakly developed Bm horizon or a transitional BC horizon is often present between the Bt and C horizons. A light-colored horizon of carbonate accumulation, Cca, is usually present, but is not an essential criterion.

Orthic Chernozemic soils may be closely correlated with the concept of Haploborolls in the U.S. system or Haplic Kastanozems and Haplic Chernozems in the World system, except when a significant textural B is present. Then they are more comparable with the concept of Argiborolls, Luvic Kastanozems, and Chernozems.

Orthic profiles with minimal grumic characteristics occur in soils of high clay content; they are characterized by granular to fine subangular blocky peds in the A horizons and massive to angular blocky structure in the B horizons. Dark tongues of the A horizon often extend into the B and C due to sloughing into cracks. The boundaries between A, Bm, and Ck horizons are usually sharper and less diffuse than in rego and calcareous Chernozemic subtypes. This profile type is designated as Grumic Orthic Brown 1.11/7.

1.12 Rego Brown

Profile type: <u>Ah</u>, <u>C</u>, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, and are underlain by C horizons. In the profiles, no major leaching of primary alkaline earth carbonates has occurred below the A horizons. Transitional AC horizons may occur. There is no distinctive development of B horizons in Rego Chernozemic soils. They are very closely correlated with the concept of Entic Haploborolls in the U.S. system.

In profiles with well-developed internal drainage, or in those on sites with moderate to excessive surface drainage, the virgin Ah horizons are generally free from carbonates or salts. When disturbed or under cultivation, the A horizons are usually calcareous.

In profiles with limited internal drainage, or in those occurring on imperfectly drained sites, the A horizons may be infused with secondary carbonates, or salts that have precipitated from solution. Carbonated rego profiles may usually be detected by visual observation of strings or beads of carbonate crystals in the Ah horizon and confirmed by an effervescence test with acid (Ahk). Under cultivation these soils usually have a distinctly grayish surface cast or color.

Grumic rego profiles are mainly confined to fine-textured soils, usually those containing 50% clay. The self-mulching properties of these soils, due to the repetition of swelling, shrinking, and the sloughing of surface material into cracks, cause the profiles to possess ill-defined A horizons, which merge into transitional AC horizons. A tendency to form a surface granular mulch is particularly characteristic of grumic phases.

Soils with grumic characteristics are closely comparable with the concept of Vertic Borolls in the U.S. system.

Gleyed rego profiles are characterized by weak development of mottling, and other characteristics of temporary wetness in the A and upper C horizons. Carbonated and saline profiles often show evidences of gleying.

1.13 Calcareous Brown

Profile type: Ah, Bmk, Cca or Ck

These soils have Ah or Ap horizons as defined in the order and great group, underlain by Bm horizons from which primary alkaline earth carbonates have not been completely removed (Bmk).

The B horizon is usually medium to fine prismatic in macrostructure, brownish in color, and slightly to moderately alkaline in reaction. Coarse prismatic structure is usually associated with coarse textures. A light-colored Cca horizon of carbonate accumulation is usually present above the C and where this condition occurs the soil may be closely compared with Calciborolls in the U.S. system and Calcic Kastanozems or Calcic Chernozems in the World system.

In profiles on sites with moderate to excessive surface drainage, the primary carbonates in the B horizons are present because of insufficient leaching.

Salinized, carbonated, grumic, and gleyed modifications of Calcareous Brown profiles occur and may be designated as Saline Calcareous Brown 1.13/5, Carbonated Calcareous Brown 1.13/6, Grumic Calcareous Brown 1.13/7, and Gleyed Calcareous Brown 1.13/8.

In profiles on imperfectly drained sites, the occurrence of carbonates or salts above the C horizon may be primarily due to retardation of leaching (Bmk), or the upward movement of moisture and precipitation of secondary carbonates. In this latter circumstance, both carbonated and gleyed phases may be recognized where significant. It is not practical to recognize a carbonated calcareous profile unless there is a significant accumulation of carbonates in the surface Ah or Ap horizon.

Grumic phases of calcareous profiles with self-mulching characteristics may be found in profiles of fine texture (greater than 50% clay). In these soils, a tendency to form a surface granular mulch is common and the separations of A, B, and C horizons tend to be diffuse and transitional. Tongues of an A horizon often extend into the B and C horizons by sloughing into cracks. Slickensides may often be observed in the C horizons. Gleyed Calcareous Brown profiles may be recognized by mottling in the A or Bmk horizons.

1.14 Eluviated Brown

Profile type: <u>Ah</u>, (Ahe), <u>Ae</u> or <u>AB</u>, <u>Bt</u> or <u>Btj</u>, <u>C</u>, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by significant horizons of leaching or eluviation, which extend beyond the concepts of the orthic chernozemic development. This eluviation is manifested by the occurrence of combinations and sequences of eluvial Ahe, Ae, and transitional AB horizons, underlain by weakly to moderately developed illuvial Btj or Bt horizons.

The leached horizons are characterized by the development of slight to moderate acidity and a minor reduction in base saturation.

Two variations of this subgroup may be recognized. They are:

A) A profile type in which eluviation is characterized by light-colored relic macroprismatic structure below the Ah or Ap, which breaks into coarse to medium platy peds that often exhibit vesicular or tubular voids, suggesting the formation of eluviated Ae or AB horizons from a former prismatic B. The Btj or Bt horizon is somewhat finer textured than the Ae with well-developed macroprismatic structure breaking to blocky peds of lower color value and slightly higher chroma than the Ae. The development of coatings on the surface of peds, if present, is less strongly expressed than in Solonetzic Bn or Bnj horizons and the cationic ratio of Ca to other ions usually remains high. This type is closely correlated with the U.S. concept of an Albic Argiboroll and the World concept of Luvic Kastanozem or Luvic Chernozem.

B) A "cumulic" eluviated type in which accumulated surface deposits of transported soil material modify the horizon differentiation caused by leaching within the profile. Such soils are characterized by thick horizons of partly leached accumulated materials, overlying former A or transitional AB horizons. They are usually found on lower concave slopes where accumulation of excess runoff and sediments may be expected to occur. These profiles are often imperfectly drained and may be weakly gleyed. This profile type may be referred to as Cumulic Eluviated. A suggested criterion for recognizing this type is a depth of surface horizons greater than 16 inches (40 cm) above what is considered as the original B horizon. This type is closely correlated with the U.S. concept of Pachic Argiboroll.

Eluviated Gleyed Brown profiles, 1.14/8, are common. Saline Eluviated Brown 1.14/5 and Carbonated Eluviated Brown 1.14/6 are uncommon, but are known to occur. Grumic Eluviated Brown profiles, 1.14/7, have not been observed and their occurrence is doubtful.

Fine-textured phases are usually characterized by an increase in granular (shotty) and fine subangular rather than medium to coarse blocky structures in the Ahe, Ae, and B horizons.

Solonetzic and Solodic Brown

Solonetzic Brown and Solodic Brown profile types have been listed as subgroups within the Chernozemic order, but should be considered as intergrades between Solonetzic and Chernozemic soils rather than as typical subgroups within either order. The soils are characterized by a Chernozemic Ah horizon and a Bnjt horizon with pronounced structure and hard consistence, usually overlying a saline subsoil. The Bnjt horizon as defined would not meet the chemical requirements of a Bn, that is, a ratio of exchangeable Ca to exchangeable Na of 10 or less, but would have a significant amount of Na, or Na + Mg, more than that considered normal for Chernozemic soils.

1.11-2.11 Solonetzic Brown

Profile type: <u>Ah</u>, <u>Bnjt</u>, <u>C</u>, (Cca), (Csk)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by a prismatic-structured Bnjt horizon with hard consistence and with blocky secondary structure characterized by a "varnish-like" coating. A Cca, Csk horizon may underlie the Bnjt. The soils may be considered as intergrades between Orthic Brown and Brown Solonetz profiles.

1.14-2.21 Solodic Brown

Profile type: <u>Ah</u>, (Ahe), <u>Ae</u> or <u>AB</u>, <u>Bnjt</u>, <u>C</u>, (Cca), (Csk)

These are soils with Ah or Ap horizons as defined in the order and great group, underlain by a sequence of eluvial Ahe, Ae, or transitional AB horizons, underlain by a prismatic or blocky Bnjt horizon with pronounced coatings. The eluvial Ae or AB horizons are often characterized by macroprismatic structures breaking into coarse to medium platy peds. These soils may be considered as intergrades between Eluviated Brown and Brown Solod profiles.

Saline, carbonated, and gleyed modifications of Solonetzic Brown and Solodic Brown profiles may occur and can be designated in a similar manner to other modified Brown subgroup profiles. Grumic modifications of these intergrades have not been observed.

Modifying Subgroups

Saline, carbonated, grumic, gleyed, and lithic modifications of all the main Brown subgroup profiles may occur and are identified by the following horizons:

1.1-/5 Saline Brown: Saline A and C or saline B and C horizons (s or sa). Salinity may be detected by visual evidence of salt crystals and confirmed by a simple qualitative field test.

1.1-/6 Carbonated Brown: A or B horizons of secondary enrichment. Ak, (Aca), Bk, (Bca), Ck

1.1-/7 Grumic Brown: Clayey soils with A and B transitional self-mulching horizons.

1.1-/8 Gleyed Brown: Weakly gleyed A, B, or C horizons.

1.1-/9 Lithic Brown: Any Brown soil with a lithic contact 4 to 20 inches (10 to 50 cm) below the mineral surface.

1.2 DARK BROWN (DARK CHESTNUT)

These are soils that have Ah horizons with values darker than 3.5 moist and 4.5 dry, with chroma usually greater than 1.5 dry, and thick enough to produce 6 inches (15 cm) of mixed surface; or an Ap horizon with color values darker than 3.5 moist and between 3.5 and 4.5 dry, and with chroma greater than 1.5 dry.

In virgin Dark Brown Chernozemic soils the Ah horizons are usually darkest in value at the surface and become progressively lighter with depth.

Dark Brown soils are usually associated with and developed from the decomposition of a cyclic growth of mesophytic grasses and forbs. They are closely correlated with the concept of Typic Borolls in the U.S. system and the Kastanozems (borustic typic phase Dark Chestnut) in the World system.

1.21 Orthic Dark Brown

Profile type: Ah, Bm, Btj or Bt, C, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by a Bm or a weak to moderately textural Btj or Bt. The B horizons are free from primary carbonates.

Additional features characteristic of Orthic Dark Brown profiles are similar to those described for Orthic Brown 1.11.

1.22 Rego Dark Brown

Profile type: Ah, C, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by C horizons.

Additional features characteristic of Rego Dark Brown profiles are similar to those described for Rego Brown 1.12.

1.23 Calcareous Dark Brown

Profile type: Ah, Bmk, Cca or Ck

These soils have Ah or Ap horizons as defined in the order and great group, underlain by Bm horizons from which primary alkaline earth carbonates have not been completely removed (Bmk).

Additional features characteristic of Calcareous Dark Brown profiles are similar to those described for Calcareous Brown 1.13.

1.24 Eluviated Dark Brown

Profile type: Ah, (Ahe), Ae or AB, Bt or Btj, C, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by sequences of eluvial Ahe, Ae, and transitional AB horizons overlying weakly to moderately developed illuvial B horizons. The leached horizons are characterized by the development of slight to moderate acidity and a minor reduction in base saturation.

Additional features characteristic of Eluviated Dark Brown profiles are similar to those described for Eluviated Brown 1.14.

1.21-2.11 Solonetzic Dark Brown

Profile type: Ah, Bnjt, C, (Cca), (Ck), (Cs)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by a prismatic-structured Bnjt horizon with hard consistence and with blocky secondary structure characterized by a "varnish-like" coating. A Cca, Ck, or Cs horizon may underlie the Bnjt. The soils may be considered as intergrades between Orthic Dark Brown and Brown Solonetz profiles.

1.24-2.21 Solodic Dark Brown

Profile type: Ah, (Ahe), Ae or AB, Bnjt, C, (Cca), (Csk)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by a sequence of eluvial Ahe, Ae, or transitional AB horizons overlying a prismatic or blocky Bnjt horizon with pronounced coatings. The eluvial Ae or AB horizons are often characterized by macroprismatic structure breaking to coarse or medium platy peds.

They may be considered as intergrades between Eluviated Dark Brown and Brown Solod profiles.

Saline, carbonated, and gleyed modifications of Solonetzic Dark Brown and Solodic Dark Brown profiles may occur and can be designated in a similar manner to other modified Dark Brown profiles. Grumic modifications of these intergrades have not been observed.

Modifying Subgroups

Saline, carbonated, grumic, gleyed, and lithic modifications of all main Dark Brown subgroup profiles may occur and are identified by the following horizons:

1.2-/5 Saline Dark Brown: Saline A and C or saline B and C horizons (s or sa).

1.2-/6 Carbonated Dark Brown: A or B horizons of secondary carbonate enrichment. Ak, (Aca), Bk, (Bca), Ck

1.2-/7 Grumic Dark Brown: Clayey soils with A and B transitional self-mulching horizons.

1.2-/8 Gleyed Dark Brown: Weakly gleyed A, B, or C horizons. Ah or Ahgj, Bgj, Cgj

1.2-/9 Lithic Dark Brown: Any Dark Brown soil with a lithic contact 4 to 20 inches (10 to 50 cm) below the surface of the mineral horizon.

1.3 BLACK

These soils have Ah horizons with values darker than 3.5 moist or dry, chromas of 1.5 or less moist, and thick enough to produce 6 inches (15 cm) of mixed surface or Ap horizons of similar value and chroma.

Although thin Black soils with Ah horizons of less than 6 inches in depth are quite common, many Black soils have Ah horizons that extend well below the normal depths of a cultivated Ap layer.

Black soils are usually, but not exclusively, associated with and developed from the decomposition of a cyclic growth of mesophytic grasses and forbs, but may also be associated with thin or discontinuous tree and shrub cover. Where this latter condition prevails the dominant ground cover is one of forbs and grasses. Black soils are closely correlated with the concept of Udic Borolls in the U.S. system and with Chernozems in the World system.

1.31 Orthic Black

Profile type: Ah, Bm or Btj, C, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by a color Bm, or a weak to moderately textural Btj or Bt. The B horizon is free from primary carbonates.

Additional features characteristic of Orthic Black profiles are similar to those described for Orthic Brown 1.11.

1.32 Rego Black

Profile type: Ah, C, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by C horizons.

Additional features characteristic of Rego Black profiles are similar to those described for Rego Brown 1.12.

1.33 Calcareous Black

Profile type: Ah, Bmk, Cca or Ck

These soils have Ah or Ap horizons as defined in the order and great group, underlain by Bm horizons from which primary alkaline earth carbonates are not completely removed (Bmk).

Additional features characteristic of Calcareous Black profiles are similar to those described for Calcareous Brown 1.13.

1.34 Eluviated Black

Profile type: Ah, (Ahe), Ae or AB, Bt or Btj, C, (Cca), (Ck)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by a sequence of eluvial Ahe, Ae, and transitional AB horizons overlying weakly to moderately developed illuvial B horizons. The leached horizons are characterized by the development of slight to moderate acidity and a minor reduction in base saturation.

Additional features characteristic of Eluviated Black soils are similar to those described for Eluviated Brown 1.14.

1.31-2.12 Solonetzic Black

Profile type: Ah, Bnjt, C, (Cca), (Ck), (Cs)

These are soils with Ah or Ap horizons as defined in the order and great group, underlain by a prismatic-structured Bnjt horizon with hard consistence and a blocky secondary structure characterized by dark "varnish-like" coatings. A Cca, Ck, or Cs horizon may underlie the Bnjt. These soils may be considered as intergrades between Orthic Black and Black Solonetz profiles.

1.34-2.22 Solodic Black

Profile type: Ah, (Ahe), Ae or AB, Bnjt, C, (Cca), (Csk)

These soils have Ah or Ap horizons as defined in the order and great group, underlain by a sequence of eluvial Ahe, Ae, or transitional AB horizons, overlying a prismatic or blocky-structured Bnjt horizon with pronounced coatings. The eluvial Ae or AB horizons are often characterized by macroprismatic structure breaking to coarse or medium platy peds. They may be considered as intergrades between Eluviated Black and Black Solod profiles.

Saline, carbonated, and gleyed modifications of Solonetzic Black and Solodic Black profiles may occur and can be designated in a similar manner to other modified Dark Brown subgroup profiles. Grumic modifications of the intergrades have not been observed.

Modifying Subgroups

Saline, carbonated, grumic, gleyed, and lithic modifications of all major Black subgroup profiles may occur and are identified with the following horizons:

1.3-/5 Saline Black: Saline A and C or saline B and C horizons, including sa horizons of saline enrichment (s or sa).

1.3-/6 Carbonated Black: A or B horizons of secondary carbonate enrichment. Ak, (Aca), Bk, (Bca), Ck

1.3-/7 Grumic Black: Clayey soils with A and B transitional self-mulching horizons. 1.3-/8 Gleyed Black: Weakly gleyed A, B, or C horizons. 1.3-/9 Lithic Black: Any Black soil with a lithic contact 4 to 20 inches (10 to 50 cm) below the surface of the mineral horizon.

1.4 DARK GRAY

These soils have Chernozemic A horizons, but have significant characteristics indicative of degradation or other modification resulting from the accumulation and decomposition of forest vegetation, including leaf mats (L–H horizons). These soils when undisturbed support a mixed vegetation of trees, shrubs, forbs, and grasses, characteristic of transitional areas between grassland and forest, but if protected from fire tend to be dominated by tree and shrub cover.

Virgin Dark Gray soils usually have leaf mats (L–H horizons), overlying Ah and Ahe horizons. The peds of the A horizons may have rather dark colored surfaces, but these will usually crush or rub out to gray or brown colors of higher value or chroma. A "salt and pepper" effect, that is, light gray spots or bands, may be observable in the horizons and these exhibit a tendency to platy structures, which crush easily to a fine granular condition. In Rego and Calcareous Dark Gray subgroups, these evidences of degradation are often weakly expressed and the horizon may be designated as an Ahej.

A Dark Gray Chernozemic A horizon has the following criteria: An Ah horizon, if present, in virgin Dark Gray soils has a value darker than 3.5 moist and 4.5 dry and a chroma usually less than 1.5. The Ahe horizon has peds that crush to lighter colors than the Ah, if present, with values between 3.5 and 5.5 dry. The Ah, Ahe, or (Ah Ahe) combination should have a minimum thickness of 3.5 inches (9 cm) or be thick and dark enough to produce 6 inches (15 cm) of a mixed surface or Ap horizon of value darker than 3.5 moist and 5.0 dry and with a chroma of less than 2 dry. A minimal development of a lighter-colored Ae horizon less than 2.5 inches (6 cm) is allowable provided that the Ap or mixed surface horizon meets the above requirements for Dark Gray soils. Where a distinct Ae horizon greater than 2.5 inches (6 cm) thick and a Bt occur beneath a Dark Gray Chernozemic surface (Ah, Ahe, or Ap), the soil is considered to have undergone sufficient podzolization to be classified with the Dark Gray Luvisols.

Dark Gray Chernozemic soils (formerly termed Degraded Black) are closely comparable but not identical with the concept of Boralfic Borolls in the U.S. system. They are at present included in the concept of Chernozems in the World system.

Other soils with dark-colored Ah or Ahe horizons developed under a forest leaf mat with moist values of 3.5 or less, but that are not thick enough to produce 6 inches (15 cm) of mixed surface or Ap with values darker than 3.5 moist or 4.5 dry are considered to be non-Chernozemic. Such soils, on the basis of their other horizon characteristics, should be classified with the Luvisolic, Brunisolic, Podzolic, or Regosolic orders.

1.41 Orthic Dark Gray

Profile type: (L-H), (Ah), <u>Ahe</u>, (Ae), <u>Bm</u> or <u>Bt</u>, <u>C</u>, (Cca), (Ck)

These soils have L-H, Ah-Ahe, L-H, Ahe, or Ap horizons as defined in the order and great group, underlain by a color Bm or textural Bt horizon free from primary carbonates.

There may be a minimal development of Ae horizon of less than 2.5 inches (6 cm) within the 6 inches (15 cm) of surface horizons of orthic profiles, if the mixed combination meets the criteria for a Chernozemic A horizon and no undisturbed or continuous Ae horizon is present below this depth.

A Bt horizon is more commonly associated with Orthic Dark Gray soil than is a Bm horizon, and this association becomes more pronounced with increasing degradation of the A horizons. These textural horizons are often subangular blocky to coarse granular in structure and may show a weakly expressed enrichment of hydrated iron. The reaction of the orthic Bt is usually slightly acidic, but the lower B horizon above the Cca may be slightly calcareous.

Saline (1.41/5) and carbonated (1.41/6) modifications of Orthic Dark Gray profiles are uncommon. Grumic modifications (1.41/7) are also uncommon, but clayey profiles tend to form a granular (shotty) and fine subangular-blocky structure in the Ahe and B horizons. Gleyed modifications (1.41/8) are common.

1.42 Rego Dark Gray

Profile type: (L-H), (Ah), <u>Ahe</u>, <u>C</u>, (Cca), (Ck)

These soils have L-H, Ah-Ahe, L-H, Ahe, or Ap horizons as defined in the order and great group, underlain by C horizons, which are usually moderately to strongly calcareous. In Rego Dark Gray soils the evidences of degradation in the Ahe are often weakly expressed and the horizon may be designated as Ahej. Under continued cultivation such soils are not easily distinguished from Rego Black soils. Rego Dark Gray profiles are most often found in sites of limited internal drainage or in imperfectly drained positions; gleyed (1.42/8) profiles are common. Rego Dark Gray soils are less commonly associated with sites of moderate to excessive surface drainage.

Saline modifications (1.42/5) of Rego Dark Gray profiles seldom occur; carbonated modifications (1.42/6) of Rego Dark Gray profiles with some carbonates in the Ah-Ahe below the leaf mat are common, but C horizons of carbonate accumulations are infrequent. Grumic modifications of Rego Dark Gray soils (1.42/7) have not been observed in virgin soils, but have been noted in cultivated clay soils where the L-H layers were destroyed.

Additional features characteristic of Rego Dark Gray soils are similar to those described for Rego Brown 1.12.

1.43 Calcareous Dark Gray

Profile type: (L-H), (Ah), Ahe, Bmk, Cca or Ck

These soils have L-H, Ah-Ahe, L-H, Ahe, or Ap horizons as defined in the order and great group, underlain by color Bm horizons from which primary alkaline earth carbonates are not completely removed (Bmk). In Calcareous Dark Gray soils, the evidences of degradation in the Ahe are often weakly expressed and the horizon may be designated as Ahej. Under continued cultivation with accompanying decomposition of leaf mat material, evidence of degradation is not easily distinguished.

Saline modifications of Calcareous Dark Gray soils (1.43/5) seldom occur. Carbonated modifications (1.43/6) are uncommon in virgin soils, but are evident under cultivation. Grumic modifications (1.43/7) have not been observed. Gleyed modifications (1.43/8) are common.

Additional features characteristic of Calcareous Dark Gray soils are similar to those described for Calcareous Brown 1.13.

Dark Gray Luvisol (Eluviated Dark Gray)

This is a "degraded" type, in which pronounced leaching and eluviation have resulted from the genetic influence of accumulation and decomposition of wooded vegetation, including leaf mats. It was formerly classified as the Eluviated Dark Gray (degraded) subgroup, and was recognized as intergrading toward the Luvisolic order.

The separation of these soils (which were also formerly designated as moderately degraded Black) from Luvisolic soils has presented some difficulties and it has been decided that they will now be classified and described with the Dark Gray Luvisol subgroup. It should be noted that Dark Gray profiles with an Ae horizon of less than 2.5 inches (6 cm) are included with the Orthic Dark Gray subgroup. Virgin soils with less than 3.5 inches (9 cm) of an Ah-Ahe beneath a leaf mat, and with an Ae horizon extending below 6 inches (15 cm) in depth will not meet the requirements for Dark Gray Chernozemic soils and will be classified in the Dark Gray Luvisol subgroup.

1.41-2.12 Solonetzic Dark Gray

Profile type: (L–H), (Ah), <u>Ahe</u>, (Ae), <u>Bnjt</u>, <u>C</u>, (Cca), (Csk)

These soils have L–H, Ah–Ahe, L–H, Ahe, or Ap horizons as defined in the order and great group, underlain by a prismatic-structured Bnjt horizon with hard consistence and subangular-blocky secondary structure characterized by distinct dark coatings on the peds. A Cca, Ck, or Cs horizon may underlie the Bnjt. An Ae horizon less than 2.5 inches (6 cm) thick is often found in this intergrade type within the upper 6 inches of the surface horizon below the leaf mat. If, however, the Ae horizon is thicker than 2.5 inches or extends to more than 6 inches (15 cm) below the leaf mat, the soil must be classified as a Solodic Gray Luvisol (3.22-2.23).

1.41-2.22 Solodic Dark Gray

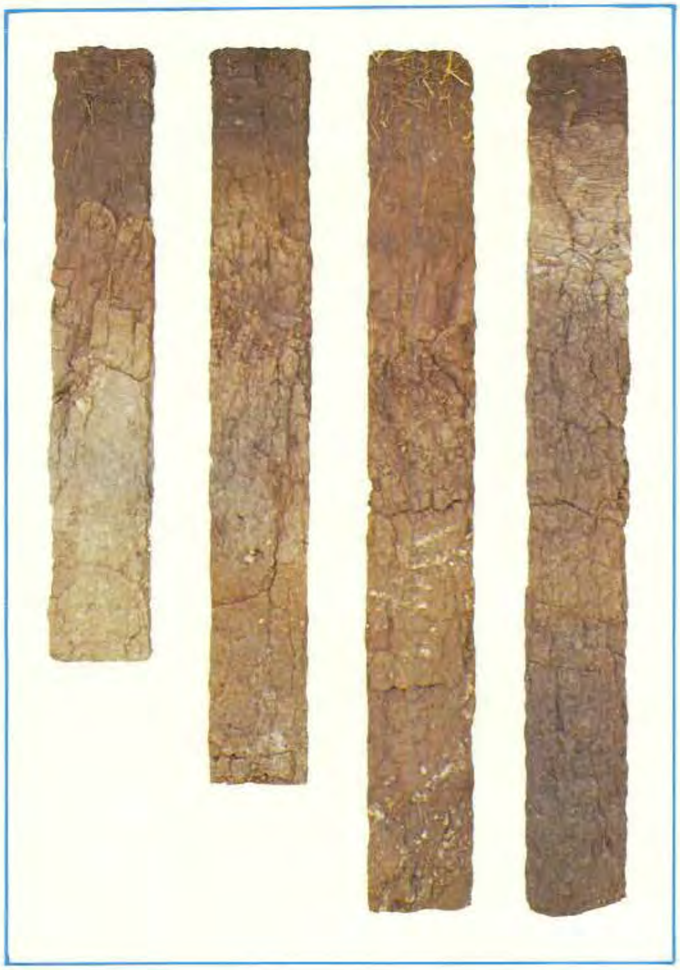
Profile type: (L–H), (Ah), <u>Ahe</u>, (Ae), <u>AB</u>, <u>Bnjt</u>, <u>C</u>, (Cca), (Csk)

These soils have L–H, Ah–Ahe, L–H, (Ahe), or Ap horizons as defined in the order and great group, with a color of the mixed A horizons of value less than 3.5 moist and less than 4.5 dry, underlain by a transitional AB horizon; or an Ae, AB sequence, overlying a prismatic or blocky-structured Bnjt horizon with pronounced coatings. Such soils can be considered as intergrades between an Orthic Dark Gray and a Gray Solod, or as intergrades between a Dark Gray Luvisol and a Gray Solod. An Ae horizon, if present, should be less than 2.5 inches (6 cm) thick.

Modifying Subgroups

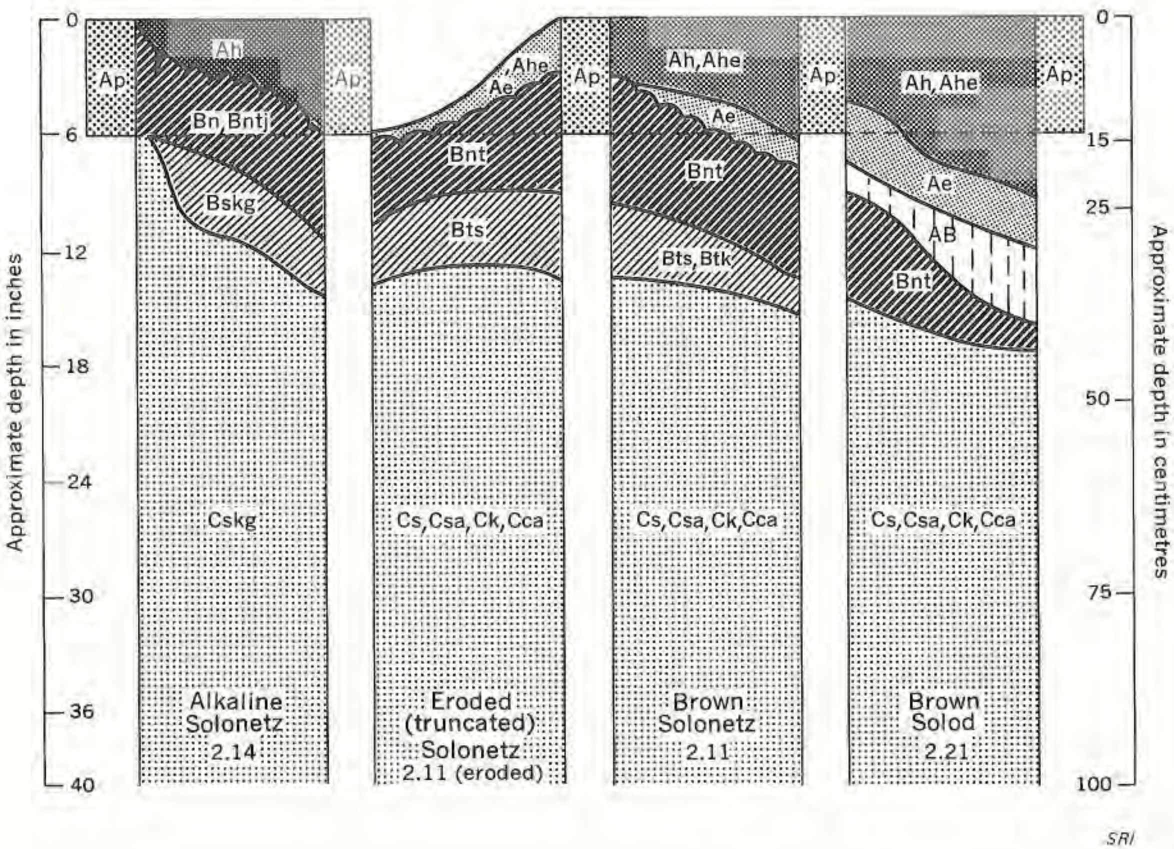
Saline modifications of all Dark Gray Chernozemic soils (1.4-/5) do not occur frequently. Carbonated modifications (1.4-/6) are commonly associated with Calcareous and Rego Dark Gray profiles but not with Orthic Dark Gray. Grumic modifications (1.4-/7) are of doubtful occurrence; gleyed modifications (1.4-/8) are common.

1.4-/9 Lithic Dark Gray: Any Dark Gray soil with a lithic contact 4 to 20 inches (10 to 50 cm) below the surface of the mineral horizon belongs to this subgroup.



A B C D

Fig. 7. Soil monoliths representative of certain Solonetzic soils: (a) Brown Solonetz, (b) Black Solonetz, (c) Brown Solod, and (d) Gray Solod.


Approximate depth in inches
0
6
12
18
24
30
36
40
Ap
Ah
Bn,Bntj
Bskg
Cskg
Alkaline Solonetz
2.14
Ahe
Ae
Bnt
Bts
Cs,Csa,Ck,Cca
Eroded (truncated) Solonetz
2.11 (eroded)
Ah,Ahe
Ae
Bnt
Bts,Btk
Cs,Csa,Ck,Cca
Brown Solonetz
2.11
Ah,Ahe
Ae
AB
Bnt
Cs,Csa,Ck,Cca
Brown Solod
2.21
Approximate depth in centimetres
0
15
25
50
75
100
SRI

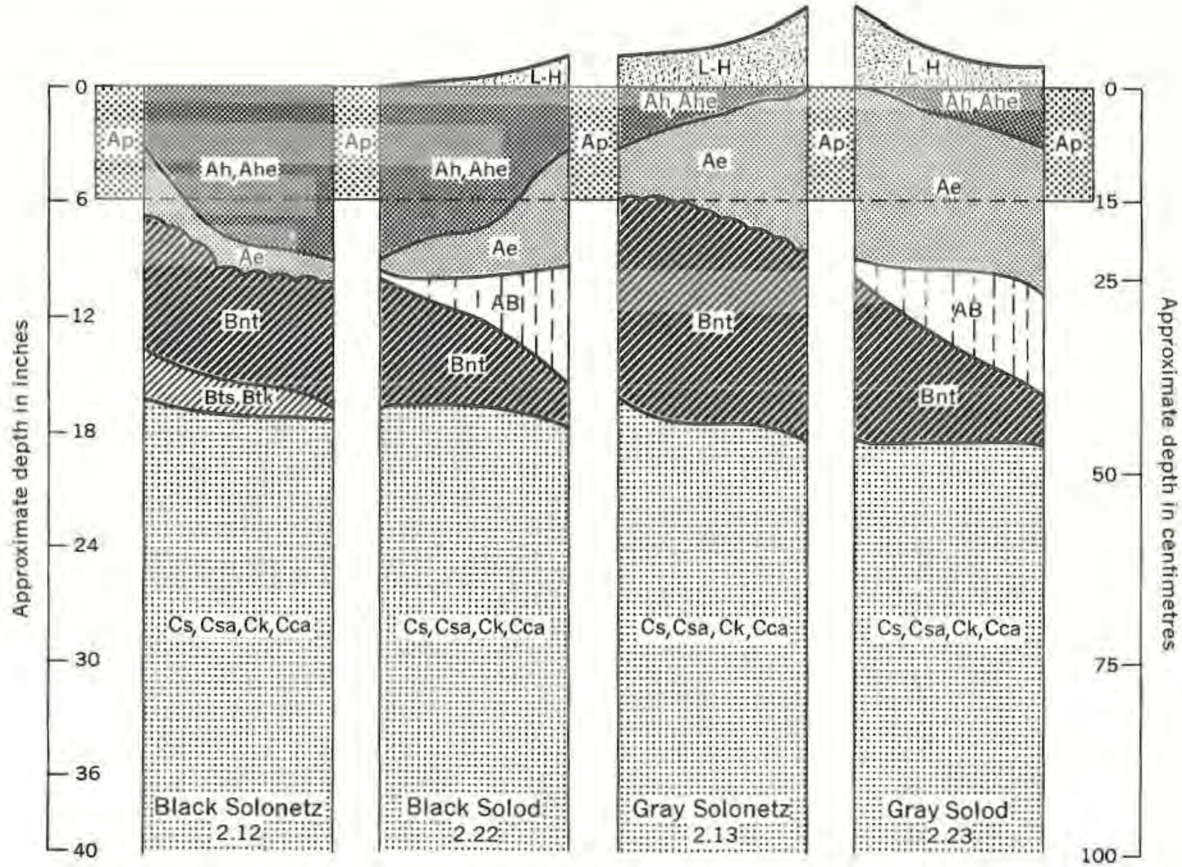


Fig. 8. A diagrammatic horizon pattern of representative Solonetzic profiles.

SOLONETZIC ORDER

Great Group	*Subgroup*	
2.1 Solonetz	2.11	Brown Solonetz
	2.12	Black Solonetz
	2.13	Gray Solonetz
	2.14	Alkaline Solonetz
	2.1-/8	Gleyed Solonetz
	2.1-/9	Lithic Solonetz
2.2 Solod	2.21	Brown Solod
	2.22	Black Solod
	2.23	Gray Solod
	2.2-/8	Gleyed Solod
	2.2-/9	Lithic Solod

The occurrence of Solonetzic soils in Western Canada was recognized by the first soil surveyors. In the Alberta Soil Survey Report No. 2 (1926) a soil area is described as loam, blowout phase. The patchy microrelief and the fact that "the surface horizon was more acid than the surface of the adjacent normal soils" were noted. Saskatchewan Soil Survey Report No. 3 (1925) referred to "burn-out" soils and in a 1931 report the Echo soil series was described as having profiles "dominantly solonetz and degraded solonetz (Soloti)."

In 1938 a monograph on the soils of Manitoba described alkalinized and degraded alkalinized soils and in a footnote called them solonetz and solod.

Following these initial classification attempts, the soil survey reports of the 1930's and 1940's began to contain the terms solonetz-like, solonetz, alkali solonetz, solod, soloti, and solodic. In 1955 the National Soil Survey Committee set up a preliminary system of soil classification. This system included at the highest category a group called Halomorphic soils that contained the Solonetz, Solodized Solonetz, and Solod great groups. In 1960 a Canadian soil classification system was adopted. It included the Solonetzic order containing the great groups Alkali Solonetz, Solonetz, Solodized Solonetz, and Solod; in 1965 these four great groups were combined into two: Solonetz and Solod.

With rare exceptions all the soils of the Solonetzic order in Canada are, to some degree, solodized; a significant point in the solodization process is where the Bnt[1] shows visible evidence of breakdown. Practically all the soils "above" this point have an A horizon that is neutral to slightly acidic, denoting varying degrees of leaching, and is

[1] Bnt - Solonetzic B (seen in horizon designations).

abruptly separated from the Bnt horizon. All the soils "below" this point have an acidic A horizon with a well-developed Ae subhorizon and usually a well-defined AB horizon.

Because there are varying degrees of leaching in the A horizon, the color of this horizon is much less amenable to precise definition than that of the same horizon of the geographically associated orthic soils. Generally the Ap of the Solonetzic soils is of higher value (lighter in color) than adjacent orthic soils of other orders. Also, because the characteristics of the Bnt horizon are dominant in these soils, the color, and therefore the organic matter content, of the A horizon is subdominant. Three color (zonal) separations are all that can be satisfactorily defined at the subgroup level.

2. SOLONETZIC ORDER

These soils have solonetzic B and saline C horizons. Morphologically a solonetzic B horizon is characterized by a columnar or prismatic macrostructure that can be broken into a blocky mesostructure. The blocks are hard to very hard in consistence when dry and have dark surface stains. Chemically the solonetzic B horizon has a ratio of exchangeable Ca to exchangeable Na of 10 or less. They are well to imperfectly drained soils.

It is generally assumed that Solonetzic soils originated from a parent material that was more or less uniformly salinized. This material was, and still is, subjected to leaching by rainwater. This leaching caused desalinization and an increase of alkali peptized and deflocculated colloids that concentrated in a B horizon. The next process is assumed to be the removal of the alkali bases and the forming of an acidic A horizon with a platy structure. In the final stages of solodization there is a structural breakdown of the solonetzic B horizon. The occurrence of "pillared black alkali" soils with a strongly alkaline A (the first stage in Solonetz formation) is not frequent in Canada. Practically all the Solonetzic soils of Canada have a neutral to acidic A horizon, indicating that solodization has become operative. Also, it is generally true that as solodization proceeds, the salt accumulation horizon moves lower in the profile, from the lower B to well down in the C, and the lime accumulation horizon moves downward. In most Solonetzic soils the C horizon has a conductivity (saturation extract) of more than 4 mmhos. There is evidence that solodization is arrested where saline groundwater is within capillary reach of the solum and in some places a recycle of salinization occurs. It is also assumed that most Solonetzic soils developed under a vegetative cover of grasses and forbs. Although some members of this order may occur under a tree cover, it is believed that the trees did not become established until solodization was well under way.

Soils that are intergrades between the Solonetzic order and the Chernozemic and Luvisolic orders are classified in the latter orders. In general, these intergrades fall into two categories: (i) soils with weak solonetzic characteristics that will usually intergrade toward the Chernozemic order, and (ii) soils with relic solodic characteristics that will intergrade toward either the Chernozemic or the Luvisolic order.

2.1 SOLONETZ

These soils have A horizons as defined in the subgroups. There is an abrupt break (less than 1 inch) between the A and B horizons. The Bnt horizon is very hard columnar (the flat or round tops may have a thin capping of white siliceous material). There are dark stains on the cleavage faces. The upper part of the Bnt columns is massive (intact) when removed from the profile. See the note under 2.14.

In soils of the Solonetz great group the A horizon is usually thin in relation to the B horizon. There are varying degrees of solodization discernible in the A horizon, indicated by the relative prominence of an eluvial horizon. The B horizon usually has a very low hydraulic conductivity. As a result, during periods of excess moisture, water may be temporarily held above the Bnt; this is often indicated by weak mottling in the lower part of the A horizon. Clay flows can usually be readily discerned on the cleavage faces of the Bnt. Roots tend to concentrate along the cleavage faces rather than penetrate into the peds, and the roots are usually flattened.

2.11 Brown Solonetz

Profile type: Ah or Ahe or both, (Ae), an intact Bnt, (Bts), (Btk), Csa or Cs, (Cca), (Ck)

These soils are associated with grass and forb vegetation and semiarid climate. The mixed A subhorizons have color values of more than 3.5, usually more than 4.5 (dry), and chromas of more than 1.5.

Areas of this subgroup are often characterized by a patchy microrelief due to the differential erosion of the A horizon. The eroded pits usually have steep sides and support very sparse vegetative growth.

2.12 Black Solonetz

Profile type: Ah or Ahe or both, (Ae), an intact Bnt, (Bts), (Btk), Csa or Cs, (Cca), (Ck)

These are soils associated with mesophytic grass and forb, shrub, or discontinuous tree vegetation and subhumid climate. The mixed A subhorizons have color values of less than 4.5 (dry) and chromas of less than 2.5.

There may occasionally be a thin L–H horizon in the profiles that are intergrading to the Gray subgroup. The differential erosion of the A horizon, common in the areas of the Brown subgroup, seldom occurs in the Black subgroup. Where such areas exist they are generally fairly well covered with grass.

2.13 Gray Solonetz

Profile type: (L–H), (Ah), Ahe or Ae or both, an intact Bnt, Csa or Cs, (Ck), (Cca)

These soils are associated with scattered or stunted forest vegetation and subhumid climate. The mixed A subhorizons have color values of more than 4.5 (dry) and chromas of less than 2.5.

2.14 Alkaline Solonetz

Profile type: (Ah), Bn or Bntj, (Bskg), Cskg

These soils are associated with grass and forb vegetation that contains a significant percentage of alkali-tolerant varieties. Areas of this soil have varying degrees of restricted drainage.

Note:

This subgroup occurs rarely in Western Canada. It differs from the other subgroups of the Solonetz great group in that the Ah horizon is strongly alkaline and the break between the A and B is usually indistinct. The prisms of the B horizon often have pointed tops that protrude into the A. The Ah usually has a color value (dry) of less than 4.5. These soils show little or no evidence of solodization.

2.1-/8 Gleyed Solonetz

These soils have the same differentiating characteristics as the above subgroups, but have in addition some mottling and duller colors in the A, B, or C, or in all three horizons.

Mottling in the A horizon (usually in the lower part) is generally the result of a temporary water table above the Bnt. Mottling is usually quite pronounced in the lower portion of the B horizon and the chroma of the B is usually lower than in the nongleyed subgroups.

2.1-/9 Lithic Solonetz

These are Solonetz soils with a lithic contact between 4 and 20 inches (10 and 50 cm) of the mineral surface.

2.2 SOLOD

These soils have A horizons with a color as defined in the subgroups. There is either a distinct (more than 1 inch) AB transition horizon or a prominent (more than 2 inches) Bnt[1] horizon that breaks readily into blocky aggregates; usually both these horizons are present. The contact between the AB and Bnt is not well defined. The Bnt is hard to very hard, but can be broken into darkly stained blocky aggregates. The C horizon is saline and usually calcareous.

In soils of this great group the A horizon is generally thicker in relation to the B horizon than in the geographically associated Solonetz soils. The Ae is pronounced and usually platy. It may retain vertical cleavage lines that are relics of a former columnar B horizon. The blocky aggregates of the AB horizon are usually silica coated and often only the center of the blocks retains the dark color of the former B horizon. The Bnt horizon is usually similar to the lower Bnt of the associated Solonetz soils. It may therefore not have well-developed columnar structure. The Cs horizon is often below the Ck horizon.

2.21 Brown Solod

Profile type: <u>Ah</u> or <u>Ahe</u> or both, <u>Ae</u>, <u>AB</u>, <u>Bnt</u>, (Cca), (Ck), <u>Csa</u> or <u>Cs</u>

These soils are associated with xero- to meso-phytic grass and forb vegetation and semiarid climate. The mixed Ah and Ahe has a color value of more than 3.5, usually more than 4.5 (dry), and a chroma of more than 1.5.

In areas of this soil there is often some incidence of previously eroded pits. They are, however, grassed over and usually quite shallow.

2.22 Black Solod

Profile type: (L–H), <u>Ah</u> or <u>Ahe</u> or both, <u>Ae</u>, <u>AB</u>, <u>Bnt</u>, (Cca), (Ck), <u>Csa</u> or <u>Cs</u>

These soils are associated with mesophytic grass and forb, shrub, or discontinuous tree vegetation and subhumid climate. The mixed Ah and Ahe has a color value of less than 4.5 (dry) and a chroma of less than 2.5.

In these soils the Cs or Csa is often considerably below the Ck or Cca horizon.

2.23 Gray Solod

Profile type: (L–H), (Ah), (Ahe), <u>Ae</u>, <u>AB</u>, <u>Bnt</u>, (Ck), (Cca), <u>Cs</u> or <u>Csa</u>

These soils are associated with forest vegetation and subhumid climate. The mixed A subhorizons have color values of more than 4.5 (dry) and chromas of less than 2.5.

2.2-/8 Gleyed Solod

These are soils with the same differentiating characteristics as any of the above subgroups, but in addition have some mottling and dull colors in the AB or C horizon, or both.

Although some evidence of gleying may occur in any of the three master mineral horizons, it is most common in the lower B and C horizons.

2.2-/9 Lithic Solod

Any Solod soil with a lithic contact between 4 and 20 inches (10 and 50 cm) of the mineral surface belongs to this subgroup.

Note 1.

The subgroup separations are based primarily on the color of the A horizon, which in turn is related to the vegetative cover and the regional climate. The color of the Ah horizon, when present, usually approximates the chroma and the value of the geographically associated Chernozemic or Luvisolic soils; specifically, it is usually of slightly higher value. Because the nature of the B horizon is the dominating characteristic of Solonetzic soils, the color of the A horizon is relatively less important than in the geographically associated Chernozemic and Luvisolic soils. For this reason, it is suggested that three subgroups, based on the color of the A horizon, are all that can be validly defined at this level of categorization. There is, going from Brown to Black to Gray or from semiarid to subhumid, generally an increase in the depth of the A horizon and in the depth of soil development. Finer subdivisions on the basis of the color of the A horizon can be recognized at the series level, if deemed significant. When there are significant color differences within the subgroup, there are usually other differentiating profile characteristics.

Note 2.

In areas where the A horizon has been eroded away the soil should be classified as an eroded phase and given the subgroup color indicated by geographically associated Solonetzic soils.

Note 3.

The classification of cultivated Solonetzic soils must be based on the diagnostic horizons that remain. For example, if the Bnt horizon lies directly under the Ap, then the subgroup color separation is determined by the Ap and the great group is determined by the characteristics of the Bnt.

Note 4.

Some Solonetzic soils occur that have bisequa features. They have been formed in areas where there is a fairly deep coarse- to medium-textured surface layer over a saline fine-textured substratum. The profiles have the following horizon sequence: Ah, (Ahe), Bm, Ae, IIBnt, IICs, and IICsk. There are insufficient data available to define a specific subgroup.

Fig. 9. A Black Solonetz soil.

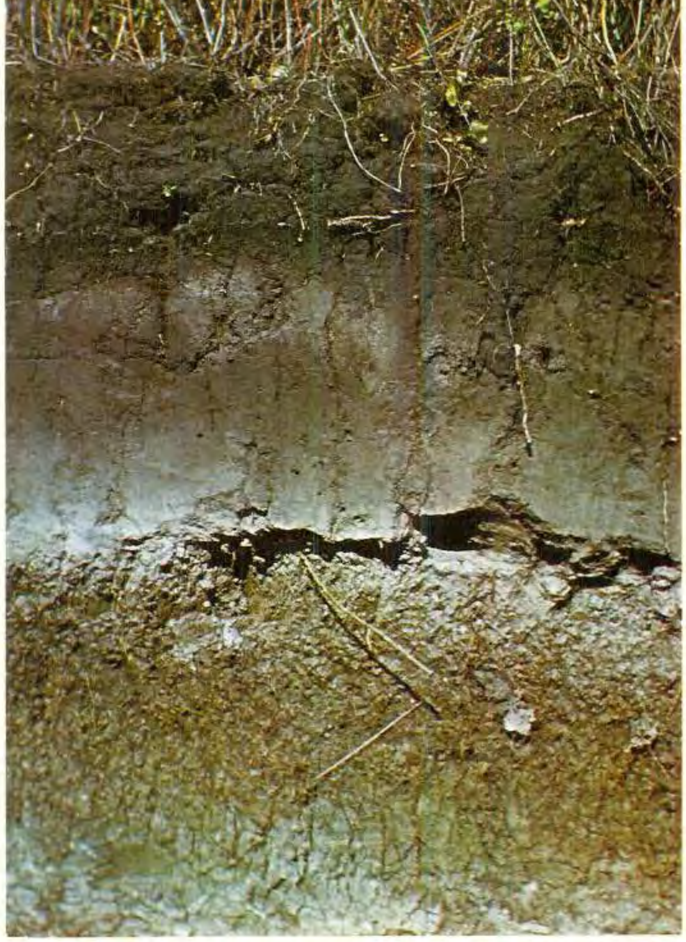
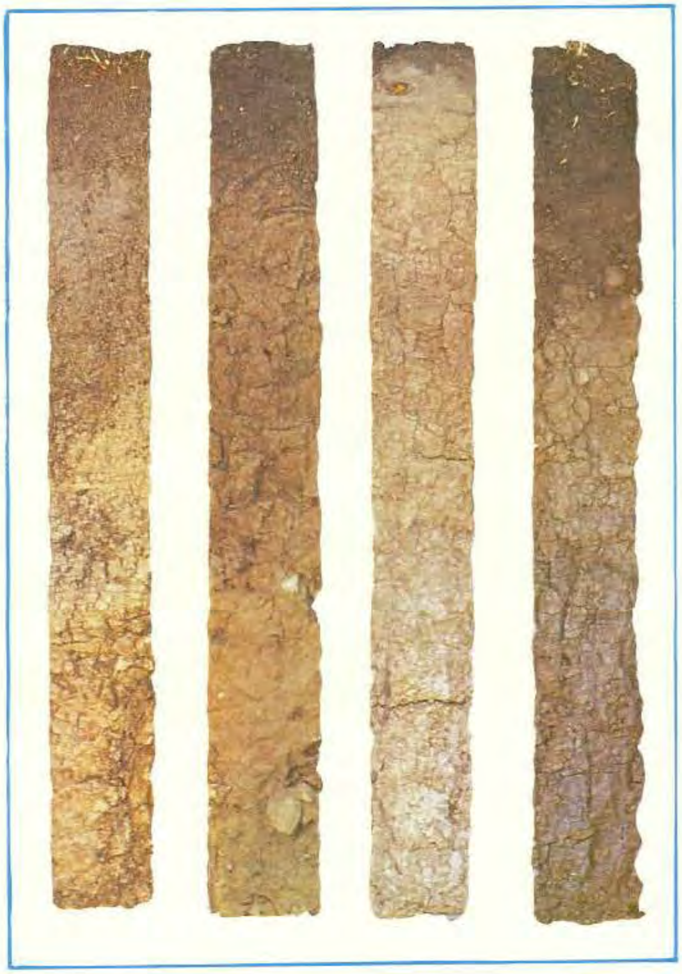
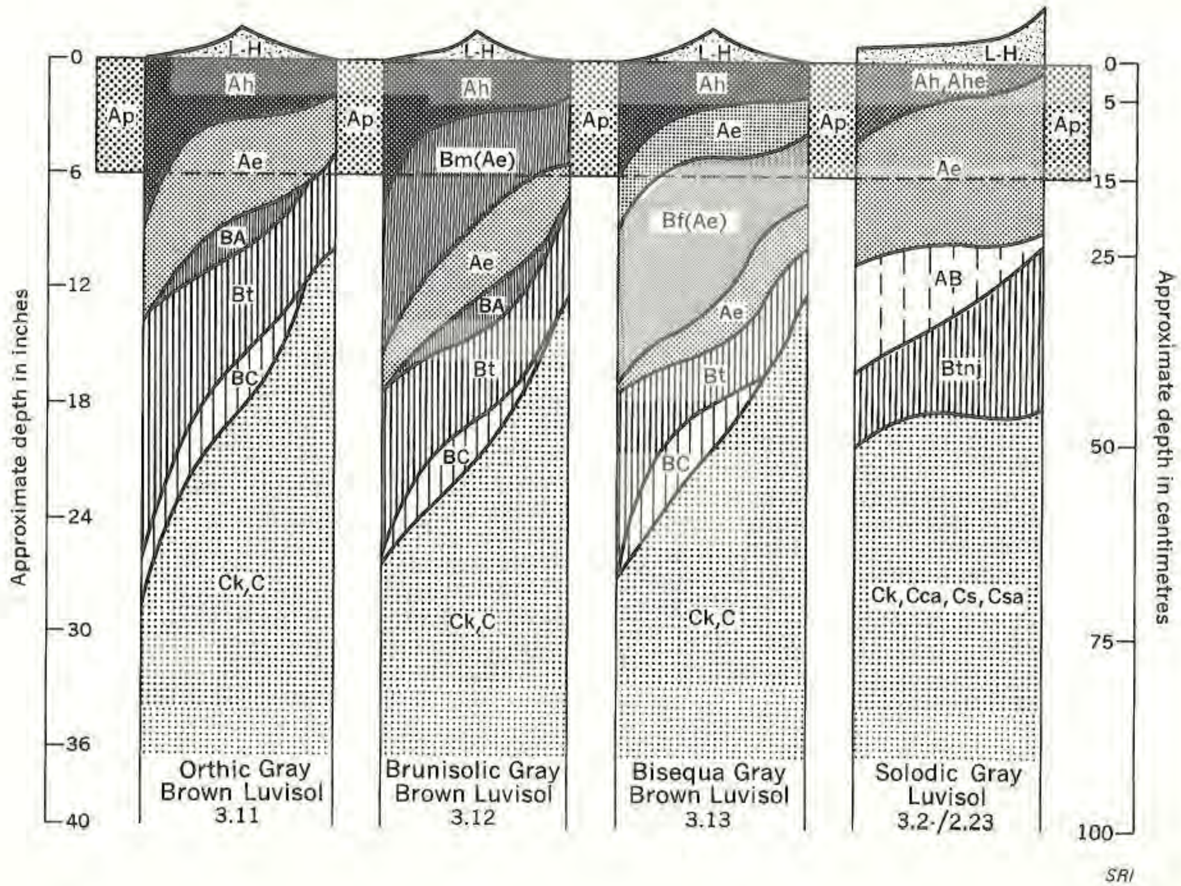


Fig. 10. A Black Solod soil.



A B C D

Fig. 11. Soil monoliths representative of certain Luvisolic soils: (a) Orthic Gray Brown Luvisol, (b) Brunisolic Gray Brown Luvisol, (c) Orthic Gray Luvisol, and (d) Dark Gray Luvisol.



L-H
Ah
Ap
Ae
BA
Bt
BC
Ck,C
Orthic Gray Brown Luvisol 3.11
Bm(Ae)
Brunisolic Gray Brown Luvisol 3.12
Bf(Ae)
Bisequa Gray Brown Luvisol 3.13
Ah,Ahe
AB
Btnj
Ck,Cca,Cs,Csa
Solodic Gray Luvisol 3.2-/2.23
Approximate depth in inches
0
6
12
18
24
30
36
40
Approximate depth in centimetres
0
5
15
25
50
75
100
SRI

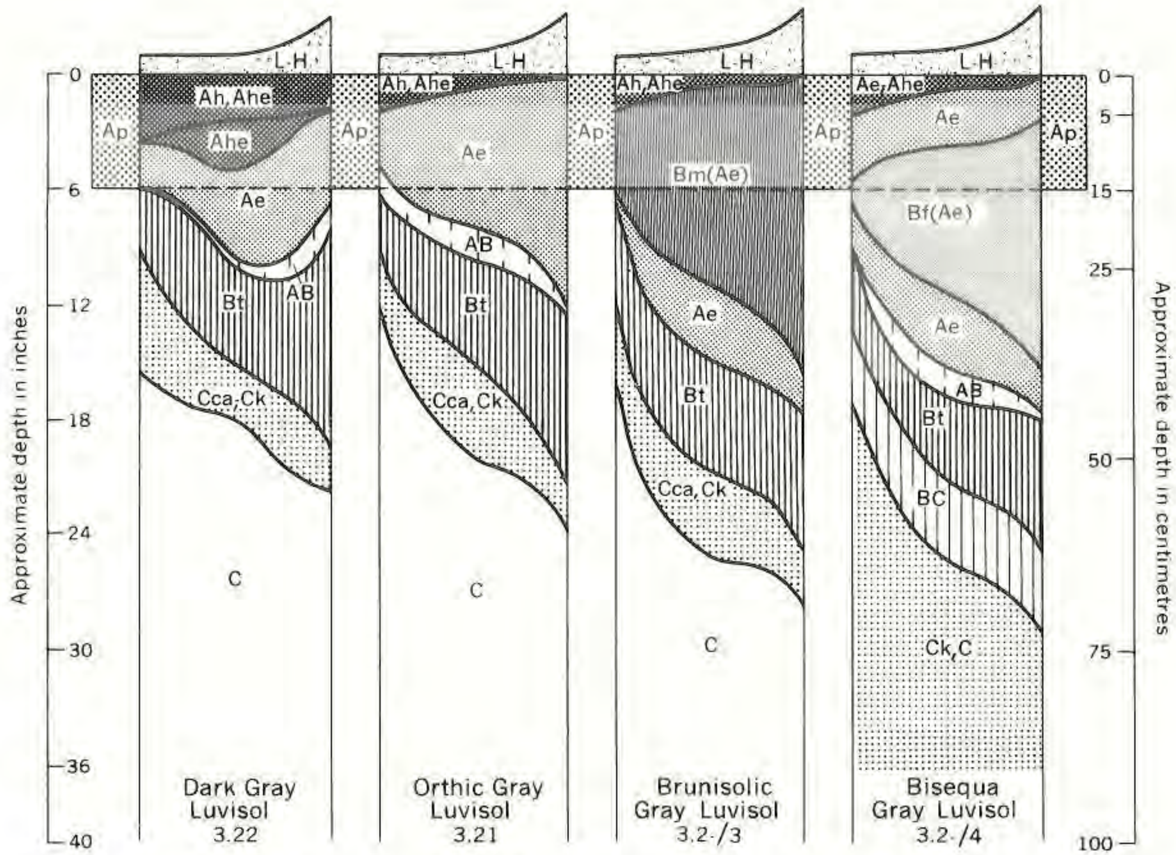


Fig. 12. A diagrammatic horizon pattern of representative Luvisolic profiles.

SRI

LUVISOLIC ORDER

Great Group		*Subgroup*
3.1 Gray Brown Luvisol	3.11	Orthic Gray Brown Luvisol
	3.12	Brunisolic Gray Brown Luvisol
	3.13	Bisequa Gray Brown Luvisol
	3.1-/8	Gleyed Gray Brown Luvisol
	3.1-/9	Lithic Gray Brown Luvisol
3.2 Gray Luvisol	3.21	Orthic Gray Luvisol
	3.22	Dark Gray Luvisol
	3.2-/3	Brunisolic Gray Luvisol
	3.2-/4	Bisequa Gray Luvisol
	3.21-2.23	Solodic Orthic Gray Luvisol
	3.22-2.23	Solodic Dark Gray Luvisol
	3.2-/8	Gleyed Gray Luvisol
	3.2-/9	Lithic Gray Luvisol

3. LUVISOLIC ORDER

The Luvisolic order consists of well- and imperfectly drained soils that have developed under deciduous, mixed deciduous-coniferous, or boreal forests, or under mixed forest in the forest-grassland transition zones in moderate and cool climates. The parent materials are generally neutral to alkaline in reaction.

These soils have eluvial (Ae) horizons and illuvial textural B horizons in which silicate clay is the main accumulation product and which meet the requirements of a Bt horizon as defined. Slight accumulations of $CaCO_3$ may occur under the B horizon, but these seldom meet the requirements of a Cca horizon.

Under virgin conditions the soils have L-H or Ah horizons overlying prominent Ae horizons. Ah horizons, where present, are generally neutral, whereas the Ae and Bt horizons may vary from slightly to moderately acid in reaction.

Under cultivated conditions, the Ap horizon, 6 inches (15 cm) thick, may vary considerably in organic matter and color (dry values 3 or higher) depending on whether the Ap consists of Ah, Ae, or a mixture of these with the Bt horizon. In general, the Ap does not meet the requirements of a Chernozemic Ap horizon. Where it does meet these requirements, it is underlain by a light-colored Ae horizon. In some cases, where the Ah and Ae are thin, the Ap is underlain by the Bt horizon.

3.1 GRAY BROWN LUVISOL

These soils have dark-colored forest-mull type of surface horizons (Ah) more than 2 inches (5 cm) thick, light-colored eluvial horizons (Ae), and illuvial horizons in which clay is the main product of accumulation (Bt). The soils have developed on basic or calcareous parent materials and the solum has a high degree of base saturation (by neutral salt extraction). These soils were formerly called Gray Brown Podzolic.

Under undisturbed conditions, the soils may have thin L, F, and H horizons, but because of high biological activity and the abundance of earthworms the leaf litter is usually quickly incorporated into the soil and humified. A transition AB or BA horizon having gray coatings on structural aggregates is generally present, particularly in medium- and fine-textured soils. Although the Bt horizon is generally immediately underlain by calcareous materials, a transition BC horizon, free from lime, may be present. These transition horizons are not diagnostic for the group. An increase of dithionite-extractable Fe and small increases of organic matter are usually associated with the accumulation of clay, but there are no significant increases in oxalate-extractable Fe and Al.

Under cultivated conditions, the Ah and often part of the Ae are mixed to form an Ap, but the Bt and some of the Ae usually remain intact under the Ap, unless cultivation greatly exceeds 6 inches (15 cm) in depth.

The Gray Brown Luvisols have developed under deciduous or mixed-forest vegetation and in a moderate climate, generally having a mean annual temperature of more than 42 F (5.5 C).

The soils of this group differ from the Degraded Melanic Brunisols, in which Ae and B development is weak and the B horizon does not meet the requirements of Bt. They differ from the Dark Gray Luvisols, which have developed in a cool climate, mainly in the nature of the Ah horizons. Whereas the Gray Brown Luvisols have a forest-mull type of Ah, with well-developed granular structure (texture permitting), the Dark Gray Luvisols have a degraded chernozemic-like Ah, as evidenced by gray streaks and spotches, which lacks strongly developed granular structure and may be platy.

The subgroups of the Gray Brown Luvisol great group are established on the basis of the profile development above the Bt horizon and on the evidence of gleying in the solum.

3.11 Orthic Gray Brown Luvisol

Profile type: (L–H), Ah, Ae, (AB), (BA), Bt, (BC), (Ck), (C)

These soils have the general characteristics of the great group and have well-developed Ah, Ae, and Bt horizons. The Ae is light-colored, with values of 4.5 or higher and with chromas of 3.0 or less; the difference in chroma between the upper and lower Ae is less than 1. The Ae is underlain directly by a blocky Bt with clay skins or by a BA horizon in which the blocky aggregates have gray coatings and tend to disintegrate. Faint mottling may occur just above the Bt or in the lower part of the B horizon.

The cultivated soil usually has a color value between 3.5 and 5.5 dry and a chroma of 3.0 or less. The color value may vary considerably with the thickness of the original Ah, and with management practices.

3.12 Brunisolic Gray Brown Luvisol

Profile type: (L–H), Ah, Ae1 or Bm or (Bf, Bm), (Ae2), (AB), Bt, (BC), (Ck), (C)

These soils have the general characteristics of the great group and have well-developed Ah, Ae, and Bt horizons. The upper Ae (Ae1) is brown, with chromas of 3.0 or more, and grades to a light-colored lower Ae (Ae2). The difference in chroma between the upper and lower Ae is 1 or more.

Two kinds of profiles may develop in the A horizon: (i) a thin Melanic Brunisol having Ah, Bm, "C" (or Ae2), or Ah, Bm horizons in which the Bm can be recognized under an Ap, and (ii) a Mini Humo-Ferric Podzol having Ah, (Ae), Bf (or Bfh), "C" (or Ae2) horizons, but in which the Bf (or Bfh) horizon does not extend below the Ap.

The Ae1 (Bm, or Bf if present) is generally friable and granular, whereas the Ae2 or "C" is often platy and friable when moist, but it may be hard and often vesicular when dry. The lower Ae often has a diffuse and irregular lower boundary with an AB or BA horizon. Faint mottling may occur in the lower Ae or just above the Bt.

This subgroup represents the early stages of podzolic development in the Ae horizon of the Gray Brown Luvisols. The degree of base saturation of the upper solum is more typical of the Gray Brown Luvisols than of the Podzols.

The cultivated surface usually has color values similar to those of the orthic subgroup, but the chroma may be slightly higher on similar parent materials.

3.13 Bisequa Gray Brown Luvisol

Profile type: (L–H), Ah, (Ae), Bfh or Bf, (Ae2 or "C"), Bt, (BC), (Ck), (C)

These are soils with the same general characteristics as the orthic subgroup (Ah, Ae, Bt), but in which a podzolic sequence of horizons, Ae, Bfh or Bf, "C" (or Ae2), has developed in the Ae of the Gray Brown Luvisol and is underlain by a continuous Bt horizon at a depth of 18 inches (45 cm) or less. The Bfh or Bf as defined must extend below the plow layer or 6 inches (15 cm). Where the upper podzolic sequence does not meet these requirements, the soil should be classified as a Brunisolic Gray Brown Luvisol.

These soils differ from the Bisequa Gray Luvisols in that the latter lack a mull Ah or, if present, it is less than 2 inches (5 cm) thick.

Under cultivated conditions the Ap is underlain by a Bfh or Bf horizon. The Ap usually has color values similar to those of the orthic subgroup, but the chroma may be slightly higher on similar parent materials.

3.1-/8 Gleyed Gray Brown Luvisol

Profile type: Ah, Aegj, Btgj, (Ck), (C); (L H), Ah, Bmgj or Bfgj, (ABgj), Btgj, (Ck), (C)

These soils have the general characteristics of the above subgroups. Due to periodic wetness in the Ae or Bt horizon, or in both, the soils are also mottled and commonly have duller colors than the associated well-drained soils. However, they lack the low chromas and prominent mottling associated with the Gleysolic soils.

The Gleyed Gray Brown Luvisols generally have thicker and darker Ah horizons than the well-drained subgroups on similar parent materials. The color and textural differences between the Ae and Bt are generally less marked in the gleyed than in the well-drained subgroups.

Peaty or mucky phases, having less than 16 inches (40 cm) of mixed peat (bulk density >0.1) or up to 24 inches (60 cm) of fibric moss peat (bulk density <0.1) over the Ah horizon, may occur in the gleyed subgroups.

Under cultivated conditions the Ap of the gleyed subgroups is generally darker than that of the orthic subgroups (dry color values may be as low as 2.0). The Ap is generally underlain by a gleyed Ae or Bt horizon, or both.

3.1-/9 Lithic Gray Brown Luvisol

These soils have the general characteristics of the above subgroups and a lithic contact within 20 inches (50 cm) of the surface.

3.2 GRAY LUVISOL

These are soils with organic surface horizons (L H), light-colored eluvial horizons (Ae), and illuvial horizons in which clay is the main accumulation product (Bt). A soil may have a degraded chernozem-like Ah or an Ahe horizon as evidenced by gray streaks and splotches and often by a platy structure. An AB or BA horizon having gray coatings on the structural aggregates is often present. An increase in dithionite-extractable Fe and small increases in organic matter are often associated with the accumulation of clay, but there are no significant increases in oxalate-extractable Fe and Al. The solum generally is slightly to moderately acid, but the degree of base saturation, based on neutral salt extraction, is generally high. The parent materials are usually neutral to slightly alkaline, and they are commonly calcareous. Most of these soils were formerly called Gray Wooded; others were Textural Podzols.

Under cultivated conditions, the Ap may consist largely of Ah material, Ae material, or mixed Ah and Ae material. Occasionally it may also contain Bt material. The organic matter content and the color of the Ap may therefore vary considerably. The color value of an Ap 6 inches (15 cm) thick, when dry, may range from 3.5 to 5.5 or more. The Ap is underlain by remnants of Ae or by Bt.

The Gray Luvisols have developed in moderately cool climates and under boreal forest or mixed forest in the grassland–forest transition zone, generally on basic materials.

3.21 Orthic Gray Luvisol

Profile type: L–H, (Ah or Ahe), Ae, (AB), Bt, (Cca), (Ck), (C)

These soils have the general characteristics of the great group, and have organic surface horizons (L–H), light-colored Ae, and Bt horizons. An Ah, if present, is less than 2 inches (5 cm) thick. The lower part of the Ae may be slightly mottled and often overlies an AB or BA horizon. The Ae has a dry color value of 5.5 or higher and a chroma of usually less than 3.0, although some higher chromas may be associated with some parent materials.

The cultivated surface soils, Ap 6 inches (15 cm) thick, have a dry color value of 5.0 or higher and are underlain by remnants of Ae or by Bt. Where the total thickness of Ah and Ae is less than 6 inches (15 cm) and substantial amounts of the Bt have been incorporated into the Ap, the Ap may be slightly darker in value than 5.0 dry, because of the darker color of the Bt. In such cases, fragments of the Bt should be clearly identifiable in the Ap.

3.22 Dark Gray Luvisol

Profile type: (L–H), Ah or Ahe, Ae, Bt, (Cca), (Ck), (C)

These soils have the general characteristics of the great group and have organic surface horizons (L–H), Ah or Ahe horizons, or both, more than 2 inches (5 cm) thick, prominent Ae horizons more than 2.5 inches (6 cm) thick, and Bt horizons as defined. The total thickness of the Ah and Ae is greater than 6 inches (15 cm).

The Ah or Ahe horizons, or both, show definite signs of degradation as evidenced by gray streaks or splotches when the soil is dry. They may have a platy or weak, fine, granular structure and represent a degraded chernozemic Ah horizon. They differ from the forest-mull type of Ah, which generally has a well-developed granular structure with more intimate association of organic and mineral constituents brought about by more active biological activity.

Under cultivated conditions, the Ap is 6 inches (15 cm) thick, and has a dry color value lighter than 3.5 and darker than 5.0, but may be darker than 3.5 when moist. The range in color value of the Ap is the same in the Dark Gray Chernozemic as in the Dark Gray Luvisol, but the Ap of the former is not underlain by a distinct Ae. The Ap of the Dark Gray Luvisol is underlain by an Ae over Bt.

These soils represent an intergrade between the Dark Gray Chernozemic and the Orthic Gray Luvisol soils and lie in the forest-grassland transition zone.

3.2-/3 Brunisolic Gray Luvisol

Profile types: L-H, (Ah), Ae1 or Bm or (Bf, Bm), (Ae2 or "C"), (AB), Bt, (Ck), (C); (L-H), Ah or Ahe, Ae1 or Bm or (Bf, Bm), (Ae2 or "C"), (AB), Bt, (Ck), (C)

These soils have the general characteristics of the great group and have L-H or Ah horizons over Ae and Bt horizons. The upper Ae1 is brown, with chromas of 3.0 or more, and usually grades to a light-colored lower Ae2. Two kinds of profiles may develop in the A horizon: (i) those having L-H or Ah, Bm, "C" (or Ae2) horizons, and (ii) those having L-H, (Ah), Bfh or Bf, or both, "C" (or Ae2) horizons. The Bm horizon should be thick enough to be recognizable under an Ap, but the Bf horizon should not extend below the plow depth. The Bm or Bf (or Bfh) horizon is underlain by an Ae or a Bt horizon, or both.

The upper Ae1 (Bm, or Bf if present) is generally friable and granular with a chroma of 3.0 or more, whereas the lower Ae2 or "C", if present, is often platy and friable when moist, but may be hard and often vesicular when dry. The lower Ae often has an irregular diffuse boundary with an AB or BA horizon, which often has gray coatings on the structural aggregates. Faint mottling may occur in the lower Ae or "C".

This subgroup represents early stages of podzolic development in the Ae horizons of the Luvisols. The degree of base saturation in the upper solum is more typical of the Luvisols than of the Podzols.

The cultivated surface soil usually has color values similar to those of the 3.21 and 3.22 subgroups, but the chroma may be slightly higher on similar materials. The Ap is underlain by Bm, which in turn may be underlain by "C" (Ae2) and by the Bt horizon.

The Brunisolic subgroup may be intergraded with the Orthic Gray Luvisol 3.21/3 or with the Dark Gray Luvisol 3.22/3.

3.2-/4 Bisequa Gray Luvisol

Profile type: L–H, (Ah), (Ae), Bfh or Bf, (Ae2 or "C"), (AB), (ABt), Bt, (Ck), (C)

These are soils with the same general characteristics as 3.21 or 3.22 (L–H or Ah, or both, Ae, Bt), but in which a podzolic sequence of horizons (Ae, Bfh or Bf, or both) has developed in the Ae of the Gray Luvisol and is underlain at a depth of 18 inches (45 cm) or less by a continuous Bt horizon. A further limitation is that the Bfh or Bf horizon, as defined, must extend below the plow layer or below 6 inches (15 cm). When the upper podzolic sequence does not meet the above limitations, the soil should be classified as a Brunisolic Gray Luvisol.

The Bisequa profiles are most commonly intergraded with the Orthic Gray Luvisol subgroup 3.21/4. This subgroup has essentially the same profile characteristics as 3.13. The climatic differences and geographic distribution may help to separate these soils. This subgroup is seldom intergraded with the Dark Gray Luvisol 3.22/4.

Under cultivated conditions, the Ap is underlain by a Bfh or Bf horizon. The Ap usually has color values similar to those of the Orthic Gray Luvisol or Dark Gray Luvisol subgroups, but the chroma may be slightly higher on similar materials.

3.21-2.23 Solodic Orthic Gray Luvisol

3.22-2.23 Solodic Dark Gray Luvisol

Profile types: L–H, Ah or Ahe, Ae, (AB), Btnj, (Cca), (Csk), (C); L–H, (Ah) or (Ahe), Ae, (AB), Btnj, (Cca), (Csk), (C)

These soils have the general characteristics of the great group, but have hard, prismatic, or blocky structural Btnj horizons with pronounced dark coatings instead of the Bt horizons characteristic of the great group.

These soils resemble the Solod structurally, but they contain somewhat less exchangeable Na than is required for Bn horizons of Solonetic soils. They may be considered as intergrades between the Dark Gray Luvisols or Orthic Gray Luvisols and the Solod.

3.2-/8 Gleyed Gray Luvisol

Profile types: L–H, (Ah), Aegj, (ABgj), Btgj, (Btg) or (BCg) or (Cg), (Ck), (C); (L–H), Ah or Ahe, Ae1 or Bmgj, (Ae2gj), (ABgj), Btgj, (Ck), (C)

These are soils with the same type of profile as any of the above subgroups, but due to periodic wetness and reducing conditions in the Ae and Bt horizons they are mottled and commonly have duller colors than the associated well-drained soils.

The Gleyed Gray Luvisols generally have thicker L–H horizons than the well-drained subgroups. Peaty or mucky phases, with less than 16 inches (40 cm) of mixed peat (bulk density > 0.1) or up to 24 inches (60 cm) of fibric moss peat (bulk density < 0.1) on the surface of the mineral soil, may occur. They often have thicker Ae and stronger-developed Bt horizons in depressions, on reasonably permeable materials, than the associated well-drained soils in the forest–grassland transition zone. In more humid regions, on level land, particularly on less permeable materials, the gleyed members may have weaker-developed Ae and Bt horizons than the associated well-drained soils. They differ from the Low Humic Eluviated Gleysols in that the latter have developed under greater extremes of wetness and usually have matrix colors of lower chroma, or more prominent mottling in the upper 20 inches (50 cm), or both.

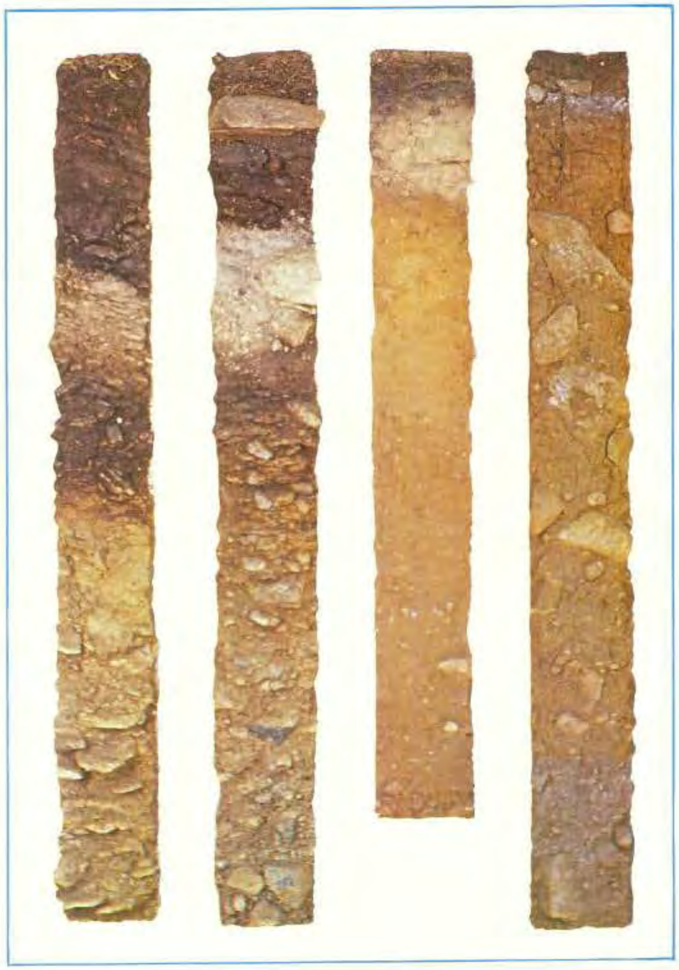
Specific profiles may be designated as 3.21/8, 3.23/8, etc.

3.2-/9 Lithic Gray Luvisol

These soils have the general characteristics of the above subgroups, but also a lithic contact within 20 inches (50 cm) of the surface.

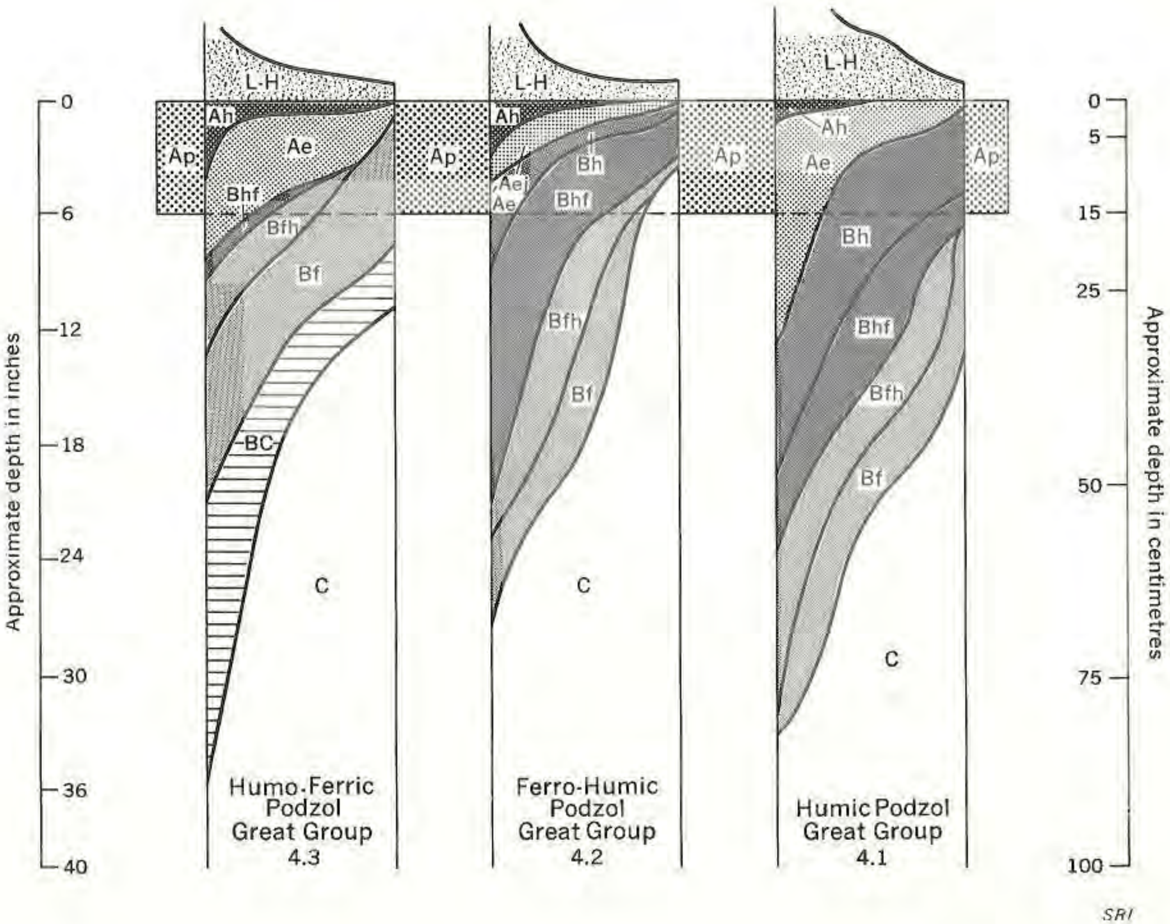
Fig. 13. An Orthic Gray Brown Luvisol.

Fig. 14. An Orthic Gray Luvisol.



A B C D

Fig. 15. Soil monoliths representative of certain Podzolic soils: (a) Orthic Humic Podzol, (b) Orthic Ferro-Humic Podzol, (c) Orthic Humo-Ferric Podzol, and (d) Mini Humo-Ferric Podzol.


Approximate depth in inches
0
6
12
18
24
30
36
40
L-H
Ah
Ae
Ap
Bhf
Bfh
Bf
BC
C
Humo-Ferric
Podzol
Great Group
4.3
L-H
Ah
Ap
Bh
Aej
Ae
Bhf
Bfh
Bf
C
Ferro-Humic
Podzol
Great Group
4.2
L-H
Ah
Ae
Ap
Bh
Bhf
Bfh
Bf
C
Humic Podzol
Great Group
4.1
Approximate depth in centimetres
0
5
15
25
50
75
100
SRI

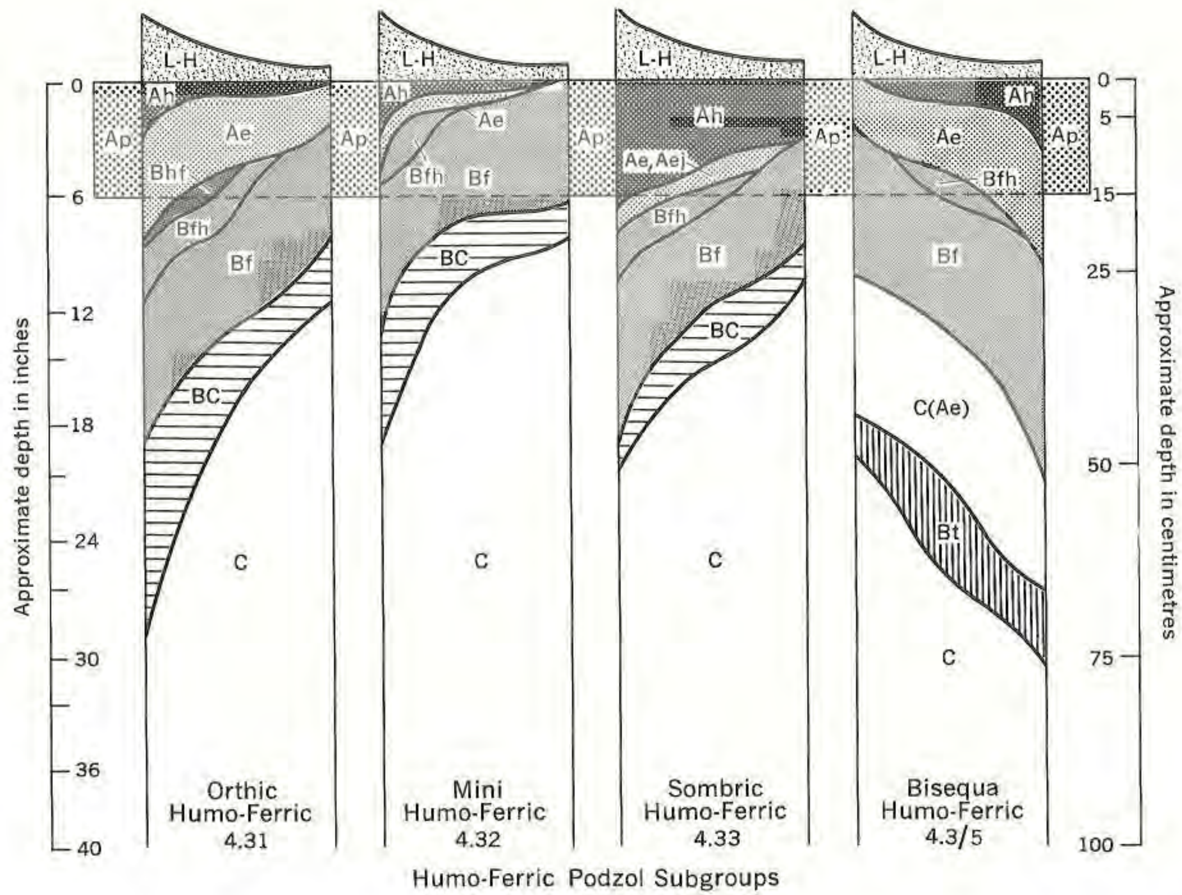


Fig. 16. A diagrammatic horizon pattern of representative Podzolic profiles.

PODZOLIC ORDER

Great Group		*Subgroup*
4.1 Humic Podzol	4.11	Orthic Humic Podzol
	4.14	Placic Humic Podzol
	4.1-/8	Gleyed Humic Podzol
	4.1-/9	Lithic Humic Podzol
4.2 Ferro-Humic Podzol	4.21	Orthic Ferro-Humic Podzol
	4.22	Mini Ferro-Humic Podzol
	4.23	Sombric Ferro-Humic Podzol
	4.2-/4	Placic Ferro-Humic Podzol
	4.2-/8	Gleyed Ferro-Humic Podzol
	4.2-/9	Lithic Ferro-Humic Podzol
4.3 Humo-Ferric Podzol	4.31	Orthic Humo-Ferric Podzol
	4.32	Mini Humo-Ferric Podzol
	4.33	Sombric Humo-Ferric Podzol
	4.3-/4	Placic Humo-Ferric Podzol
	4.3-/5	Bisequa Humo-Ferric Podzol
	4.3-/7	Cryic Humo-Ferric Podzol
	4.3-/8	Gleyed Humo-Ferric Podzol
	4.3-/9	Lithic Humo-Ferric Podzol

4. PODZOLIC ORDER

Podzolic soils are well and imperfectly drained soils that have developed under coniferous and mixed-forest vegetation and heath, mostly in cold to temperate climates and on acid parent materials.

These soils have podzolic B horizons,[1] in which the characteristic accumulation products are organic matter (dominantly fulvic acid) combined in varying degrees with Fe and Al. These amorphous materials form coatings on sand, silt-sized particles, or fine pellets. The lowest values, reddest hues, or highest chromas occur in the upper part of the B horizon. The soils are acid (usually pH < 5.5) and have a high pH-dependent cation exchange capacity (usually > 8 meq/100 g) in the B horizon.

[1] A podzolic B horizon consists of one or more Bh, Bhf, Bfh, or Bf horizons. By definition this horizon is similar to the spodic B horizon in the U.S. system.

Under virgin conditions, the soils have organic surface horizons (L–H), dominantly of a mor or moder type. They may have an Ah horizon below the organic surface layer. Generally, they have eluviated, light-colored horizons (Ae), but these may be indistinct or absent.

Under cultivated conditions, the Ap horizon is usually underlain by remnants of the Ae and a podzolic B horizon. If the Ae and podzolic B horizons are incorporated in the Ap, the Ap must have (a) more than 3% organic matter (1.7% C), (b) Δ (Fe + Al) greater than 0.8%, and (c) hues redder than 10YR and moist color values less than 3.0, or chromas of 3.0 or more in hues of 10YR or redder.

The Podzolic order is divided into the Humic, Ferro-Humic, and Humo-Ferric great groups, based on the dominance of the Bh, Bhf, or Bfh (or Bf) horizons as defined.

4.1 HUMIC PODZOL

These soils have dark-colored (values and chromas usually <3.0 moist) illuvial Bh horizons at least 4 inches (10 cm) thick in which organic matter is the main accumulation product. The upper B horizon (Bh) contains more than 2% organic matter but very little or no free Fe; it usually contains extractable Al; it does not turn redder on ignition; and the ratio of organic matter to free Fe is 20 or more. The Bh horizon may be underlain by Bhf, Bfh, or Bf horizons. A thin, or a series of very thin, hard, involute, impervious, dark reddish-brown hardpans (placic horizon) may occur in the solum.

Under virgin conditions, the soil has thick, mor-type surface horizons (L, F, H) that are underlain by light-colored eluviated horizons (Ae), or by eluviated horizons that are stained with infiltrated humic materials, or by Bh horizons. The Bh horizons may be underlain by Bhf, Bfh, or Bf horizons that contain appreciable amounts of free Fe and Al as well as organic matter. They may vary from soft and friable to firm or very hard in consistence and may be strongly mottled.

The Humic Podzols have developed under heath, under forest with heath and sphagnum undercover, or under western coastal forest. Consequently, the L–H horizons are generally thick and peaty. These soils occur in moist coastal regions, in cool moist locations at high altitudes inland, and locally in some peaty depressions in warmer or less moist regions. These soils have formed on materials originally low in Fe or on materials that have been strongly leached and have most of the free Fe removed (Bh horizons developed in deeply leached Ae horizons).

4.11 Orthic Humic Podzol

Profile type: <u>L</u>, <u>F</u>, <u>H</u>, <u>Ae</u>, <u>Bh</u>, (Bhf), (Bfh), (Bf), (C)

These soils have the general characteristics of the great group including L–H, Ae, and Bh horizons, but lack a placic horizon. The Bh horizon generally contains more than 2% organic matter and less than 0.35% of oxalate-extractable Fe and does not turn redder on ignition. It generally contains free Al. The Bh may be underlain by a Bhf, Bfh, or Bf horizon.

4.14 Placic Humic Podzol

Profile type: L, F, H, Ae, Bh, (Bhf), Bhfc or Bfc, (Bf), (C)

These soils have the general characteristics of the great group, but have a thin placic horizon usually less than 1 inch (2.5 cm) thick. The placic horizon consists of a single band, or a series of very thin (generally < ⅛ inch) bands that are irregular or involute, hard, impervious, often vitreous, and dark reddish-brown in color. These horizons (pans) are apparently cemented by dithionite-extractable Fe, by dithionite-extractable Fe + Mn, or by organic matter (mainly fulvic acid, Fe, and Al). In the soils studied so far the carbon content is 1–12%, Fe 5–20%, and Mn 0–15%. The pan may occur in any part of the B horizon, except the Bh, and often extends into the C horizon.

The impermeability of the pan usually causes some gleying just above it, particularly in the troughs of the involute pans. However, the soil may be well drained below the pan. The wavy nature of the pan causes a substantial variation in the moisture regime of the overlying profiles. Orthic Humic Podzols and Gleyed Humic Podzols occur on the lower slopes and troughs. In extreme cases Gleysols with a peaty surface may occur over the deeper troughs of the pan.

4.1-/8 Gleyed Humic Podzol

Profile type: L, F, H, Aegj, Bhgj, (Bhfgj), (Bfhgj), (Bfgj), (Bhfc), (C)

These soils have the general characteristics of the above subgroups and indications of wetness in the upper part of the solum. Iron mottling, indicative of reducing conditions, is not noticeable in the Ae and Bh horizons, but occurs in the underlying Bhf, Bfh, or Bf horizons. The Bh horizons are often splotched black and gray; they may have diffuse upper and lower boundaries depending on the alternating water table.

4.1-/9 Lithic Humic Podzol

These soils have the general characteristics of the above subgroups, but also have a lithic contact within 20 inches (50 cm) of the surface.

4.2 FERRO-HUMIC PODZOL

These are soils with podzolic B horizons in which organic matter, Fe, and Al are the main accumulation products. Under undisturbed conditions, they have mineral-organic surface horizons (L-H or Ah) usually underlain by eluviated light-colored horizons (Ae). In some cases the Ae may be thin, indistinct, or missing. The upper 4 inches (10 cm) of the B horizon contains more than 10% organic matter and the oxalate-extractable Fe + Al exceeds that of the C horizon by 0.8% or more. The ratio of organic matter to oxalate-extractable Fe in the B horizon is less than 20. A Bh horizon less than 4 inches (10 cm) thick may overlie the Bhf horizon or the Bhf may directly underlie the Ah or Ae horizon. The Bhf may be underlain by Bfh or Bf horizons.

The solum is acid (usually pH < 5.5) and has a low degree of base saturation based on permanent charge. The B horizon has a high pH-dependent charge. A thin, or a series of very thin, hard, involute, impervious, dark reddish-brown hardpans (placic horizon) may occur in the B horizon. The B horizon may be underlain by a placic horizon or a textural B horizon.

The Ferro-Humic Podzols have developed mainly under a coniferous or mixed-forest vegetation in cold to temperate climates. The parent materials are usually less leached or richer in Fe than those from which the Humic Podzols develop in a similar climate. There is evidence that some of the Ferro-Humic Podzols developed under oak forests with an understory of grasses and ferns.

4.21 Orthic Ferro-Humic Podzol

Profile type: L, F, H, Ae, (Bh), Bhf, (Bfh), (Bf), (C)

These soils have podzolic B horizons that are dark colored (moist value and chroma usually 3.0 or less) in the upper part, are 4 inches (10 cm) or more thick, and contain more than 10% organic matter; and in which Δ (Fe + Al) is greater than 0.8% and the ratio of organic matter to oxalate-extractable Fe is less than 20.

Under undisturbed conditions, these soils have thick organic surface horizons (L, F, H) of the mor type, underlain by light-colored Ae horizons more than 1 inch thick. They may have a Bh horizon less than 4 inches (10 cm) thick that grades into the Bhf, which in turn may be underlain by Bfh or Bf horizons, or both.

The Bhf horizon may contain more clay than the Ae or C horizons, but the clay is not oriented and does not form clay skins. The most prominent accumulation of clay occurs just below the Ae in the horizon of greatest organic matter and sesquioxide accumulation.

The B horizons may be friable, firm, or cemented, and they may be underlain by a fragipan. There is no thin hardpan (placic horizon).

Although the soils generally are not cultivated, cultivation may vary the Ap considerably. Where the Ae is rather thin and the Ap consists largely of a mixture of the organic surface layers or contains a considerable admixture with Bhf horizon, the Ap may be dark. Where the Ap consists mainly of Ae material, it may be light colored. Generally clean, white, bleached mineral grains are clearly visible in the Ap.

The Orthic Ferro-Humic Podzols have developed under heath, under forest with heath-type undercover, or under western coastal forest.

4.22 Mini Ferro-Humic Podzol

Profile type: L, F, H, (Ae), Bhf, (Bfh), (Bf), (C)

These soils have the general characteristics of 4.21, but have a thin Ae (< 1 inch) or lack a visible Ae horizon. Thin (< 3 inches) Ah horizons may be present.

Under cultivation the Ap is dark (moist value and chroma of 3.0 or less). Clean bleached sand grains are rare, but amorphous coatings and pellets may be plentiful.

4.23 Sombric Ferro-Humic Podzol

Profile type: (L-H), Ah, (Aej), Bhf, (Bfh), (Bf), (C)

These are soils with L-H, Ah, and podzolic Bhf horizons, but without distinct eluviated Ae horizons. The podzolic B horizon has oxalate-extractable Δ (Fe + Al) greater than 0.8% and the upper 4 inches (10 cm) of the B horizon (Bhf) contains more than 10% organic matter. The pH (0.01 M $CaCl_2$) is less than 5.5 and the pH-dependent charge is high (> 8 meq/100 g). The base saturation (NaCl) is 90-100%. The chroma is 3.0 or higher and the difference in chroma between the B and C is 1 or more.

Under undisturbed conditions, the soils have thin organic surface horizons (L-H) of mor or moder type and a sombric (umbric) Ah horizon more than 3 inches thick with a value less than 3.5 moist and less than 4.5 dry and chroma less than 2.0 moist and dry. The pH ($CaCl_2$) is generally less than 5.5 and the base saturation (acetate) is low. The free Fe content is moderately high.

A distinct Ae horizon is generally lacking and the only evidence of eluviation is the clean mineral grains (salt and pepper) over the Bhf horizon. Usually the Ah-Bhf boundary is gradual. The Bhf horizon generally grades through Bfh or Bf horizons to the acidic C horizon. The soils lack thin (placic) hardpans, but they may be underlain by fragipans.

Under cultivated conditions, the Ap horizon 6 inches (15 cm) thick has a value of less than 3.5 moist and less than 4.5 dry. When the Ap is underlain by remnants of Ah, the chroma is less than 2.0. If a substantial amount of B material is incorporated into the Ap, the chroma may be 2.0 or 2.5. The Ap is underlain by remnants of Ah or by podzolic B horizons.

There is evidence that these soils have developed under grass and fern vegetation having a canopy of oak trees, and that this vegetation has been or is being replaced by coniferous vegetation and shrubs. These soils occur mainly in the coastal areas of British Columbia where the mean annual temperature is above 47 F (8 C) and the annual precipitation varies from 27 to 45 inches, of which only 1.1 to 2.2 inches falls during July and August. These soils are not common in Eastern Canada.

4.2-/4 Placic Ferro-Humic Podzol

Profile type: L, F, H, (Ae), (Bh), Bhf with Bhfc or Bfc, (C)

These soils have the general profile characteristics of 4.21 and 4.22 and a placic horizon as described in 4.14. This horizon may occur in any of the B horizons and may extend into the C horizon.

4.2-/8 Gleyed Ferro-Humic Podzol

Profile type: L, F, H, or Ah, (Aegj), Bhfgj, (Bfhgj), (Bfgj), (C)

These soils have the general characteristics of the above subgroups, but have indications of wetness and reducing conditions (mottling and dull colors) in the upper part of the solum. The Bhf horizons may be splotched black and gray and the upper and lower boundaries are often diffuse depending on the alternating water table. Iron mottling is generally distinct in the lower B horizons, but may be faint in the Bhf horizons. Peaty or mucky phases having less than 16 inches (40 cm) of mixed peat (bulk density >0.1) or up to 24 inches (60 cm) of fibric moss peat (bulk density <0.1) on the surface may occur in the gleyed subgroups.

4.2-/9 Lithic Ferro-Humic Podzol

These soils have the general characteristics of the above subgroups and a lithic contact within 20 inches (50 cm) of the surface.

4.3 HUMO-FERRIC PODZOL

These soils have podzolic B horizons in which organic matter, Fe, and Al are the main accumulation products. The upper 4 inches (10 cm) of the B horizon contains less than 10% organic matter and the oxalate-extractable Fe + Al exceeds that of the C horizon by 0.8% or more. The ratio of organic matter to oxalate-extractable Fe is less than 20.

Under undisturbed conditions, these soils have an organic surface horizon (L–H), usually of a mor or moder type. The L–H horizon is directly underlain by a mineral–organic Ah horizon, an Ae horizon, or a podzolic B horizon. The soils may have a distinct eluviated bleached horizon (Ae), and they may have an Ah horizon.

Under cultivated conditions, the Ap or remnants of the Ae are underlain by a podzolic B horizon.

The Humo-Ferric Podzols have developed under mixed and coniferous-forest cover over a wide range of climatic conditions, but they are dominant on the well-drained sites in moist cool regions on coarse, noncalcareous materials, or on materials from which free lime has been removed.

4.31 Orthic Humo-Ferric Podzol

Profile type: <u>L–H</u>, <u>Ae</u>, (Bhf), <u>Bfh</u> or <u>Bf</u>, (C)

These soils have the general characteristics of the great group and L–H, Ae, and Bfh or Bf horizons.

Under virgin conditions, these soils have organic surface horizons (L, F, H) and eluviated light-colored horizons (Ae) more than 1 inch thick, which overlie Bfh or Bf horizons, or both.

The podzolic B horizons generally have a chroma of 4.0 or more. A thin Bhf horizon may be present above the Bfh, but the average organic matter content of the upper 4 inches of a B horizon is less than 10%. In the Bfh and Bf horizons Δ (Fe + Al) is greater than 0.8%, except in some soils with textures of loamy sand or coarser. The B may be friable, may contain concretionary structures, or may be cemented into ortstein. The Bfh horizon may contain more clay than the Ae or C horizons, but the clay is not oriented and does not form clay skins. The most prominent accumulation of clay occurs just below the Ae in the horizon containing the greatest organic matter and sesquioxide accumulation. Some mottling may occur in the lower B horizon, particularly if the latter is underlain by a fragipan. The B is not underlain by a thin hardpan, a textural B horizon, or permafrost.

Under cultivated conditions, the organic surface, the Ae, and the upper B horizons may be mixed. The Ap horizon is underlain by remnants of Ae or by Bfh or Bf horizons or both.

4.32 Mini Humo-Ferric Podzol

Profile type: <u>L</u>, <u>F</u>, <u>H</u>, (Ah), (Ae), <u>Bfh</u> or <u>Bf</u>, (C)

These soils have the general characteristics of the great group except that under undisturbed conditions the eluviated horizon (Ae) is thin (generally <1 inch), discontinuous, indistinct (salt and pepper), or missing. The B horizons have a chroma of 4.0 or more in hues of 10YR or redder and they have Δ (Fe + Al) greater than 0.8%, except in loamy sands or soils with coarser textures. Thin (<3 inch) Ah horizons may be present.

Under cultivated conditions, the Ap horizon [6 inches (15 cm) thick] generally contains substantial amounts of Bfh or Bf horizons, or both. If it is not underlain by a diagnostic podzolic B horizon, the Ap should contain more than 3% organic matter, have Δ (Fe + Al) greater than 0.8%, and have a color value less than 3.0 moist with a hue redder than 10YR, or chroma of 3.0 or more with a hue of 10YR or redder.

4.33 Sombric Humo-Ferric Podzol

Profile type: (L–H), Ah, Bfh or Bf, (C)

These are soils with L–H, Ah, and podzolic Bfh or Bf horizons, or both, containing less than 10% organic matter in the upper 4 inches (10 cm) and oxalate-extractable Δ (Fe + Al) greater than 0.8%. The pH (0.01 M $CaCl_2$) is less than 5.5 and the degree of base saturation (NaCl) is 90–100%. The pH-dependent charge is high (> 8 meq/100 g). The chroma is 3.0 or more, moist or dry, and the difference in chroma between the B and the C is 1 or more.

Under undisturbed conditions these soils have thin L, F, and H horizons over dark-colored mineral–organic horizons (Ah) 3 inches or more thick, underlain by Bfh or Bf horizons, or both. The Ah horizon has a color value less than 3.5 moist and 4.5 dry and a chroma of less than 2 moist or dry. This horizon contains at least 1% organic matter, has a base saturation (NaCl) of 80–100%, and has a pH (0.01 M $CaCl_2$) less than 5.5. A continuous Ae horizon is generally lacking or there is evidence of eluviation in the form of clean mineral grains (salt and pepper) over the Bfh or Bf horizon. These soils lack placic horizons, but may be underlain by fragipans.

Under cultivated conditions, the Ap horizon [6 inches (15 cm) thick] has a color value less than 3.5 moist and less than 4.5 dry and a chroma of less than 2.0. If considerable B horizon is incorporated into the Ap, the chroma may be 2.0 or 2.5. The Ap is underlain by remnants of Ah or by podzolic B horizons.

These soils occur in parts of Eastern Canada where the mean annual temperature is often below 42 F (5.5 C) and the precipitation averages about 40 inches annually, well distributed throughout the year. They occur mainly under deciduous trees, and the development of the Ah horizons is attributed to the incorporation of the L–H horizons by earthworms into the upper part of the mineral sola of the Podzols.

4.3-/4 Placic Humo-Ferric Podzol

Profile type: L–H, (Ae), Bfh or Bf, Bfc, (C)

These soils have the general characteristics of 4.31, but have a placic horizon as defined in 4.14. This horizon may occur in any of the B horizons and extend into the C horizon. This pan occurs less often in the Humo-Ferric Podzols than in the Ferro-Humic Podzols.

4.3-/5 Bisequa Humo-Ferric Podzol

Profile type: L–H, (Ae), Bfh or Bf, (Ae2 or "C"), Bt, (C)

These soils have the general characteristics of 4.31 and 4.32, but the podzol sola are underlain by a textural (Bt) horizon at a depth of 18 inches (45 cm) or more. These Podzols have developed in the Ae horizons of Luvisols. The diagnostic Bfh, Bf, and Bt horizons should meet the requirements of the respective horizons as defined. The podzolic B horizon must extend below a depth of 6 inches (15 cm).

Soils in which the Bt horizon occurs at 18 inches (45 cm) or less and which have a podzol sequence that meets the above requirements, should be classified with the Bisequa Luvisols. Where the upper sequence does not meet the minimal requirements of the Podzol, as defined above, the soils should be classified with the Brunisolic Luvisols. Soils in which the textural B horizon shows enough evidence of degradation so that it does not meet the requirements of a Bt horizon as defined, or in which the Bt horizon is at such a depth that it does not influence the moisture regime of the upper 40 inches (1 m) of the soil, are classified in other subgroups of the Humo-Ferric Podzols.

4.3-/7 Cryic Humo-Ferric Podzol

Profile type: L-H, (Ae), Bfhz or Bfz, (Cz)

These soils have the general characteristics of 4.31 and 4.32, but have permafrost within 40 inches (100 cm) of the mineral surface. Most of the Cryic Podzols studied meet the requirements of Mini Humo-Ferric Podzols.

4.3-/8 Gleyed Humo-Ferric Podzol

Profile type: L, F, H, or Ah, (Aegj), Bfhgj or Bfgj, (C)

These are soils with the general characteristics of the above subgroups but with mottling and duller colors due to periodic wetness in the Ae or B horizons, or both. The surface organic horizons are generally thicker in the gleyed subgroups than in the catenary well-drained subgroups. Peaty or mucky phases with less than 16 inches (40 cm) of mixed peat (bulk density >0.1) or up to 24 inches (60 cm) of fibric moss peat (bulk density <0.1) on the surface may occur in this subgroup.

4.3-/9 Lithic Humo-Ferric Podzol

These soils have the general characteristics of the above subgroups but also a lithic contact within 20 inches (50 cm) of the surface.

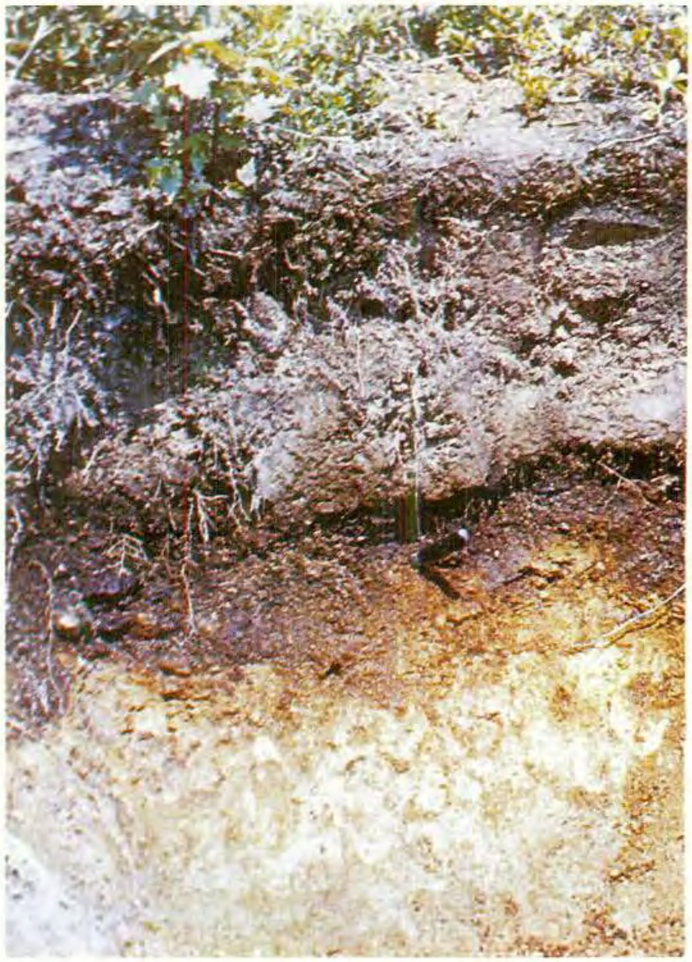


Fig. 17. An Orthic Humic Podzol.

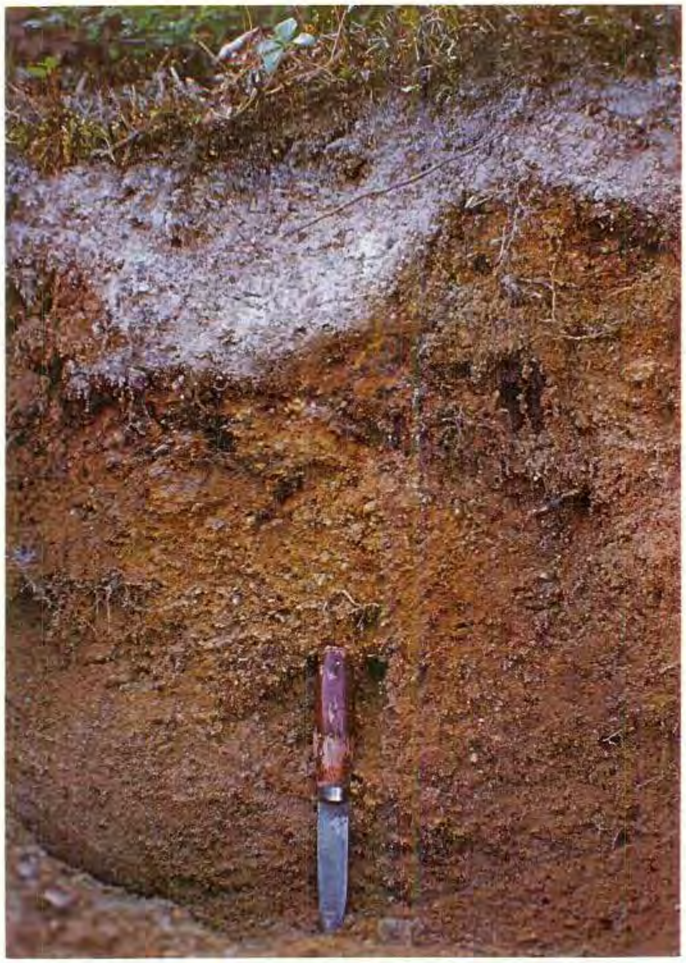
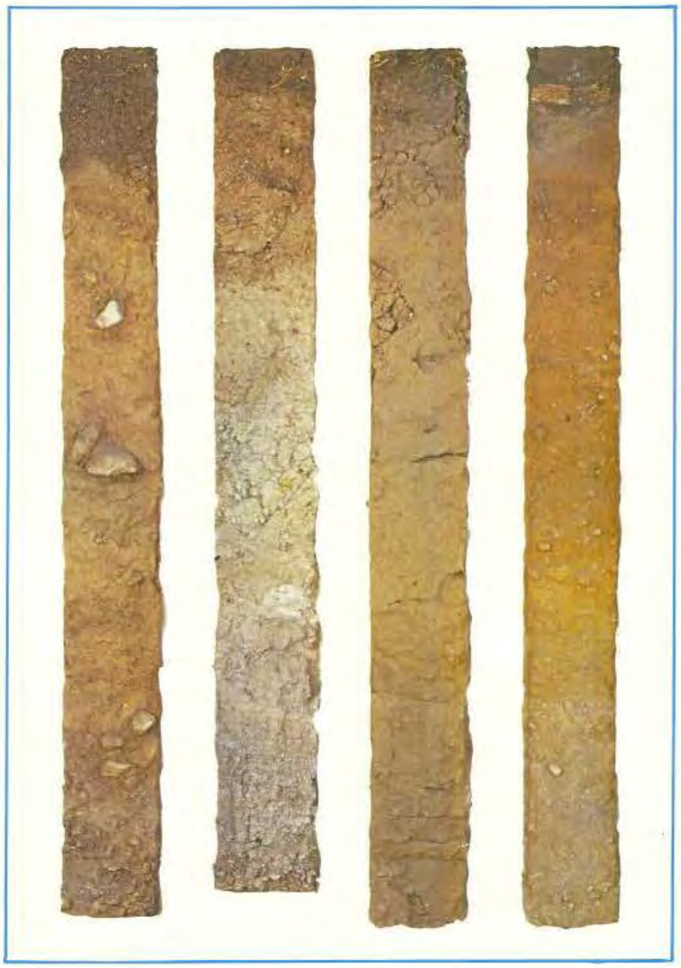


Fig. 18. An Orthic Humo-Ferric Podzol.

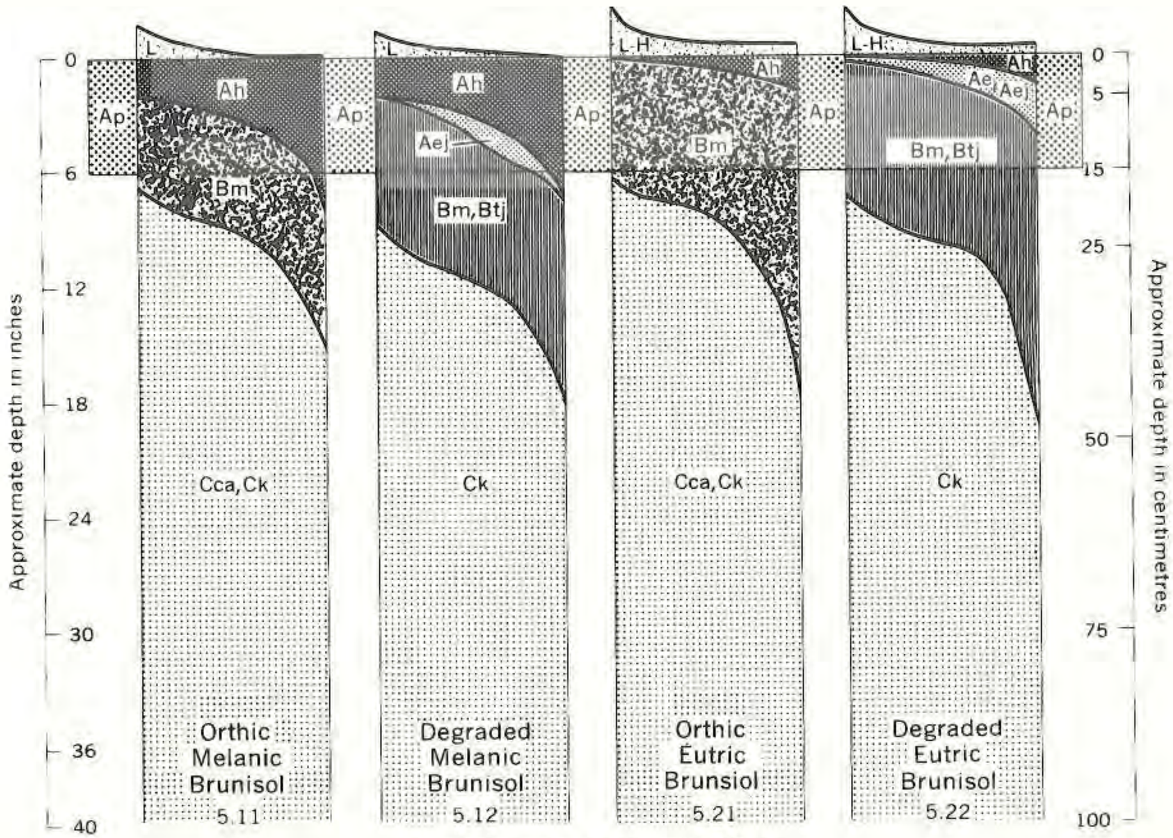


A B C D

Fig. 19. Soil monoliths representative of certain Brunisolic soils: (a) Orthic Melanic Brunisol, (b) Orthic Eutric Brunisol, (c) Degraded Eutric Brunisol, and (d) Degraded Dystric Brunisol.

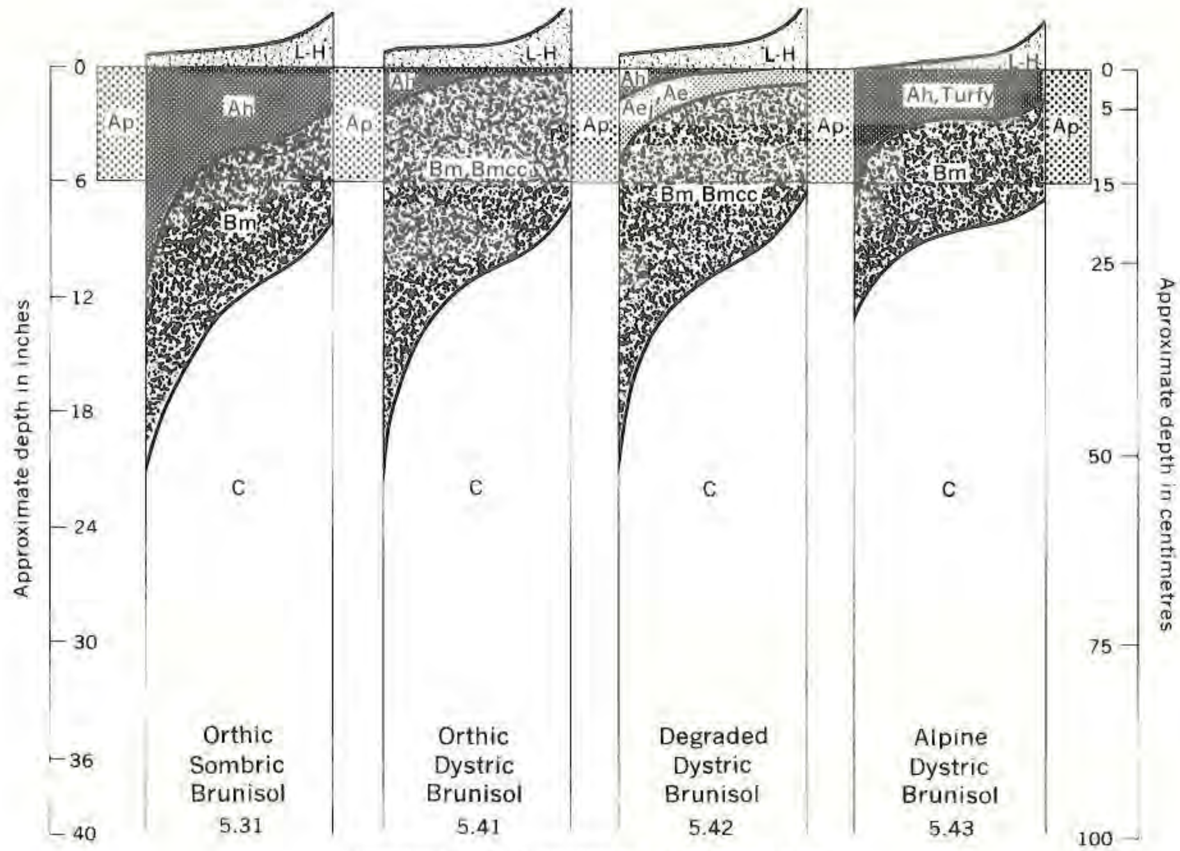
A B C D

Fig. 19. Soil monoliths representative of certain Brunisolic soils: (a) Orthic Melanic Brunisol, (b) Orthic Eutric Brunisol, (c) Degraded Eutric Brunisol, and (d) Degraded Dystric Brunisol.



Brunisolic soils of high base status

SRI



Brunisolic soils of moderate to low base status.

Fig. 20. A diagrammatic horizon pattern of representative Brunisolic profiles.

SRI

Great Group	*Subgroup*	
5.1 Melanic Brunisol	5.11	Orthic Melanic Brunisol
	5.12	Degraded Melanic Brunisol
	5.1-/8	Gleyed Melanic Brunisol
	5.1-/9	Lithic Melanic Brunisol
5.2 Eutric Brunisol	5.21	Orthic Eutric Brunisol
	5.22	Degraded Eutric Brunisol
	5.23	Alpine Eutric Brunisol
	5.2-/7	Cryic Eutric Brunisol
	5.2-/8	Gleyed Eutric Brunisol
	5.2-/9	Lithic Eutric Brunisol
5.3 Sombric Brunisol	5.31	Orthic Sombric Brunisol
	5.31/8	Gleyed Sombric Brunisol
	5.31/9	Lithic Sombric Brunisol
5.4 Dystric Brunisol	5.41	Orthic Dystric Brunisol
	5.42	Degraded Dystric Brunisol
	5.43	Alpine Dystric Brunisol
	5.4-/7	Cryic Dystric Brunisol
	5.4-/8	Gleyed Dystric Brunisol
	5.4-/9	Lithic Dystric Brunisol

5. BRUNISOLIC ORDER

This order consists of soils with sola indicative of good to imperfect drainage or of good to moderate oxidizing conditions which have developed under forest, mixed forest and grass, grass and fern, or heath and tundra vegetation associations representative of forest, alpine, or tundra communities. Under virgin conditions, they may have organic surface horizons (L H) and Ah horizons. They may also have weakly developed (salt and pepper Aej) or strongly developed (Ae) eluvial horizons. All have a brownish or structured Bm, but none have a Bt (textural) or a podzolic B horizon.

5.1 MELANIC BRUNISOL

These are Brunisolic soils that, under virgin conditions, generally lack F and H horizons. They have mineral-organic (Ah) surface horizons thicker than 2 inches (5 cm), which have developed primarily from the incorporation of plant residues into the soil through the action of soil fauna, principally earthworms. The Ah horizons have granular (mull) structure promoted by the intimate mixing of humus and clay.

The Melanic Brunisols have Bm horizons in which the base

5.41 Orthic Dystric Brunisol

Profile type: L–H or Ap, Bm or Bmcc, (C)

These are Dystric Brunisols that, under virgin conditions, have organic surface horizons (L–H), over Bm horizons. The Bm horizons usually have chromas of 3 or more. Between the B and C the chroma difference is greater than 1 or there is a shift to a more yellowish hue in the C. The Bm horizons may contain concretions.

Ap horizons 6 inches (15 cm) thick have color values greater than 3.5 moist or 4.5 dry, and the chromas are usually 3 or more when dry.

The Ap horizon is usually underlain by a Bm horizon. If there are no remnants of a Bm horizon underneath the Ap horizon, these cultivated soils should be classified as Regosols. (This subgroup includes remnants of the former 4.31–Acid Brown Wooded, and 4.51–Orthic Concretionary Brown.)

5.42 Degraded Dystric Brunisol

Profile type: L–H or Ap, Aej or Ae, Bm or Bmcc, (C)

These are Dystric Brunisols that have either an Aej or Ae horizon and a Bm horizon that contains insufficient illuvial material to meet the requirements of the podzolic B. The Ap horizon may have low chroma if it consists mostly of Ae material. (This subgroup includes remnants of the former 4.32–Degraded Acid Brown Wooded, and 5.21–Arenic Podzo Regosol.)

5.43 Alpine Dystric Brunisol

Profile type: (L–H), Ah, Bm, (C)

These are Dystric Brunisols that have thin organic surface layers (L–H) and moderately thick turfy Ah horizons over Bm horizons.

The parent materials of these soils are moderately acidic and of medium to coarse texture. The cation exchange capacity and base saturation are low. There is no visual evidence of translocation of mineral elements in the profile. Frost processes and downslope movement are active.

These soils have developed in the forest–alpine transitional areas of the Cordillera. With increasing grass cover (higher elevations) the Ah horizons become thicker and more turfy, but with decreasing grass cover and increasing forest cover (lower elevations) the Ah horizons become thinner and less turfy. (This subgroup includes the former 4.6–Alpine Brown on acidic parent material.)

5.4-/7 Cryic Dystric Brunisol

These are Dystric Brunisols having within the control section [40 inches (100 cm)] a permanently frozen layer or a layer in which the

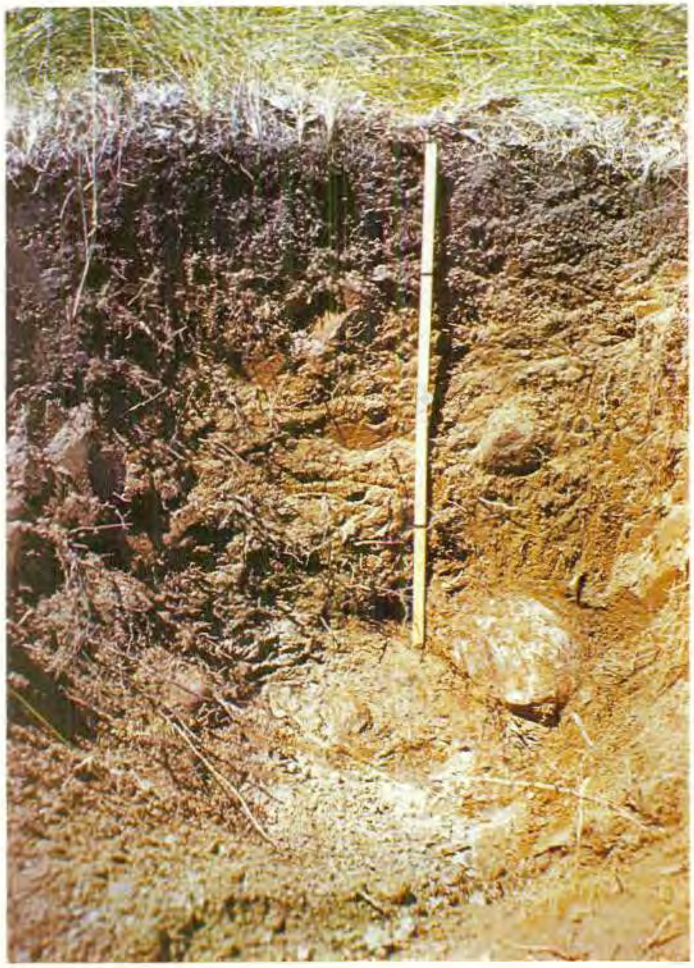


Fig. 21. An Orthic Melanic Brunisol.

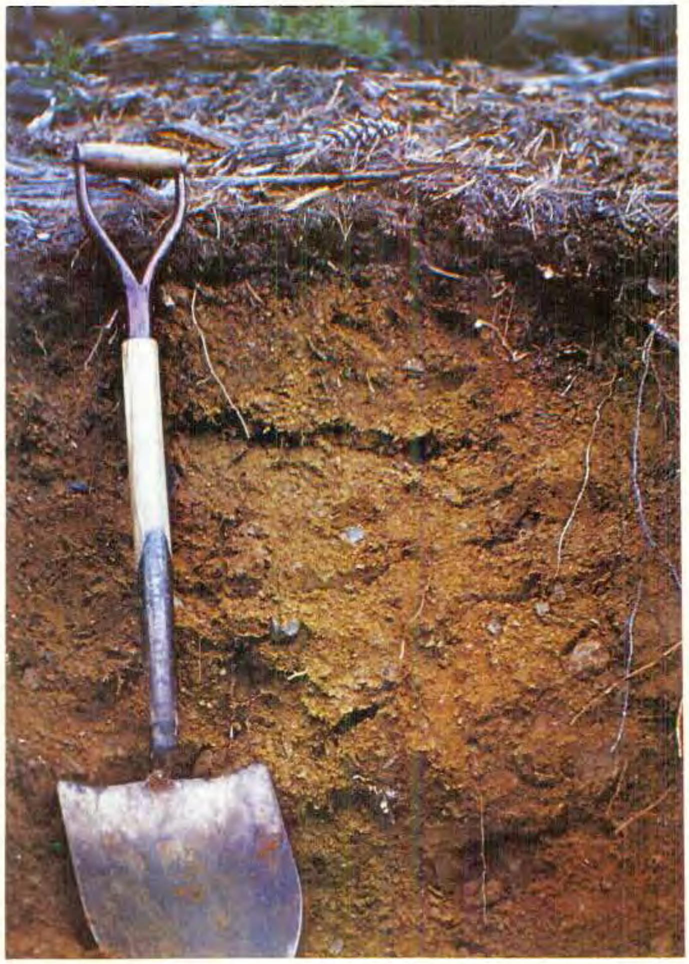


Fig. 22. A Degraded Dystric Brunisol.

temperature is 0 C or lower 2 months after the summer solstice (August 21).

5.4-/8 Gleyed Dystric Brunisol

These are Dystric Brunisols with mottling and usually duller matrix colors in the B horizon than in the associated orthic soils. However, gleyed concretionary Bm horizons usually have higher chroma than the Bm and the Ap tends to be somewhat darker than those in the orthic types.

5.4-/9 Lithic Dystric Brunisol

These are Dystric Brunisols with a lithic contact between 4 and 20 inches (10 and 50 cm) from the mineral surface.

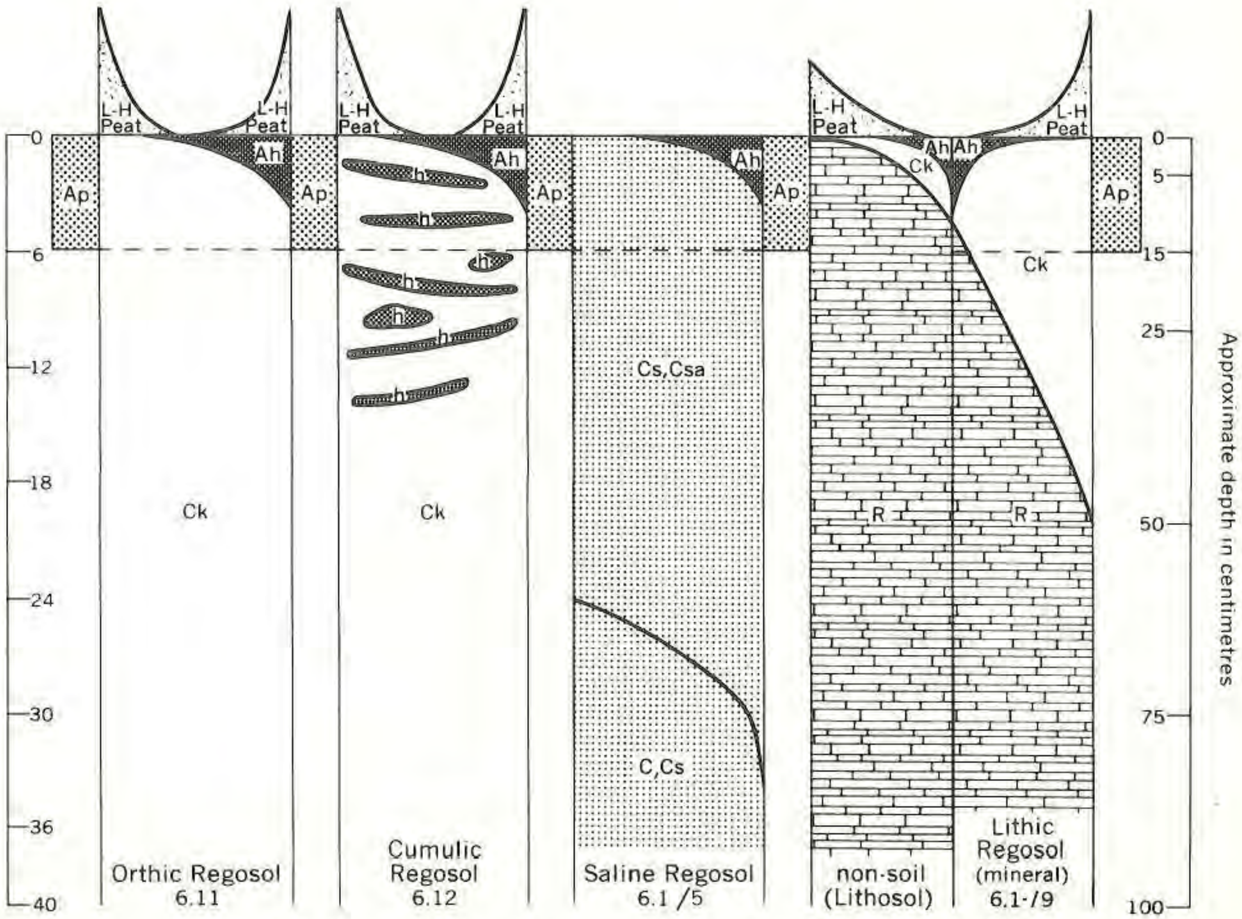


Fig. 23. A diagrammatic horizon pattern of representative Regosolic profiles.

REGOSOLIC ORDER

Great Group		*Subgroup*
6.1 Regosol	6.11	Orthic Regosol
	6.12	Cumulic Regosol
	6.1-/5	Saline Regosol
	6.1-/7	Cryic Regosol
	6.1-/8	Gleyed Regosol
	6.1-/9	Lithic Regosol

6. REGOSOLIC ORDER

These are well- and imperfectly drained mineral soils with good to moderate oxidizing conditions, having horizon development too weak to meet the requirements of soils in any other order. Soils with nonchernozemic[1] Ah horizons may be included.

6.1 REGOSOL

Only one great group has been established, therefore its definition is the same as that of the order.

6.11 Orthic Regosol

Profile type: (L–H), (Ah), Ck or C

These soils have from the surface, or below any nonchernozemic Ah horizon, color values that are uniform with depth, or color values that increase gradually to the depth of the control section [40 inches (100 cm)]. The organic matter content usually decreases regularly with depth. The soils lack soluble salts, gleying, permafrost, and a lithic contact within the control section.

6.12 Cumulic Regosol

Profile type: C, Ahb, C or Ck; Ah, C, Ahb, C or Ck

These soils have from the surface, or below any nonchernozemic Ah horizon, color values that vary by one or more units with depth in the control section. The organic matter content usually decreases irregularly with depth. The soils lack soluble salts, gleying, permafrost, and a lithic contact within the control section.

6.1-/5 Saline Regosol

These are Regosolic soils that have salinity exceeding 4 mmhos/cm in a layer or layers within 24 inches (60 cm) of the surface, or salinity

[1] See definition of Chernozemic A horizon included in the description of the Chernozemic order.

exceeding 6 mmhos/cm between 24 and 40 inches (60 and 100 cm) from the surface if the soil above is nonsaline (< 4 mmhos/cm).

6.1-/7 Cryic Regosol

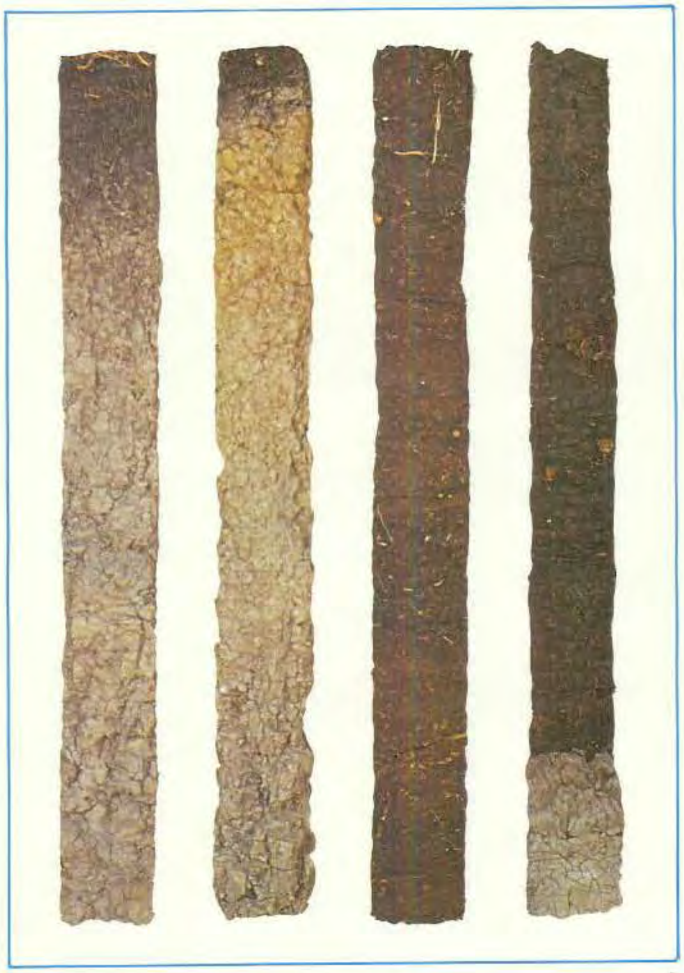
These are Regosolic soils with a permanently frozen layer or layers in which the temperature within the control section is 0 C or lower 2 months after the summer solstice (August 21).

6.1-/8 Gleyed Regosol

These are Regosolic soils with mottling and dull colors within 20 inches (50 cm) of the surface.

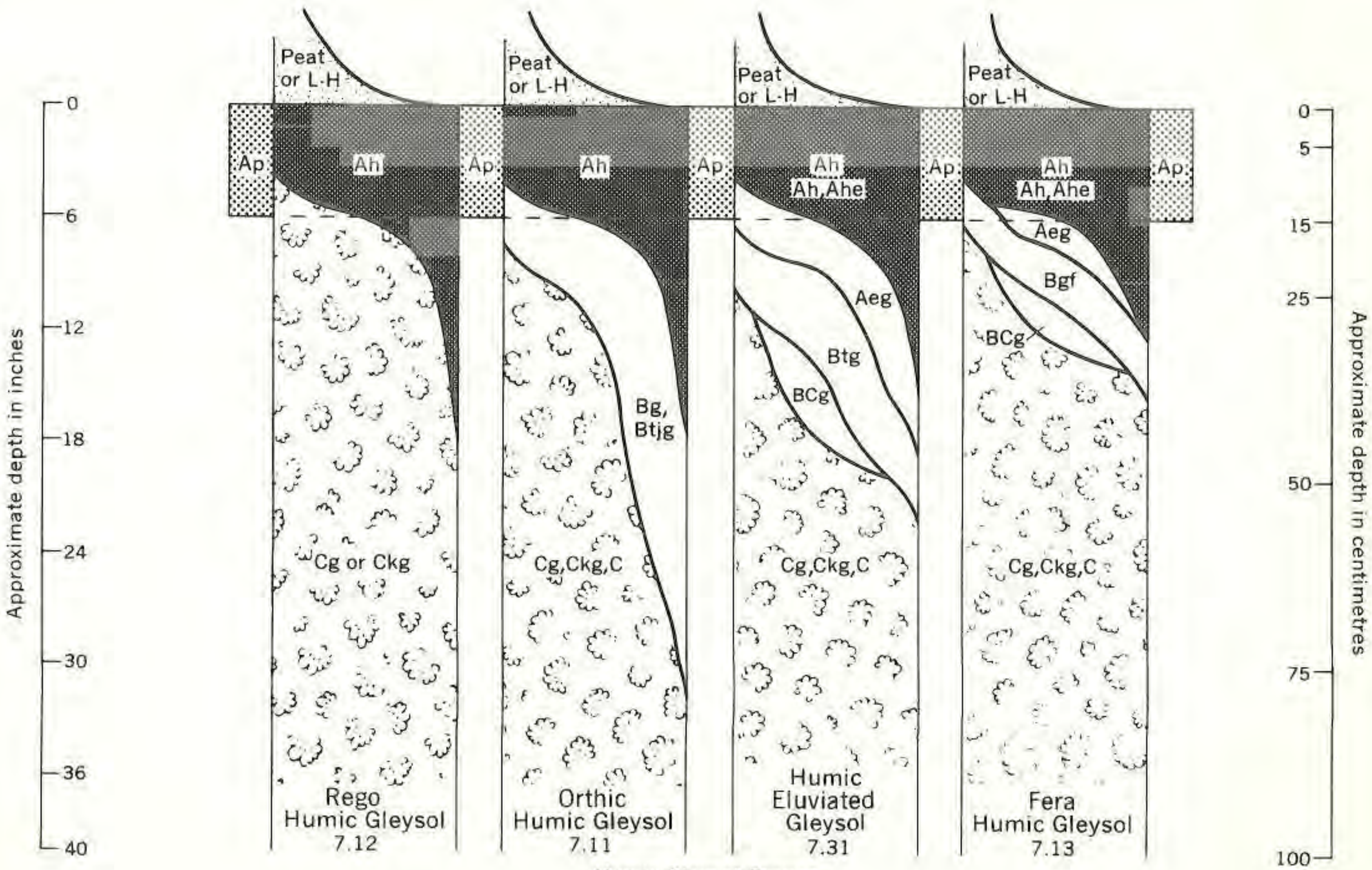
6.1-/9 Lithic Regosol

These are Regosolic soils that have a lithic contact at a depth greater than 4 inches (10 cm) but less than 20 inches (50 cm) below the mineral soil surface.



A B C D

Fig. 24. Soil monoliths representative of certain Gleysolic and Organic soils: (a) Orthic Humic Gleysol, (b) Orthic Gleysol, (c) Terric Mesisol, and (d) Sphagno-Fibrisol.



Humic Gleysol Groups

SRI

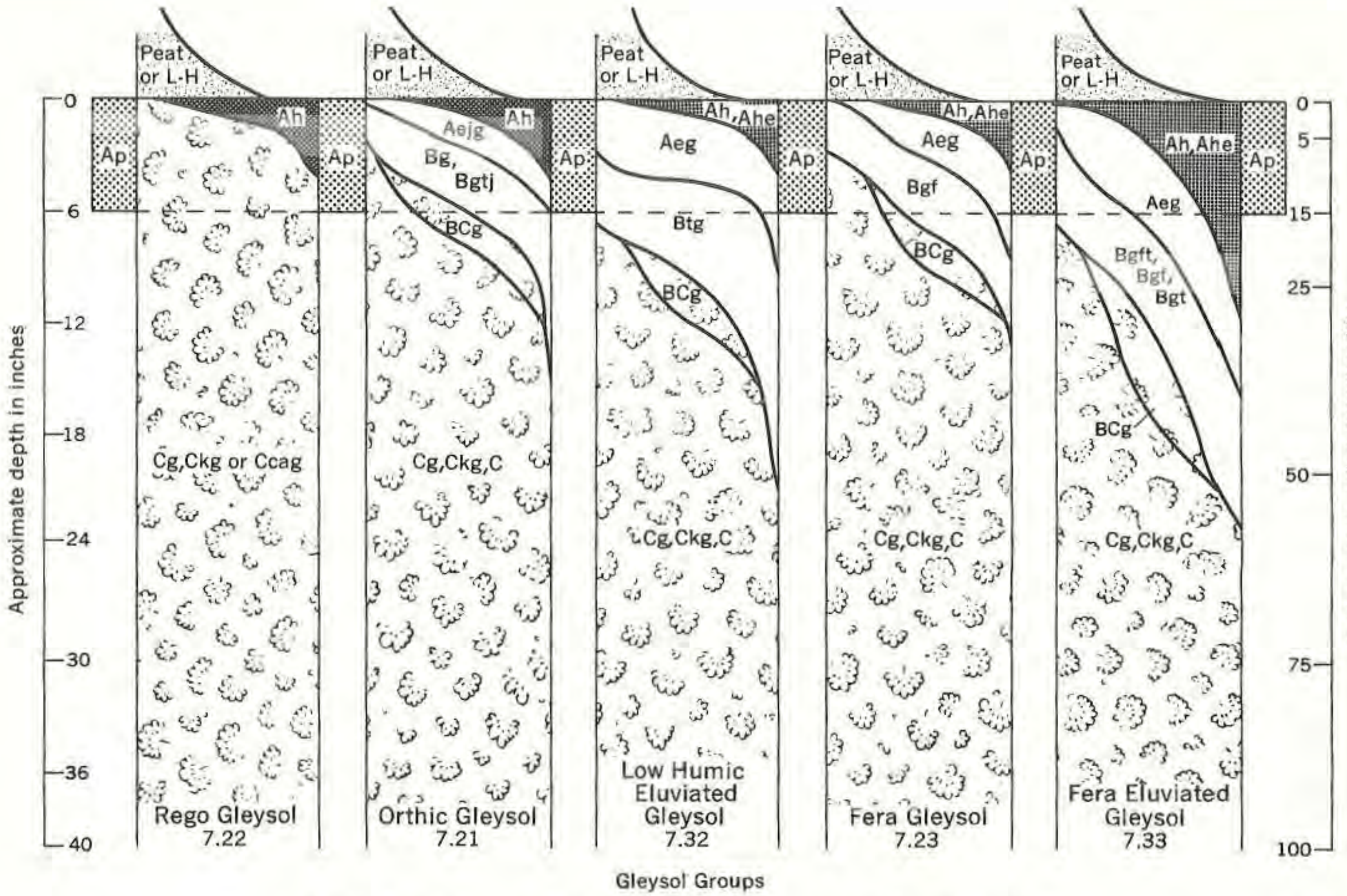


Fig. 25. A diagrammatic horizon pattern of representative Gleysolic profiles.

SRI

Great Group	*Subgroup*	
7.1 Humic Gleysol	7.11	Orthic Humic Gleysol
	7.12	Rego Humic Gleysol
	7.13	Fera Humic Gleysol
	7.1-/5	Saline Humic Gleysol
	7.1-/6	Carbonated Humic Gleysol
	7.1-/7	Cryic Humic Gleysol
	7.1-/9	Lithic Humic Gleysol
7.2 Gleysol	7.21	Orthic Gleysol
	7.22	Rego Gleysol
	7.23	Fera Gleysol
	7.2-/5	Saline Gleysol
	7.2-/6	Carbonated Gleysol
	7.2-/7	Cryic Gleysol
	7.2-/9	Lithic Gleysol
7.3 Eluviated Gleysol	7.31	Humic Eluviated Gleysol
	7.32	Low Humic Eluviated Gleysol
	7.33	Fera Eluviated Gleysol
	7.3-/9	Lithic Eluviated Gleysol

7. GLEYSOLIC ORDER

These soils are saturated with water and are under reducing conditions continuously or during some period of the year, unless they are artificially drained. As a result of the reducing conditions they have matrix colors of low chroma within 20 inches (50 cm) of the mineral surface. They may have distinct or prominent mottles of high chroma, presumably as a result of localized oxidation of ferrous iron and the deposition of hydrated ferric oxides. They have, within 20 inches (50 cm) of the surface, a horizon or horizons at least 4 inches (10 cm) thick with dominant moist colors as follows:

a) Chromas of 1 or less, without mottles, on ped surfaces or in the matrix if peds are lacking; or
b) Chromas of 2 or less, in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by prominent mottles; or
c) Chromas of 3 or less, in hues yellower than 10YR, on ped surfaces or in the matrix if peds are lacking, accompanied by prominent mottles; or
d) Hues bluer than 10Y, with or without mottles, on ped surfaces or in the matrix if peds are lacking.

These soils have developed under hydrophytic vegetation and they may be expected to support hydrophytic vegetation if left undisturbed. They may have an organic surface layer of less than 16 inches (40 cm) of mixed peat (bulk density greater than 0.1) or up to 24 inches (60 cm) of fibric moss peat (bulk density less than 0.1). They may have A and B horizons.

The color criteria listed are tentative because they have not been checked on enough soils. However, color is the most useful indicator of the oxidation-reduction status of a soil. Some accessory properties that may help to identify some of these soils are:

1) Saturation to the surface for a month or more while the soil is not frozen
2) Organic surface layers
3) Hydrophytic vegetation
4) Position in the landscape–undrained depressions in subhumid regions and level areas in humid regions.

An Eh of less than 100 mv within the upper 20 inches (50 cm) for a period of a week or more is a possible chemical criterion for these soils, but little information is available.

The inclusion of "under reducing conditions" in the definition of the order is necessary because some soils that are saturated with water for a month or more each year are not gleyed. Two examples are soils on slopes that are saturated with aerated water, and some soils in depressions that are flooded only in the spring when the temperature is only a few degrees above freezing. Temperatures high enough (above about 5 C) to permit microbial activity and hence depletion of oxygen are thought to be essential to the gley process. Some Podzols and Humic Podzols are saturated with water for several months each year, yet they are not considered to be Gleysolic soils.

7.1 HUMIC GLEYSOL

These are Gleysolic soils that, when virgin, have an Ah horizon more than 3 inches (8 cm) thick. When cultivated to a depth of 6 inches (15 cm), they have an Ap layer with more than 3% organic matter and a rubbed color value as follows:

a) 3.5 or lower moist, or 5.0 or lower dry; and
b) At least 1.5 units of value (moist) lower than that of the next underlying horizon, either B or C, if the value of the underlying horizon is 4 or more; or
c) At least 1 unit (moist) lower than that of the next underlying horizon if the value of the underlying horizon is less than 4.

Examples of color values of cultivated soils:

Ap / B or C	3.5 or less / 5.0	or	2.0 or less / 3.0

All the subgroups may have organic surface layers, up to 16 inches (40 cm) of mixed peat with bulk density greater than 0.1, or up to 24 inches (60 cm) of fibric moss peat with bulk density less than 0.1.

7.11 Orthic Humic Gleysol

Profile type: (L-H), Ah, (Ahe), (Aeg), Bg or Btjg, (Cg) or (C) or (Ckg), etc.

These are Humic Gleysols with a noneffervescent[1] Ah horizon or Ap layer with a gleyed B horizon. They lack the characteristics specified below for Saline, Cryic, and Lithic subgroups. The C horizon may appear to be strongly gleyed.

7.12 Rego Humic Gleysol

Profile type: (L-H), Ah, Cg or Ckg or Ccag

These are Humic Gleysols with a noneffervescent[1] Ah horizon or Ap layer, and without a B horizon. They lack the characteristics specified below for Saline, Cryic, and Lithic subgroups.

7.13 Fera Humic Gleysol

Profile type: (L-H), Ah, (Ahe), (Aeg), Bgf, (BCg), (Cg) or (Cgj) or (C) or (Ckg), etc.

These are Humic Gleysols with a noneffervescent[1] Ah horizon or Ap layer. They also have a B horizon with many prominent mottles of high chroma, an accumulation of dithionite-extractable iron[2] (at least 1% more dithionite Fe than the IC horizon), and little or no accumulation of dithionite-extractable Al (dithionite Al in the B horizon exceeds that in the IC horizon by less than 0.5%). They lack the characteristics specified below for Saline, Cryic, and Lithic subgroups.

7.1-/5 Saline Humic Gleysol

These are Humic Gleysols with saline horizons as specified:

a) The conductivity of the saturation extract of a horizon within 24 inches (60 cm) of the surface exceeds 4 mmhos/cm; or
b) The conductivity of the saturation extract of a horizon between 24 and 48 inches (60 and 120 cm) from the surface exceeds 6 mmhos/cm, if the soil above is nonsaline (< 4 mmhos/cm).

[1] No effervescence with 1 N HCl.
[2] The method of Mehra and Jackson. 1960. 7th Nat. Conf. on Clays and Clay Minerals. p. 317-327.

7.2-/7 Cryic Gleysol

These are Gleysols with permafrost (z) within 40 inches (1 m) of the mineral surface.

7.2-/9 Lithic Gleysol

These are Gleysols with a lithic contact between 4 and 20 inches (10 and 50 cm) from the mineral surface.

7.3 ELUVIATED GLEYSOL

These are Gleysolic soils with Aeg and Btg horizons. All the subgroups may have organic surface layers as specified for 7.1 and

7.32 Low Humic Eluviated Gleysol

Profile type: (L-H), (Ah), (Ahe), Aeg, Btg, (BCg), (Cg) or (Cgj) or (C) or (Ckg), etc.

These are Eluviated Gleysols without an Ah horizon or with an Ah or Ap horizon as specified for 7.2, and with Aeg and Btg horizons. They do not have lithic layers.

7.33 Fera Eluviated Gleysol

Profile type: (L-H), (Ah), (Ahe), Aeg, Bgft or Bgf and Btg, (BCg), (Cg) or (Cgj) or (C) or (Ckg), etc.

These are Eluviated Gleysols having a B horizon with many prominent mottles of high chroma, an accumulation of dithionite-extractable Fe (at least 1% more dithionite Fe than the C horizon), and little or no accumulation of dithionite-extractable Al (dithionite Al in the B horizon exceeds that in the C horizon by less than 0.5%). They do not have lithic layers.

7.3-/9 Lithic Eluviated Gleysol

These are Eluviated Gleysols with a lithic contact between 4 and 20 inches (10 and 50 cm) from a mineral surface.

Note: Peaty phases

As specified, Gleysolic soils may have up to 24 inches (60 cm) of fibric moss peat or 16 inches (40 cm) of mixed peat at the surface. Peaty soils are no longer separated from other soils at the subgroup level. Gleysolic soils having 6 to 16 inches (15 to 40 cm) of mixed peat or 6 to 24 inches (15 to 60 cm) of fibric moss peat may be designated as peaty phases of the appropriate subgroups.

Fig. 26. A Rego Humic Gleysol.

Fig. 27. A Typic Mesisol.

To facilitate the understanding of the classification system of organic soils, definitions of the control section, tiers and layers, and morphological features and nomenclature as used in the classification are first presented.

CONTROL SECTION

The control section refers to the part of the soil that is considered in the classification of organic soils. The thickness of the control section is variable; it depends on the type of organic layer at the surface and on the presence of lithic or hydric layers at shallow depths. It is assumed to include the zone of maximum microbiological activity.

The thickness of the control section in organic soils is:

a) 64 inches (160 cm) if there is on the surface 24 inches (60 cm) or more of fibric organic material (of which more than 75% of the fiber volume is derived from *Sphagnum* spp.), or
b) 52 inches (130 cm) if there is on the surface less than 24 inches (60 cm) of fibric organic material (of which more than 75% of the fiber volume is derived from *Sphagnum* spp.) or more than 16 inches (40 cm) of other kinds of organic material, or
c) To any lithic contact that occurs below a depth of 4 inches (10 cm) but shallower than either a) or b), or
d) To any hydric contact that occurs below a depth of 16 inches (40 cm) but shallower than either a) or b) if the water extends to a depth greater than 52 or 64 inches (130 or 160 cm).

TIERS AND LAYERS

For classification purposes the control section has three tiers, surface, middle, and bottom, each of which may have one or more kinds of layers. The tiers and layers are as follows:

Surface Tier

The surface tier, exclusive of loose litter or living mosses, is 24 inches (60 cm) thick if there is on the surface 24 inches or more of fibric organic material (more than 75% of the fiber volume being derived from *Sphagnum* spp.); or it is 12 inches (30 cm) thick if there is on the surface less than 24 inches of fibric organic material of the kind described above or of other kinds or mixed kinds of organic material (less than 75% of the fiber volume being derived from *Sphagnum* spp.), or it extends to a lithic contact if deeper than 4 inches (10 cm) but shallower than 12 inches (30 cm) or 24 inches (60 cm).

A surface mineral horizon less than 16 inches (40 cm) in thickness, if present, is considered a part of the surface tier.

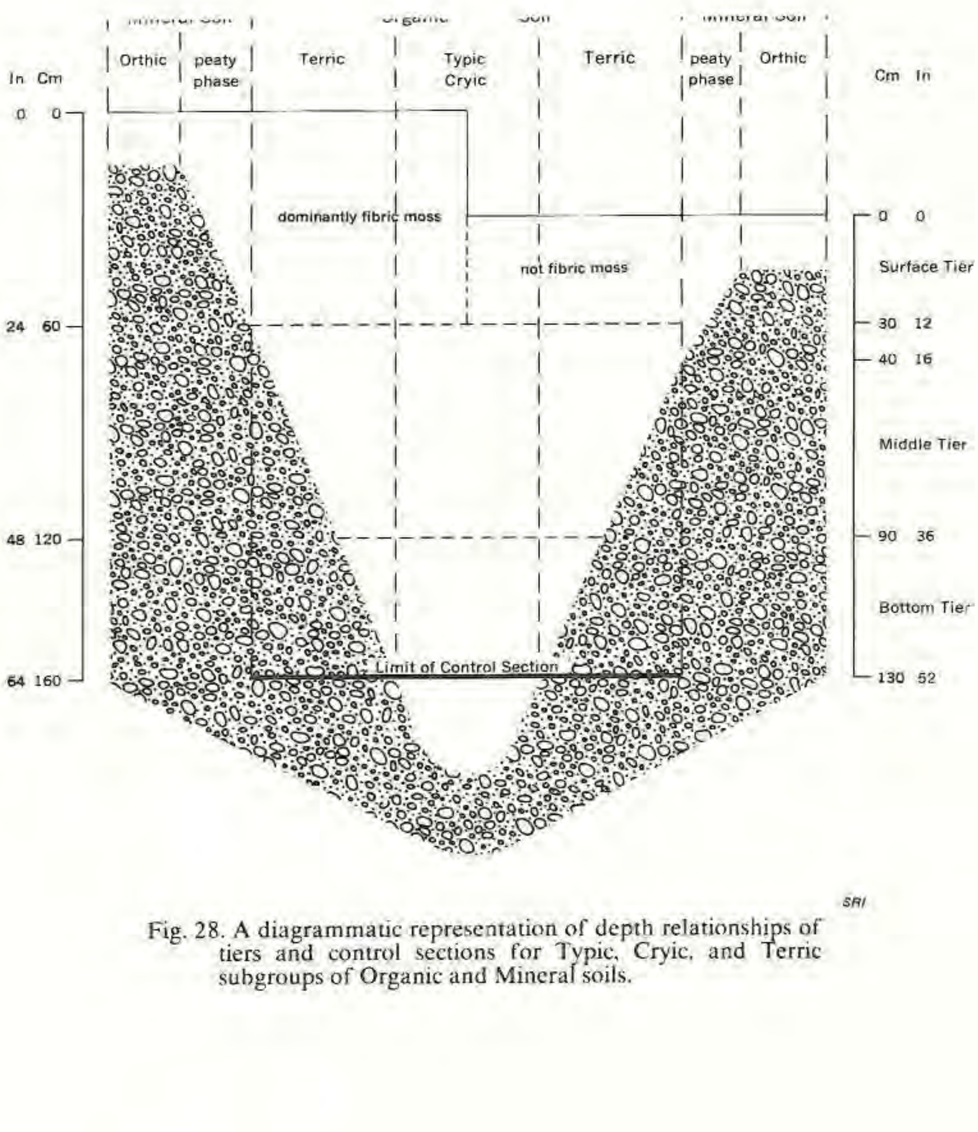


Fig. 28. A diagrammatic representation of depth relationships of tiers and control sections for Typic, Cryic, and Terric subgroups of Organic and Mineral soils.

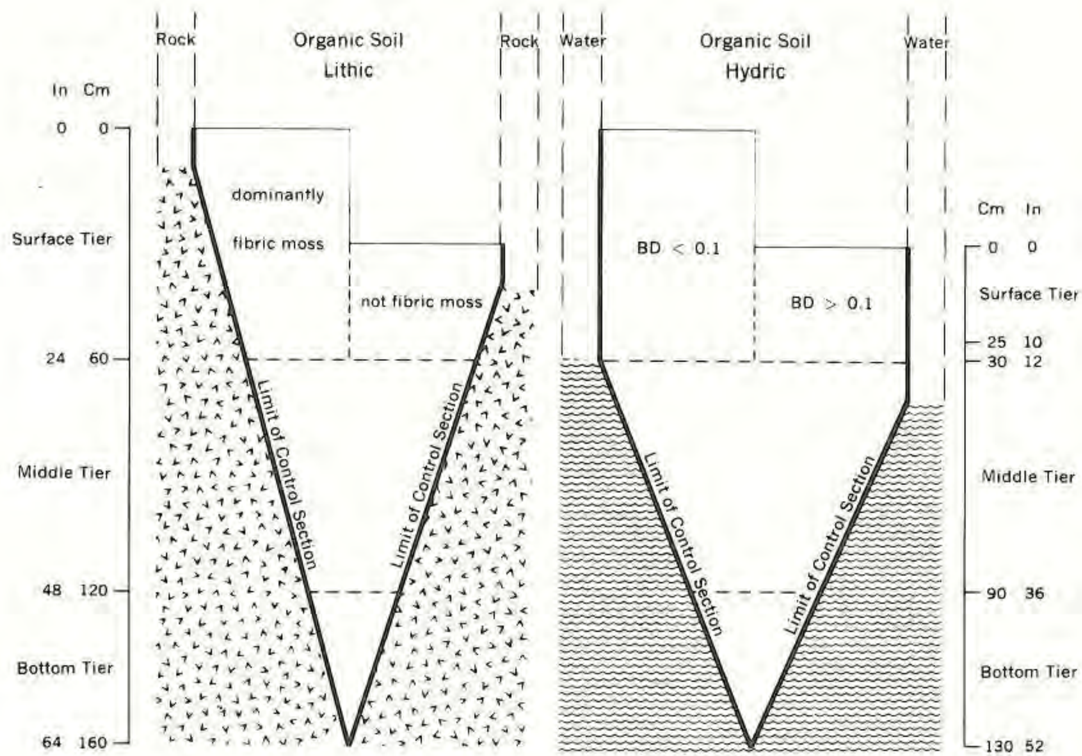


Fig. 29. A diagrammatic representation of depth relationships of tiers and control sections for Lithic and Hydric subgroups of Organic soils.

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Middle Tier

The middle tier is 24 inches (60 cm) thick, or extends to any lithic or hydric contact. This tier establishes the great group classification if no terric, lithic, hydric, or cryic substratum is present. If any substratum is present the dominant kind of organic material in this and the surface tier establishes the great group classification.

Bottom Tier

The bottom tier is 16 inches (40 cm) thick or extends to a lithic or hydric contact that occurs within a depth of between 36 and 52 inches (90 and 130 cm) or between 48 and 64 inches (120 and 160 cm). This tier may include unconsolidated mineral material, but it does not include rock or water (see definition of hydric layer). The material in this tier establishes or assists in establishing the subgroup classification.

Diagnostic Layers

Fibric—The fibric layer is the least decomposed of all of the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin.

A fibric layer has (i) a rubbed fiber content of more than 4/10 of the organic volume, and (ii) an unrubbed fiber content of more than 2/3 of the organic volume. Also, if the rubbed fiber content is less than 6/10 of the organic volume it yields a sodium pyrophosphate extract color, on white filter paper, that is 7/1, 7/2, 8/1, 8/2, or 8/3.

This material usually has a bulk density of less than 0.1 g/cc and a maximum saturated water-holding capacity ranging from 850 to over 3,000% on an ovendry basis.

The Fibric subgroup name is used alone or in combination only with Terric. Terric Fibric is given precedence over Cumulo.

Mesic—The mesic layer is the intermediate stage of decomposition. The material has intermediate amounts of fiber, medium bulk density, and medium saturated water-holding capacity. The material is partly altered both physically and biochemically.

A mesic layer has (i) a rubbed fiber content of more than 1/10 if the unrubbed fiber content is between 1/3 and 2/3 of the organic volume, or (ii) a rubbed fiber content of between 1/10 and 4/10 if the unrubbed fiber content is greater than 2/3 of the organic volume, or (iii) a rubbed fiber content of between 1/10 and 4/10 and yields a sodium pyrophosphate extract color, on white filter paper, of 5/1, 6/1, 6/2, 7/3, 8/4, 8/6, 8/8. Usually this mesic material has a bulk density between 0.1 and 0.2 g/cc and a maximum saturated water-holding capacity between 450 and 850% on an ovendry basis.

The Mesic subgroup name is used alone or in combination only with Terric. Terric Mesic is given precedence over Cumulo.

Humic—The humic layer is the most highly decomposed of the organic soil materials. It has the least amount of plant fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes little physically and chemically with time, in comparison with the others.

A humic layer (i) has a rubbed fiber content of less than 1/10 of the organic volume, and (ii) yields a sodium pyrophosphate extract color on white filter paper that is below or to the right of a line drawn to exclude 5/1, 6/2, and 7/3 on 7.5YR or 10YR hue.

This humic material usually has a bulk density of more than 0.2 g/cc and a maximum saturated water-holding capacity of less than 450% on an ovendry basis.

The Humic subgroup name is used alone or in combination only with Terric. Terric Humic is given precedence over Cumulo.

The sodium pyrophosphate extract color separations are shown in the sketch of the 10YR Munsell color chart.

Other Layers

Typic—This is a dominantly mesic or humic layer throughout the middle and bottom tiers. The control section lacks any terric, lithic, hydric, cryic, cumulo, or limno layers. It is used alone and only in the Mesisol and Humisol great groups.

Fenno—This is a dominantly fibric layer, derived from rushes, reeds, and sedges throughout the middle and bottom tiers. The control section is 52 or 64 inches (130 or 160 cm) deep and lacks any terric, lithic, hydric, cryic, cumulo, or limno layers. It is used alone and only in the Fibrisol great group.

Silvo—This is a dominantly fibric layer, derived from wood, moss (less than 75% of the volume consisting of *Sphagnum* spp.) and other herbaceous plants, throughout the middle and bottom tiers. The control section is 52 or 64 inches (130 or 160 cm) deep and lacks any terric, lithic, hydric, cryic, cumulo, or limno layers. It is used alone and only in the Fibrisol great group.

Sphagno—This is a dominantly fibric layer, derived from *Sphagnum* spp. throughout the middle and bottom tiers. The control section is 52 or 64 inches (130 or 160 cm) deep and lacks any terric, lithic, hydric, cryic, cumulo, or limno layers. It is used alone and only in the Fibrisol great group.

Limno—This is a layer or layers 2 inches (5 cm) thick or more of coprogenous earth (sedimentary peat), diatomaceous earth, or marl. Except for some of the coprogenous earths containing more than 30% organic matter, most of these limnic materials are inorganic in composition.

Coprogenous earth has 50% or more by volume of fecal pellets less than a few tenths of a millimeter in diameter and dry color values less than 5. It has slightly viscous water suspensions, is slightly plastic but not sticky, and shrinks upon drying to form clods that are difficult to rewet and often tend to crack along horizontal planes. It has very few or no plant fragments recognizable to the naked eye and has sodium pyrophosphate extracts higher in value and lower in chroma than 10YR 7/3, or the cation exchange capacity (CEC) is less than 240 meq per 100 g organic matter.

Diatomaceous earth has a matrix color value of 4 ± 1, if not previously dried, that changes on drying to the permanent, light gray or whitish color of diatoms, which can be identified by microscopic (440 ×) examination. Also, it has a saturated sodium pyrophosphate extract color on white filter paper that is higher in value and lower in chroma than 10YR 7/3. The layers are frequently more nearly mineral than organic in composition.

Marl has a moist color value of 6 ± 1 and effervesces with dilute HCl. It usually does not change matrix color upon drying and consequently there is no permanent color change. Marl contains too little organic matter to coat the carbonate particles.

The Limno subgroup name is used alone and is given precedence over Fibric, Mesic, Humic, or Cumulo.

Cumulo—This consists of multiple layers of mineral material (alluvium) together more than 2 inches (5 cm) thick or one layer 2 to 12 inches (5 to 30 cm) thick. One continuous mineral layer more than 12 inches (30 cm) thick in the middle or bottom tier is a terric layer.

The Cumulo subgroup name is used alone and is given precedence over Fibric, Mesic, or Humic.

Cryic—This is a permanently frozen layer, or a layer in which the temperature is 0 C or lower in the control section 2 months after the summer solstice (August 21).

The Cryic subgroup name is used alone and is given precedence over Cumulo, Terric, Fibric, Mesic, Humic, and Limno.

Terric—This is an unconsolidated mineral substratum not underlain by organic matter, or one continuous unconsolidated mineral layer (with less than 30% organic matter) more than 12 inches (30 cm) thick in the middle or bottom tiers underlain by organic matter, within a depth of 52 or 64 inches (130 or 160 cm) from the surface.

The Terric subgroup name is used alone or in combination only with Fibric, Mesic, or Humic. It is given precedence over Limno or Cumulo.

Lithic—This is a consolidated mineral layer (bedrock) occurring within a depth of between 4 inches (10 cm) and 52 or 64 inches (130 or 160 cm) from the surface.

The Lithic subgroup name is used alone and is given precedence over Fibric, Mesic, Humic, Limno, Cumulo, and Terric.

Hydric—This consists of a layer of water that extends from a depth of not less than 16 inches (40 cm) or 24 inches (60 cm) to a depth of more than 52 inches (130 cm) or 64 inches (160 cm).

The Hydric subgroup name is used alone.

MORPHOLOGICAL FEATURES AND NOMENCLATURE

To characterize organic soils adequately, their morphology should be described as thoroughly and quantitatively as possible. Morphological features that seem most important in descriptions follow.

Layer Thickness

Cryic organic soils usually have very irregular surfaces with small or large mounds of variable vertical and horizontal dimensions. If the mounds are organic and are so closely spaced that the pedons are less than 5 m^2, the soil should be classified as though the mounds had been leveled. If the mounds are mineral or are so widely spaced that they do not occur in each pedon of 5 m^2, the soils should be classified as they now exist.

Definition of Size of Fibers

Fibers are the organic materials retained on a 100-mesh sieve (0.15 mm diameter), except for wood fragments that cannot be crushed in the hand and are larger than ¾ inch (2 cm) in the smallest dimension. Reed and rush fragments retained on the sieve should be picked out and weighed separately.

Content of Fiber, Pyrophosphate Test, and pH in $CaCl_2$

The amount of fiber and its durability (as measured by destruction on rubbing) are the most important characterizing and differentiating features among different kinds of organic soils. The fiber content for the undisturbed and rubbed states should be estimated in a moist to wet condition; if the soil is dry, it should be moistened.

For the undisturbed or unrubbed estimate, a fragment of the layer is broken in the vertical direction and an area of at least 4 sq inches (25 cm^2) is scanned with the aid of a 10 × hand lens. With practice, fiber content can be estimated to the nearest 5 to 10%. Horizontal planes should be avoided when making the estimate because they may be cleavage faces that have a concentration of certain size of fibers.

To determine the content of fiber after rubbing, a fragment of the layer is rubbed between the thumb and forefinger about ten times or a fragment is macerated with a knife blade in the palm about ten times using very firm pressure. The material is then molded into a ball, broken in half, and the broken face is observed with a lens to estimate the fiber content. Skill in estimating the correct fiber content, as with hand texturing, is enhanced by comparing the estimate with a laboratory-determined value.

The determination of fiber content and pyrophosphate solubility is easily performed in the laboratory or wherever tapwater is available, using a 5- or 6-ml plastic hypodermic syringe modified to make a measuring device.

The syringe is modified by cutting away half of the cylinder wall, in a longitudinal direction, between the 0- and 6-ml marks. The plunger end, the needle end, and the piston are not altered in any way. Only syringes that have calibration marks embedded in the plastic are suitable for extended use.

The procedures for preparing the sample and for determination of unrubbed and rubbed fiber, pyrophosphate solubility, and pH follow.

1. *Preparation of sample*

Place about 25 cm^3 of sample on a strip of paper towel, forming the sample into a cigar shape. Roll up in the paper towel and squeeze lightly to express surplus water, that is, dry the sample until it does not glisten but is still very moist. Unroll and, using scissors, cut the sample into 0.5-cm lengths. Mix the cut pieces to ensure representative subsamples.

2. *Determination of unrubbed fiber content*

2.1 Pack the modified syringe adjusted to 5 cm^3 capacity level-full with sample, pressing hard enough to express air but not water. Transfer all the soil material, using the rounded end of a spatula 6 mm wide, to a 3-inch-diameter (7.5-cm), 100-mesh sieve.

2.2 Wash the sample with cold water from a faucet adjusted to deliver about 400 ml in 5 seconds until the water passing through the sieve appears clean when observed against a white surface. Collect the sample together at the side of the sieve. Dry the sample by pressing a finger against it over a wad of towel held against the bottom surface of the sieve.

2.3 Transfer the sample cleanly into the modified syringe and pack it level-full into the smallest volume by simultaneously pushing the syringe piston and leveling the surface with a spatula. Be sure that the moisture content is the same as that in the initial sample (Step 1). Water can be withdrawn from the sample by lightly pressing a piece of paper towel on the sample surface.

Read the volume and express as a percentage of the initial volume. This percentage represents the unrubbed fiber content.

Transfer the sample to the 3-inch (7.5-cm) sieve.

3. *Determination of rubbed fiber content*

3.1 Rub the above sample lightly between thumb and finger(s) under a

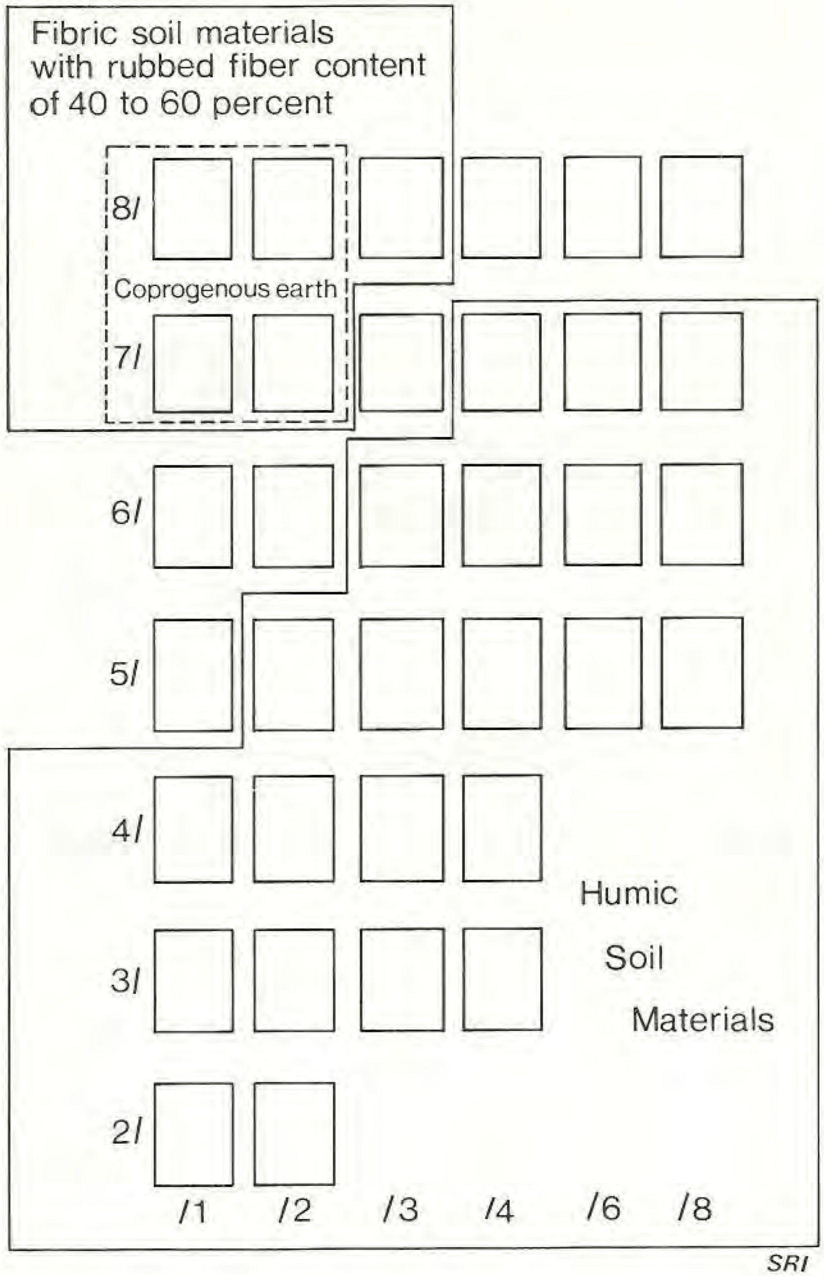

Fig. 30. Sketch of 10YR Munsell color chart showing the sodium pyrophosphate extract color separations for fibric, mesic, and humic materials.

Fig. 31. Empty modified syringe, level-full syringe, plastic screw-top jars, and spatula used in determining some properties of Organic soils.

stream of water until the water passing through the sieve is clean. Clean fibers will roll between thumb and fingers rather than glide or smear.

3.2 Dry the sample residue on the sieve as described above in step 2.2. Transfer the sample residue to the modified syringe and measure its volume as described in step 2.3. This percentage represents the rubbed fiber content. Discard the residue.

4. *Determination of pyrophosphate solubility*
Place a heaping ⅛-teaspoon (1 g) of granular sodium pyrophosphate in a small plastic screw-topped container. Add 4 ml of water and stir briefly. Pack the modified syringe adjusted to 5 cm^3 capacity with material from the sample prepared in step 1 above. Transfer the sample into the plastic container, stir, cover, and let stand overnight. Mix again thoroughly. Insert one end of a strip of chromatographic paper about 5 cm long vertically into the suspension with tweezers. Let stand until paper strip has wetted to the top with screw top in place to avoid evaporation from the paper strip. Remove test strip with tweezers, cut off and discard the soiled end. Blot the remaining strip on absorbent paper. Compare color with Munsell chart, using good illumination and viewing through holes in the chart.

5. *Determination of pH in $CaCl_2$*
The pH in 0.01 M $CaCl_2$ may be measured on the sample prepared in step 1 above. To make allowance for the dilution of the $CaCl_2$ solution by the water contained in the peat, the $CaCl_2$ solution used is prepared at 0.015 M.
Place 4 ml of 0.015 M $CaCl_2$ in a small plastic screw-topped container. Transfer ½-teaspoonful of packed moist sample into the plastic container, mix, after about 15 minutes read pH on narrow-range test papers or by a combination glass electrode.

Color

Color is determined in the moist or wet condition on a broken face, on a mass that has been firmly pressed between the thumb and forefinger, and on the rubbed mass. These kinds of color determinations help to distinguish the different kinds of diagnostic layers. Fibric layers containing mostly sphagnum fibers exhibit a substantial change in color after being pressed, compared with the color of a broken vertical face. Generally, the mesic layers have a rubbed color darker than the unrubbed color. Also, humic layers with over 50% mineral matter are unique in that the difference in color between the wet rubbed condition and the dry rubbed condition is greater than for other kinds of layers. The rubbed mass usually increases in value by one or more units upon drying.

Structure

The description of structure in organic soils is a problem. In general, fibric and mesic layers have either layered or amorphous structure. Layered structure seems to result either from the stratification of different kinds of organic material or from the annual growth of the bog flora. These two situations should be differentiated if possible. Humic layers have more varieties of structure than do most other kinds of layers. Granular structure is common, particularly where the mineral content is high; blocky structure sometimes occurs; and clods are often present in cultivated surfaces.

Consistence

Notations for consistence of fibric layers should be omitted because they are meaningless. Mesic layers, having a minimum fiber content, may have slightly sticky consistence and it is suggested that only wet consistence be indicated because it varies in mesic layers. The consistence of humic layers parallels that for mineral soils, and the appropriate consistence term should be noted.

Mineral Content and Other Features

If mineral grains can be observed, their size, range of sizes, and their proportion in the mass should be estimated. Other morphological features not described above could include such things as permafrost, artifacts, and living root content.

Boundary Between Layers

Generally the form of boundaries is smooth, but the distinctness may vary appreciably. A record of both the distinctness and the form should be made.

Nomenclature for Organic Layers

Organic soil layers within Fibrisols, Mesisols, and Humisols are indicated by the letter O with appropriate suffixes to indicate the degree of decomposition:

Of—fibric layer

Om—mesic layer

Oh—humic layer

Organic layers within Folisols are designated as L–F–H (see section on Criteria for Identification of Horizons and Layers).

Mineral strata within organic soils are designated using the appropriate mineral horizon terminology. The suffix z for cryic layers may be used for organic layers. Each letter combination has a unique meaning notwithstanding any other definition for each of the suffixes.

Contrast Classes

The dominant diagnostic layer in the middle tier establishes the great group and the subdominant layers in the organic section of the middle and bottom tiers establish the subgroup when any terric, lithic, hydric, or cyric contact occurs only within the bottom tier. The subdominant layers in the middle and surface tiers establish the subgroup when a terric, lithic, hydric, or cryic contact occurs in the middle tier. Control sections that lack subdominant organic layers and terric, lithic, hydric, cryic, cumulo, and limno layers are assigned to one of the following subgroups: Fenno-Fibrisol, Silvo-Fibrisol, Sphagno-Fibrisol, Typic Mesisol, or Typic Humisol.

The method for establishing whether or not a subdominant organic layer is to be recognized at the subgroup level is as follows: If the layers are strongly contrasting (fibric versus humic) the subdominant layer, either as a single layer or in aggregate, must be thicker than 5 inches (12.5 cm). If the layers are weakly contrasting (mesic versus humic or fibric) the subdominant layer, either as a single layer or in aggregate, must be thicker than 10 inches (25 cm).

CLASSIFICATION

Great Group	*Subgroup*	
8.1 Fibrisol	8.1-1a	Fenno-Fibrisol
	8.1-1b	Silvo-Fibrisol
	8.1-1c	Sphagno-Fibrisol
	8.1-2	Mesic Fibrisol
	8.1-3	Humic Fibrisol
	8.1-4	Limno Fibrisol
	8.1-5	Cumulo Fibrisol
	8.1-6	Terric Fibrisol
	8.1-7	Terric Mesic Fibrisol
	8.1-8	Terric Humic Fibrisol
	8.1-9	Cryic Fibrisol
	8.1-10	Hydric Fibrisol
	8.1-11	Lithic Fibrisol
8.2 Mesisol	8.2-1	Typic Mesisol
	8.2-2	Fibric Mesisol
	8.2-3	Humic Mesisol
	8.2-4	Limno Mesisol
	8.2-5	Cumulo Mesisol
	8.2-6	Terric Mesisol
	8.2-7	Terric Fibric Mesisol
	8.2-8	Terric Humic Mesisol
	8.2-9	Cryic Mesisol
	8.2-10	Hydric Mesisol
	8.2-11	Lithic Mesisol

8.3 Humisol	8.3-1	Typic Humisol
	8.3-2	Fibric Humisol
	8.3-3	Mesic Humisol
	8.3-4	Limno Humisol
	8.3-5	Cumulo Humisol
	8.3-6	Terric Humisol
	8.3-7	Terric Fibric Humisol
	8.3-8	Terric Mesic Humisol
	8.3-9	Cryic Humisol
	8.3-10	Hydric Humisol
	8.3-11	Lithic Humisol
8.4 Folisol	8.4-1	Typic Folisol
	8.4-11	Lithic Folisol

8. ORGANIC ORDER

These are soils that have developed dominantly from organic deposits. The majority of them are saturated for most of the year, or are artificially drained, but some of them are not usually saturated for more than a few days. They contain 30% or more of organic matter and must meet the following specifications:

a) If the surface layer consists dominantly (more than 75%) of fibric sphagnum moss, the organic materials must extend to a depth of at least 24 inches (60 cm).

b) If the surface layer consists of other kinds or mixed kinds of organic materials, the organic materials must extend to a depth of at least 16 inches (40 cm).

c) If a lithic contact occurs at a depth shallower than stated in a) or b) above, the organic material must extend to a depth of at least 4 inches (10 cm). Mineral material less than 4 inches (10 cm) thick may overlie the lithic contact, but the organic materials must be more than twice the thickness of the mineral layer.

d) The organic soil may have a mineral layer thinner than 16 inches (40 cm) on the profile surface. If covered with less than 16 inches of mineral soil, the organic layer or layers taken singly or cumulatively must be at least 16 inches (40 cm) thick.

e) Mineral layers thinner than 16 inches (40 cm), beginning within a depth of 16 inches from the surface, may occur within the organic soil. A mineral layer, or layers taken cumulatively, thinner than 16 inches (40 cm) may occur within the upper 32 inches (80 cm).

8.1 FIBRISOL

These are organic soils with a dominantly[1] fibric middle tier, or middle and surface tiers if a terric, lithic, hydric, or cryic contact occurs in the middle tier.

8.1-1a Fenno-Fibrisol

These soils consist of uniform fibric organic material, derived dominantly from rushes, reeds, and sedges, throughout the middle and bottom tiers. They lack mesic or humic subdominant[2] layers. The control section is 52 or 64 inches (130 or 160 cm) thick and lacks any terric, lithic, hydric, cryic, cumulo, or limno layers.

8.1-1b Silvo-Fibrisol

These soils consist of uniform fibric organic material, derived from wood, moss (less than 75% of the volume consisting of *Sphagnum* spp.) and other herbaceous plants, throughout the middle and bottom tiers. They lack mesic or humic subdominant layers. The control section is 52 or 64 inches (130 or 160 cm) thick and lacks any terric, lithic, hydric, cryic, cumulo, or limno layers.

8.1-1c Sphagno-Fibrisol

These soils consist of uniform fibric organic matter, derived dominantly from *Sphagnum* spp. throughout the middle and bottom tiers. They lack mesic or humic subdominant layers. The control section is 52 or 64 inches (130 or 160 cm) thick and lacks any terric, lithic, hydric, cryic, cumulo, or limno layers.

8.1-2 Mesic Fibrisol

These soils consist of a dominantly fibric middle tier and a subdominant mesic layer thicker than 10 inches (25 cm) in the remainder of the middle tier or in the bottom tier. Other kinds of layers are absent.

8.1-3 Humic Fibrisol

These soils consist of a dominantly fibric middle tier and subdominant humic layer thicker than 5 inches (12.5 cm) in the remainder of the middle tier or in the bottom tier. Other kinds of layers are absent.

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[1] Dominantly, in this context, means the most abundant. If only two kinds of organic materials are present, one of the materials occupies more than half of the thickness. If there are three kinds of materials, e.g., fibric, mesic, and humic, the dominant one may occupy less than half the thickness, but will occupy a greater thickness than either of the other two considered separately.

[2] Subdominant means that it fulfills the requirement stated under contrast classes.

8.1-4 Limno Fibrisol

These soils have a limno layer beneath the surface tier. Mesic, humic, and cumulo layers may be present but other kinds are absent.

8.1-5 Cumulo Fibrisol

These soils have a cumulo layer beneath the surface tier. Mesic or humic layers may be present but other kinds are absent.

8.1-6 Terric Fibrisol

These soils have a terric layer beneath the surface tier. Cumulo or limno layers may be present but other kinds are absent.

8.1-7 Terric Mesic Fibrisol

These soils have a terric layer beneath the surface tier and a subdominant mesic layer thicker than 10 inches (25 cm) in the organic portion of the control section. Cumulo layers may be present but other kinds are absent.

8.1-8 Terric Humic Fibrisol

These soils have a terric layer beneath the surface tier and a subdominant humic layer thicker than 5 inches (12.5 cm) in the organic portion of the control section. Cumulo layers may be present but other kinds are absent.

8.1-9 Cryic Fibrisol

These soils have a cryic layer within the control section. Cumulo, terric, mesic, humic, or limno layers may be present.

8.1-10 Hydric Fibrisol

These soils have a hydric layer below a depth of 16 inches (40 cm) or 24 inches (60 cm) that extends to a depth below either 52 or 64 inches (130 or 160 cm). Cumulo, mesic, humic, or limno layers may be present.

8.1-11 Lithic Fibrisol

These soils have a lithic layer (bedrock) occurring within a depth of between 4 and 52 or 64 inches (10 and 130 or 160 cm) from the surface. Mesic, humic, cumulo, or limno layers may be present.

8.2 MESISOL

These organic soils have a dominantly mesic middle tier, or middle and surface tiers if a terric, lithic, hydric, or cryic contact occurs in the middle tier.

8.2-1 Typic Mesisol

These soils consist of dominantly mesic organic material throughout the middle and bottom tiers. The control section lacks any terric, lithic, hydric, cryic, cumulo, or limno layers.

8.2-2 Fibric Mesisol

These soils consist of a dominantly mesic middle tier and a subdominant fibric layer thicker than 10 inches (25 cm) in the remainder of the middle tier or in the bottom tier. Other kinds of layers are absent.

8.2-3 Humic Mesisol

These soils consist of a dominantly mesic middle tier and a subdominant humic layer thicker than 10 inches (25 cm) in the remainder of the middle tier or the bottom tier. Other kinds of layers are absent.

8.2-4 Limno Mesisol

These soils have a limno layer beneath the surface tier. Fibric, humic, and cumulo layers may be present but other kinds are absent.

8.2-5 Cumulo Mesisol

These soils have a cumulo layer beneath the surface tier. Fibric or humic layers may be present but other kinds are absent.

8.2-6 Terric Mesisol

These soils have a terric layer beneath the surface tier. Cumulo or limno layers may be present but others are absent.

8.2-7 Terric Fibric Mesisol

These soils have a terric layer beneath the surface tier and a subdominant fibric layer thicker than 10 inches (25 cm) in the organic portion of the control section. Cumulo layers may be present but other kinds are absent.

8.2-8 Terric Humic Mesisol

These soils have a terric layer beneath the surface tier and a subdominant humic layer thicker than 10 inches (25 cm) in the organic portion of the control section. Cumulo layers may be present but other kinds are absent.

8.2-9 Cryic Mesisol

These soils have a cryic layer within the control section. Cumulo, terric, fibric, humic, or limno layers may be present.

8.2-10 Hydric Mesisol

These soils have a hydric layer below a depth of 16 inches (40 cm) or 24 inches (60 cm) that extends to a depth below either 52 or 64 inches (130 or 160 cm). Cumulo, fibric, humic, or limno layers may be present.

8.2-11 Lithic Mesisol

These soils have a lithic layer (bedrock) occurring within a depth between 4 and 52 or 64 inches (10 and 130 or 160 cm) from the surface. Fibric, humic, cumulo, or limno layers may be present.

8.3 HUMISOL

These are organic soils with a dominantly humic middle tier, or middle and surface tiers if a terric, lithic, hydric, or cryic contact occurs in the middle tier.

8.3-1 Typic Humisol

These soils have dominantly humic organic material throughout the middle and bottom tiers. The control section lacks any terric, lithic, hydric, cryic, cumulo, or limno layers.

8.3-2 Fibric Humisol

These soils have a dominantly humic middle tier and a subdominant fibric layer thicker than 5 inches (12.5 cm) in the remainder of the middle tier or in the bottom tier. Other kinds of layers are absent.

8.3-3 Mesic Humisol

These soils have a dominantly humic middle tier and a subdominant mesic layer thicker than 10 inches (25 cm) in the remainder of the middle tier or in the bottom tier. Other kinds of layers are absent.

8.3-4 Limno Humisol

These soils have a limno layer beneath the surface tier. Fibric, mesic, and cumulo layers may be present but other kinds are absent.

8.3-5 Cumulo Humisol

These soils have a cumulo layer beneath the surface tier. Fibric or mesic layers may be present but other kinds are absent.

8.3-6 Terric Humisol

These soils have a terric layer beneath the surface tier. Cumulo or limno layers may be present but other kinds are absent.

8.3-7 Terric Fibric Humisol

These soils have a terric layer beneath the surface tier and a subdominant fibric layer thicker than 5 inches (12.5 cm) in the organic portion of the control section. Cumulo layers may be present but other kinds are absent.

8.3-8 Terric Mesic Humisol

These soils have a terric layer beneath the surface tier and a subdominant mesic layer thicker than 10 inches (25 cm) in the organic portion of the control section. Cumulo layers may be present but other kinds are absent.

8.3-9 Cryic Humisol

These soils have a cryic layer within the control section. Cumulo, terric, fibric, mesic, or limno layers may be present.

8.3-10 Hydric Humisol

These soils have a hydric layer, below a depth of 16 inches (40 cm) or 24 inches (60 cm), that extends to a depth below either 52 or 64 inches (130 or 160 cm). Cumulo, fibric, mesic, or limno layers may be present.

8.3-11 Lithic Humisol

These soils have a lithic layer (bedrock) occurring within a depth between 4 and 52 or 64 inches (10 and 130 or 160 cm) from the surface. Fibric, mesic, cumulo, or limno layers may be present.

8.4 FOLISOL

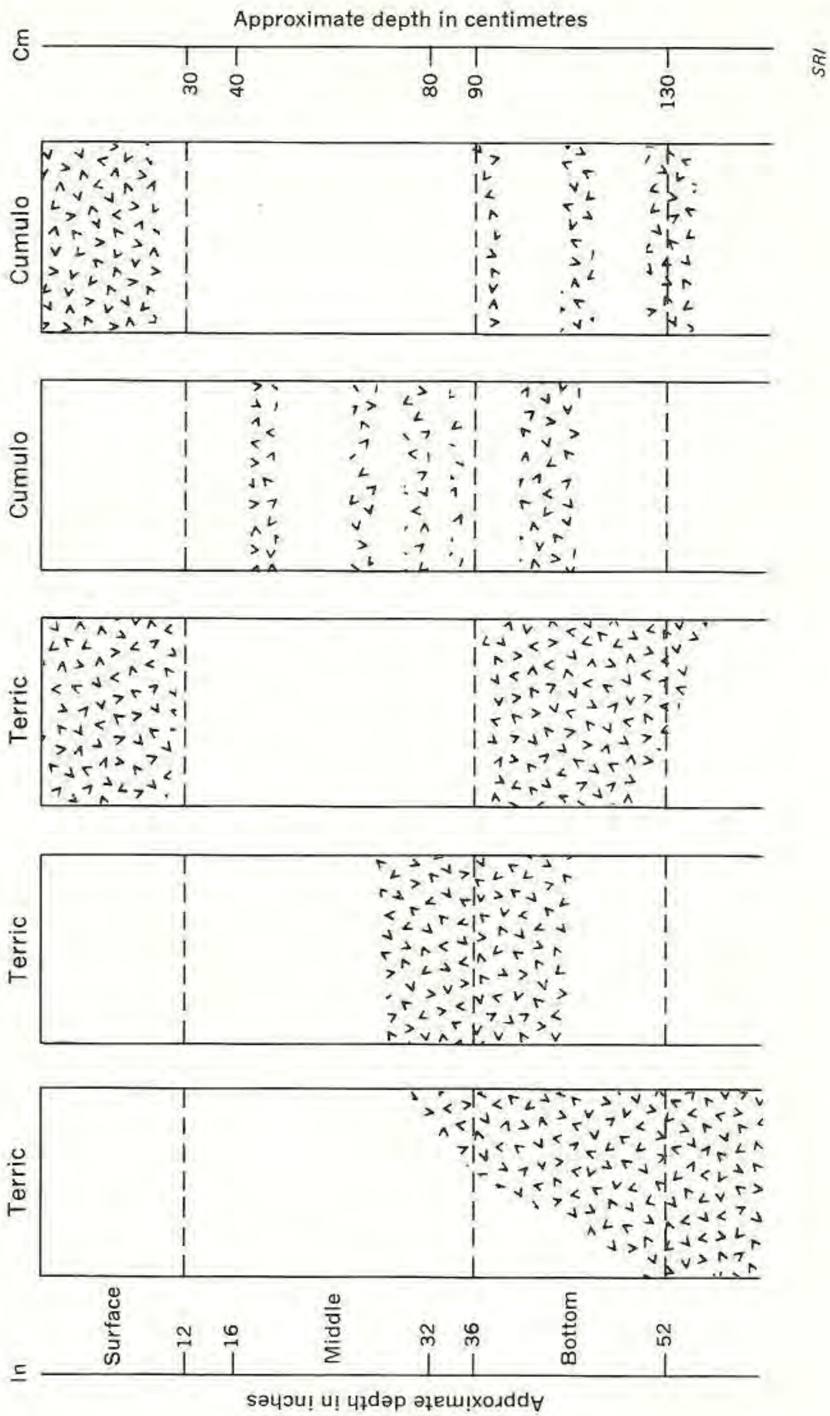
These organic soils are not usually saturated with water for more than a few days, and consist of 4 inches (10 cm) or more of L-H horizons derived from leaf litter, twigs, branches, and mosses. A lithic contact occurs at a depth of less than 52 inches (130 cm), or the organic layers rest on fragmental material with interstices filled or partially filled with organic material. A lithic contact may occur below the fragmental material. Mineral layers thinner than 4 inches (10 cm) may lie above the lithic contact and the organic materials are more than twice the thickness of the mineral layer.

8.4-1 Typic Folisol

These soils consist of organic layers underlain by fragmental materials (rock debris) with interstices filled with organic materials, i.e., more than half of each pedon. A lithic contact may occur below the fragmental material.

8.4-11 Lithic Folisol

These soils consist of organic layers underlain by a lithic contact within 52 inches (130 cm) of the soil surface.


Approximate depth in centimetres
Cm
30
40
80
90
130
SRI
Cumulo
Cumulo
Terric
Terric
Terric
In
Surface
12
16
Middle
32
36
Bottom
52
Approximate depth in inches

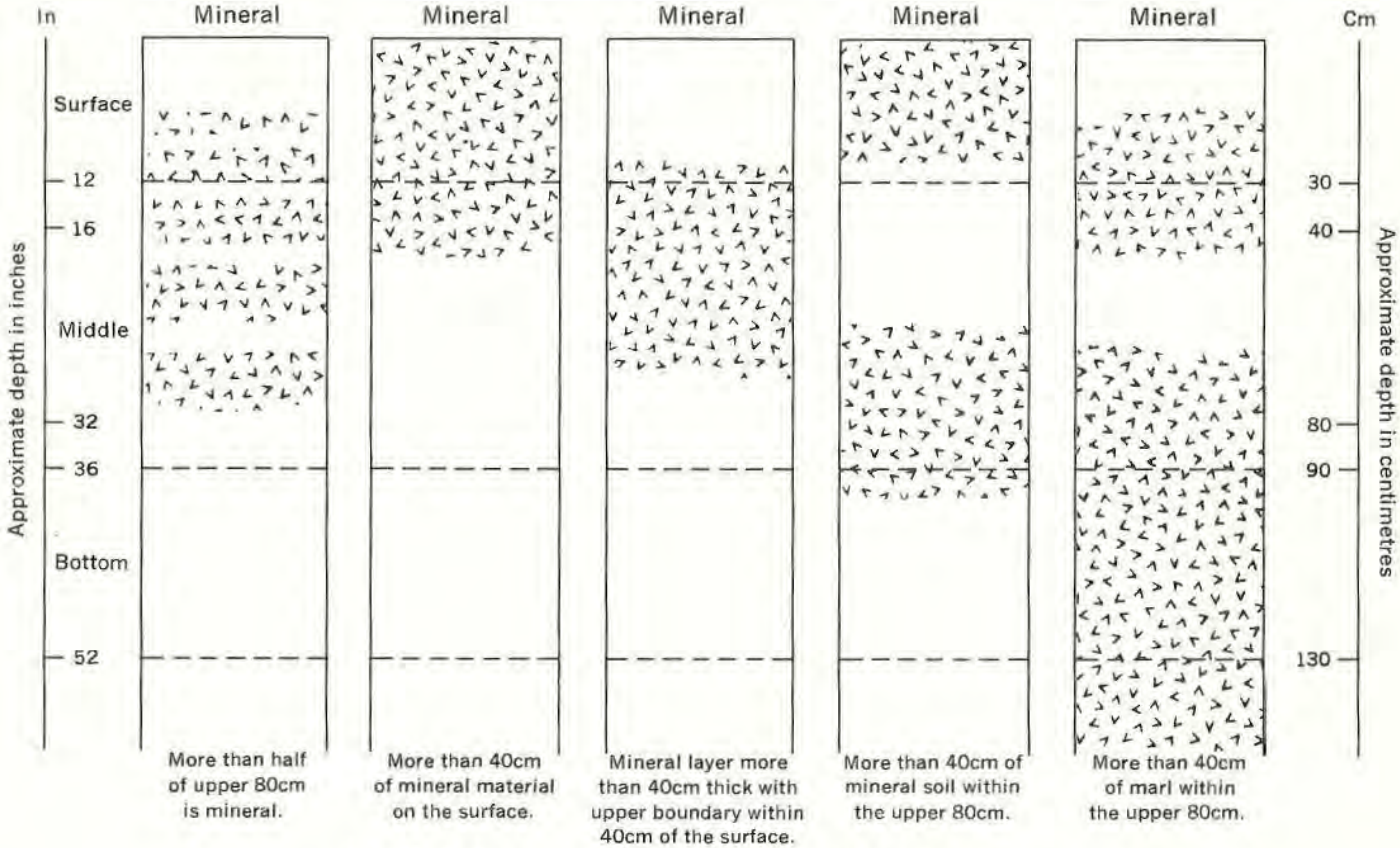


Fig. 32. A diagrammatic representation of depth relationships and the distribution of mineral layers in Terric and Cumulo subgroups of Organic and Mineral soils.

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NOTES ON CLASSIFICATION PROCEDURES

The great group gets its name from the dominant type of organic material in the middle tier, or from the middle and surface tiers if the profile is shallow. The subgroup gets its name from the subdominant organic material or from other layers in the remainder of the organic section in the middle and bottom tiers, or in the middle and surface tiers if the profile is shallow.

The characteristics of the surface tier are used as differentiae at the family and series levels. In addition, the nature of the surface tier at categorical levels above the family can be indicated by establishing types for this purpose. The following five types, indicative of both decomposition and botanical origin of the organic material in the surface tier, are proposed: fennic, silvic, sphagnic (each being used only for fibric surface tiers), mesic, and humic.

If the surface is dominantly mineral material (cumulo) (see Fig. 32), use the textural group name with the type, e.g., moderately fine type.

These types may be used after the subgroup name in the form (hyphen + name in lowercase both ending in "ic" + type) in order to avoid confusion with the subgroup names Fenno-, Silvo-, and Sphagno-. For broad reconnaissance mapping the type names suggested could be used after the great group name, e.g., Mesisol-fennic type. However, these types are not to be considered as categorical units. Some criteria must be kept for the family and series levels.

Terric, Lithic, or Hydric Substratum

A soil with less than 24 inches (60 cm) of fibric moss (75% or more of the fibers being derived from *Sphagnum* spp.), or less than 16 inches (40 cm) of other kinds or mixed kinds of organic material over a substratum is not a member of the Organic order except when it is underlain by a lithic substratum. Organic soils that extend below the bottom tier or control section are classified on the basis of the concepts previously outlined except that Terric, Lithic, and Hydric are not applicable.

Fenno-, Silvo-, and Sphagno- Subgroups

These subgroups of the Fibrisol great group are chosen on the basis of dominance of species. It is suggested that only one of these subgroup names be used, e.g., Sphagno-Fibrisol rather than Silvo-Sphagno-Fibrisol.

Termination of the Control Section

The control section ends at a lithic contact if it occurs at a depth shallower than 52 or 64 inches (130 or 160 cm) from the surface because this substratum is deemed "not soil." The control section ends at a hydric contact only if the water extends below a depth of 52 or 64 inches.

Fibric, Mesic, and Humic Subgroups

With the contrast class procedure outlined previously, some difficulty may be encountered in the unusual circumstances where there are two subdominant layers, e.g., Mesic Humic Fibrisol. Only the more decomposed subgroup name is used, e.g., Humic Fibrisol.

Mineral Soil on the Surface

Soils that have a mineral layer thicker than 16 inches (40 cm) at the surface, or that have a mineral layer thicker than 16 inches (40 cm) beginning within a depth of 16 inches (40 cm) from the surface (see first and last paragraphs in this section), or that have a mineral layer or layers, taken cumulatively, thicker than 16 inches (40 cm) within the upper 32 inches (80 cm) of the profile, are not members of the Organic order.

Minimum Thickness of Organic Soils

Soils with less than 4 inches (10 cm) of organic material over rock and less than 16 or 24 inches (40 or 60 cm) of organic material over water are not members of the Organic order.

POSSIBLE FAMILY CRITERIA

The following characteristics are proposed for trial as criteria for differentiation at the family level.

Characteristics of the Surface Tier

The characteristics of the surface tier may be recognized by using one of the following names for organic materials: fennic, silvic, sphagnic (each used only for fibric surface tiers), mesic, or humic, or by using one of the following names for surface mineral layers of between 6 and 16 inches (15 and 40 cm) thick: coarse, moderately coarse, medium, moderately fine, fine, and very fine.

Reaction Classes

Euic—The pH is 4.5 or more (0.01 M $CaCl_2$) in at least some part of the control section.

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

Climatic Classes

In our classification the cold organic soils that are frozen August 21 are recognized as a subgroup. However, it is important to differentiate also between the rather cold, unfrozen organic soils and the rather warm organic soils in areas such as the lower Fraser Valley in British Columbia and southern Ontario. The selection of appropriate climate criteria will be made later, but for an example let there be a mild-perhumid class and a cool-perhumid class of noncryic organic soils.

Mineral Content Classes

The classes refer to the mean mineral content of the organic material in the middle and bottom tiers, or of the organic material above any terric, lithic, hydric, or cryic contact that occurs in the middle tier. The classes are:

Clastic: These contain more than 55% mineral matter but less than 70%.

Ferruginous: These contain more than 1% of iron.

Sulfurous: These contain more than 1% of sulfur.

Toxic elements: These contain Al, Zn, and other elements, at levels sufficient to induce toxicity in forage or vegetation.

Textural Classes of the Underlying Mineral Soil

The classes apply to the average texture of the upper 1 foot of the terric layer or to that part of the layer that is within the control section, whichever is greater. These classes apply only to Terric subgroups and are: coarse, moderately coarse, medium, moderately fine, fine, very fine, fragmental (stone with voids between) and organic fragmental (stones with organic material in the interstices).

Limnic Classes

These classes apply only to Limno subgroups and are: marl, diatomaceous, and coprogenous.

In naming the soil family, the class names are used in the order described above; i.e., characteristics of surface tier, reaction, climate, mineral content, texture of underlying mineral soil, limnic material. The first three are named in every family, the others as appropriate. Examples of family names are:

1) Sphagnic, dysic, mild-perhumid, coprogenous

2) Mesic, euic, mild-perhumid

3) Mesic, euic, cool-perhumid, fine.

POSSIBLE SERIES CRITERIA

The following characteristics are proposed for trial as criteria for differentiation at the series level. They are divided into two groups.

Criteria for Series in All Families

Woody—50% or more of the fibers are woody.

Calcareous—The grades suggested are those defined as weakly, moderately, strongly, very strongly, or extremely calcareous.

Bulk density—Some Humisols have quite high bulk density values (> 0.5 g/cc) and these could be separated from other Humisols on this basis.

Inorganic fraction—The composition of the inorganic fraction of the organic layers is a possible criterion.

Limno layer—The limno layer on the surface or in the surface tier is also a possible criterion.

Criteria for Series in Limno, Cumulo, Cryic, Terric, Lithic, and Hydric Subgroups

Depth classes to the contact

Very shallow: lithic or cryic contact within a depth of 12 inches (30 cm).

Shallow: any contact between depths of 12 and 36 inches (30 and 90 cm).

Deep: any contact between depths of 36 and 64 inches (90 and 160 cm).

Soil development—This includes the kind and degree of development in the underlying mineral soil.

Reaction of the mineral soil

Dysic < pH 5.5 (0.01 M $CaCl_2$)

Euic > pH 5.5 (0.01 M $CaCl_2$)

Mineralogy of mineral soil or cumulic layers.

Texture of cumulo layers in middle and bottom tiers.

Presence of luvic (illuvial) layer in the middle or bottom tiers with more colloidal material than the underlying peat. This layer has fine materials with a greasy, glossy appearance in fractures and in root channels. To be recognized as a differentia in classification, the illuvial humus should constitute at least half the volume of a horizon at least 2 cm thick.

Phases of the soil series—Phases could be established according to the presence of logs in the organic material, stones resting on a terric layer, sloping land (appropriate to some blanket peat in Newfoundland), or any other characteristic significant to use such as anthropic (burned, scalped, or mined).

CRITERIA FOR SOILS AT THE FAMILY, SERIES, AND PHASE LEVELS

SOIL FAMILY

The concept of the soil family seeks to define the mineralogy, the organo-mineral fabrics, and the pedoclimate of soil series in general terms. From these viewpoints, interesting and new relationships can be seen among 3,000 Canadian soil series. Furthermore, the soil family may enable us to examine critically the limits set forth in the study of soil series or soil individuals.

The concepts developed at the order, great group, and subgroup levels have been the overall and yet vaguely defined processes of soil formation such as calcification and podzolization, their relative intensities, and modal expressions of them. Deliberately, the choice of criteria reflecting these processes were for each of the higher categories the nature of the solum, and the presence or absence of so-called diagnostic horizons and their development within arbitrary limits, which are vague in many cases. The family concept, which is closer to the soil series, soil types, and soil individuals, demands more specific limits for these diagnostic horizons or their equivalents in the soil regolith.

Not so long ago, the soil families were thought to be a means of bringing soil series into useful groupings to show soil-plant relationships. It is difficult at this time to foresee that soil families will show unknown soil-plant relationships in a better way than the soil series. Soil families per se, at any level in the system, are relevant to soil-plant relationships inasmuch as the criteria chosen are significant to these objectives. In this statement the soil family is used as a taxonomic unit.

A soil family is a group of soil series, within a subgroup, that are relatively uniform in genetic horizons, or in the properties of the soil regolith if genetic horizons are thin, faint, or absent, but the uniformity is at a broader degree than in the soil series. The soil family is therefore used to define and group together the soil series of the same subgroup that are relatively uniform in their physical and chemical composition as found or inferred by a given set of soil properties or criteria defined below.

CONTROL SECTION FOR SOIL FAMILY

For the control section,[1] attention is centered on genetic horizons if they are well expressed and not thin. If these horizons are not well expressed, or are thin or absent, attention is centered on a corresponding portion of the regolith. In either case, the portion of the soil used in differentiating series within a family of mineral soils is as follows:

Cryic—From the mineral surface to a depth of 30 inches, or to a lithic or paralithic contact, or to a depth of 10 inches below the level at which the soil temperature is 0 C 2 months after the summer solstice, whichever is shallower.

Very shallow soils—From the mineral surface down to a lithic or paralithic contact if the thickness of the regolith is 14 inches or less.

All other mineral soils—From a depth of 10 inches down to (i) a lithic contact if it is within a depth of 40 inches, (ii) a depth of 40 inches if the regolith is thicker than that, but the named diagnostic horizons and subjacent Cca horizons are not, or (iii) the bottom of the named diagnostic horizons and any subjacent Cca horizon if the thickness of both the named diagnostic horizons and the regolith exceeds 40 inches, but not below a depth of 80 inches (2 m).

CRITERIA

1. Texture
   a) Coarse-textured group
      (1) Very coarse textured: sands and loamy sands
      (2) Moderately coarse textured: sandy loams and fine sandy loams
   b) Medium-textured group
      (1) Medium textured: loam, silt loam, and silt
      (2) Moderately fine textured: sandy clay loam, clay loam, and silty clay loam
   c) Fine-textured group
      (1) Fine textured: sandy clay, clay, and silty clay
      (2) Very fine textured: heavy clay (more than 60% clay)
   d) Coarse particle size classes
      (1) Fragmental: Having stones [10 inches (25 cm) or more], cobbles [3–10 inches (7.5–25 cm)], or gravel [1/10–3 inches (2–75 mm)],

[1] U.S. Department of Agriculture. 1967. Supplement to Soil Classification System (7th Approximation). p. 39, 43, and 45.

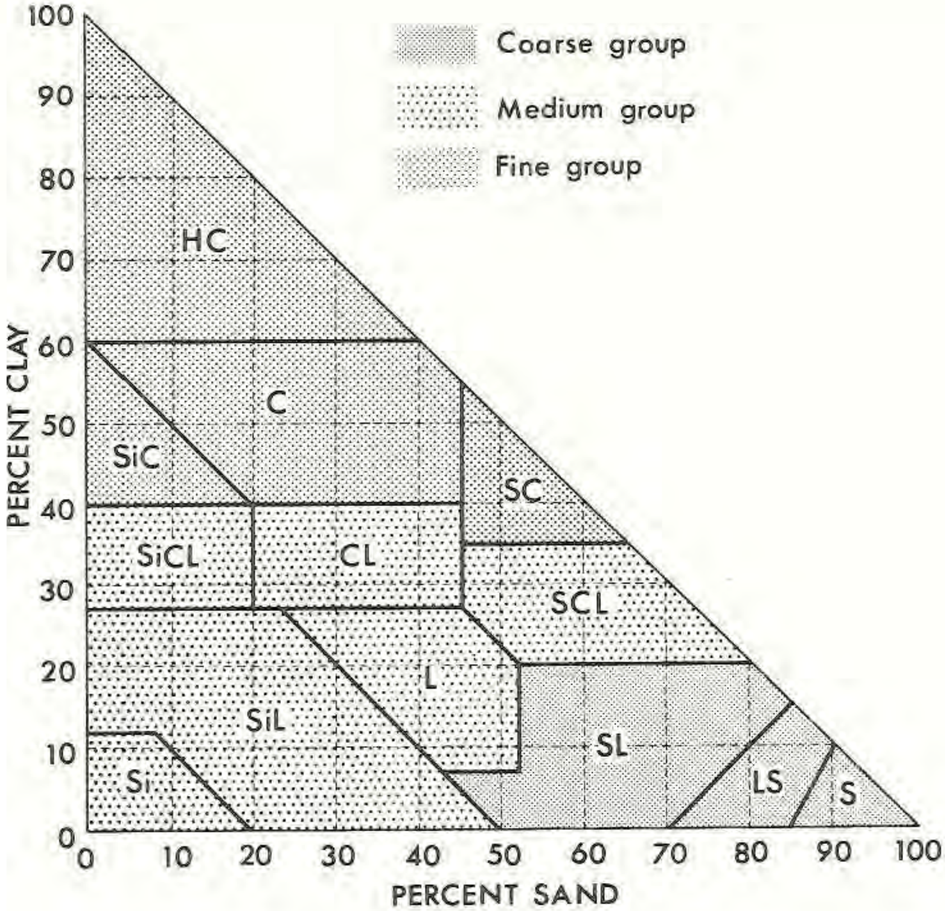

Fig. 33. The composition of family textural groups. Percentages of clay and sand in the main textural classes of soils; the remainder of each class is silt.

with fines too few to fill interstices larger than 1 mm. (Soils with roughly 90% or more of coarse materials are called cobble land type.)

(2) Coarse-skeletal: Having more than 35% but less than 90%, by volume, coarser than 2 mm with enough fines to fill interstices larger than 1 mm; fraction less than 2 mm is defined under coarse-textured group given previously.

(3) Medium-skeletal: Having more than 35% but less than 90%, by volume, coarser than 2 mm with enough fines to fill interstices larger than 1 mm; fraction less than 2 mm is defined under medium-textured group given previously.

(4) Fine-skeletal: Having more than 35%, by volume, coarser than 2 mm with enough fines to fill interstices larger than 1 mm; fraction less than 2 mm is defined under fine-textured group given previously.

2. Strongly Contrasting Textures or Nonconforming Layers

The strongly contrasting textures to be recognized within the control section are given in Table 1. By definition, textures are strongly contrasting if they occur within a vertical distance of 5 inches (12.5 cm). Both textures are used in the class name, for example fine over coarse.

Table 1. Possible combinations of strongly contrasting textures to be used if they occur within a vertical distance of 5 inches (12.5 cm)

over	Fragmental	Coarse-skeletal	Medium-skeletal	Fine-skeletal	Very coarse	Moderately coarse	Medium	Moderately fine	Fine	Very fine
Fragmental						X	X	X	X	X
Coarse-skeletal						X	X	X	X	X
Medium-skeletal										
Fine-skeletal										
Coarse	X		X	X			X	X	X	X
Medium	X	X			X				X	X
Fine	X	X	X		X	X	X	X		

Table 2. Key to mineralogy classes*

Class	Definition	Determinant size fraction
	Classes applied to loamy, silty, and clayey soils	
Fine-carbonatic	More than ⅓ of the <0.002 mm fraction consists of carbonates and the apparent texture of the soil is fine-loamy or fine-silty or clayey. Particle-size classes are not used with this mineralogy.	<0.002 mm
Serpentinitic	More than 40% (by weight) serpentine minerals (antigorite, chrysotile, fibrolite, and talc).	Whole soil <2 mm
	Classes applied to sandy, silty, and loamy soils	
Glauconitic	More than 40% (by weight) glauconite.	Whole soil <2 mm
Carbonatic	More than 40% (by weight) carbonates (as $CaCO_3$) and gypsum, and carbonates are more than 65% of the sum of carbonates and gypsum.	Whole soil smaller than 2 mm, or whole soil smaller than 20 mm
Gypsic	Gypsum is more than 35% of the sum of carbonates and gypsum and carbonates and gypsum are more than 40% (by weight).	Whole soil smaller than 2 mm, or whole soil smaller than 20 mm
Ashy	More than 60% (by weight†) volcanic ash, cinders, or pumice, and dominantly smaller than 2 mm.	0.02–20 mm
Cindery	Cindery if dominantly larger than 2 mm.	0.02–20 mm
Micaceous	More than 40% (by weight†) mica.	0.02–20 mm
Siliceous	More than 90% (by weight†) silica minerals (quartz, chalcedony, opal) and other minerals with hardness of 7 or more in the Mohs scale.	0.02–2 mm
Mixed	All others, with less than 40% of any one mineral other than quartz.	

* U.S. Department of Agriculture. 1967. Supplement to Soil Classification System (7th Approximation). p. 43. The classes Ferritic, Gibbsitic, and Oxidic are not given because they do not apply to Canadian soils.

† Weight percentages as estimated from grain counts; usually, a count of one or two dominant size fractions of conventional mechanical analysis is sufficient for the placement of the soil.

Class	Definition	Determinant size fraction
Classes applied to clayey soils		
Halloysitic	More than half by weight of halloysite with smaller amounts of allophane or kaolinite or both.	<0.002 mm
Kaolinitic	More than half by weight of kaolinite, dickite, and nacrite, and with smaller amounts of other 1:1 or nonexpanding 2:1 layer minerals or gibbsite.	<0.002 mm
Montmorillonitic	More than half by weight of montmorillonite and nontronite, or a mixture with more montmorillonite than any other single clay mineral.	<0.002 mm
Illitic	More than half by weight of illite (hydrous mica) commonly with >3% K_2O.	<0.002 mm
Vermiculitic	More than half by weight of vermiculite or more vermiculite than any other single clay mineral.	<0.002 mm
Mixed	Other soils.‡	<0.002 mm
Mineralogy subclasses		
Mineralogy subclasses are used in addition to mineralogy classes in some groups of soils.		
Sulfureous (tentative)	Soils containing either iron sulfates, commonly jarosite (straw-colored) if the pH after oxidation is less than 3.5; or more than 0.75% sulfur in the form of polysulfides if the soil contains less than three times as much carbonate (as $CaCO_3$ equivalent) as sulfur (less Ca than $SO_4^{=}$ if all sulfur is oxidized).	Whole soil <2 mm Histosols and Aquents only
Calcareous	Continuous presence of free carbonates in all parts of the fine earth fraction between depth of 10 and 20 inches (25 and 50 cm). (Use in Aquepts other than Fragiaquepts, in Aquolls, and in Entisols other than Psamments and Psammaquents.)§	Whole soil <2 mm

‡ Sepiolitic, more than half by weight of sepiolite, attapulgite, and palygorskite, should be used if found in soils that are not fine-carbonatic.

§ As applied in the American System.

3. Mineralogy

The mineralogy classes, reported in Table 2, are those suggested by the USDA.[2] An effort should be made to group soils (podzolic) according to their content of "amorphous forms of iron and aluminum oxides."

It is well to remember: "Not all of the evidence must come from X-ray, surface, and DTA determinations. Other physical and chemical properties suggest the mineralogy of many clayey soils. Volume changes, cation exchange capacities, and consistence also are useful in estimating the nature of the clay."[2] Mineralogy classes are based on the approximate mineralogical composition of selected size fractions of the same segment of the soil profile (control section) that is used for application of particle-size classes.

4. Depth Classes

Although the relative importance of depths of soils could vary in various provinces, the following classes for mineral soil families are used:

Micro: soils having a solum thickness of less than 7 inches (18 cm).

Shallow: soils having a solum thickness of 7 or more inches (18 cm) but less than 20 inches (50 cm) to the upper boundary of a lithic or cryic contact (ice contact or <0 C 2 months after the summer solstice).

A lithic contact is a layer of hard rock (hardness of 3 or more on the Mohs scale). A paralithic contact is a layer where the rock hardness is less than 3 on the Mohs scale.

5. Pedoclimate (Inferred from Temperature and Moisture Air Data)

In order to qualify soil families with respect to temperature, either Boughner's growing degree-days during the effective growing season,[3] or the climatic zones listed by Chapman and Brown[4] may be used.

Some provinces, such as Manitoba, have combined Chapman's climatic zones into four broad regions that appear to correlate reasonably well with major soil type changes, particularly in the transitional zones between Chernozemic and Podzolic soils. Because of insufficient meteorological and soils data the relationship was not as good in the northern areas.

[2] U.S. Department of Agriculture. 1967. Supplement to Soil Classification System (7th Approximation). p. 42.

[3] Boughner, C. C. 1964. Growing degree days during the effective growing season. Can Meteorol. Memoir 17.

[4] Chapman, L. J., and Brown, D. M. 1966. The climate of Canada. Report No. 3. Canada Land Inventory.

At present, Chapman and Brown's climatic zones for air temperatures are recommended. They infer that the soil temperature and moisture regimes must have a relationship with the air temperatures. The sandy soils would be warmer and drier than the clayey soils and the clayey soils would be cooler and more humid than the sandy soils. This is called an inferred pedoclimate.

Tables 3, 4, and 5 follow Chapman and Brown's report[5] and are used to infer the pedoclimate including temperature and moisture.

6. Reaction Classes

Three reaction classes, based on the pH in 0.01 M $CaCl_2$, are suggested temporarily:

a) Acid: pH lower than 5.0 in the control section.

b) Acid to neutral: pH 5.0–7.5 in at least some part of the control section.

c) Alkaline: pH higher than 7.5.

Calcareous Classes (See also Carbonatic Class under Mineralogy)

a) Weakly calcareous: 1 to 6% $CaCO_3$ equivalent.

b) Moderately to very strongly calcareous: 6 to 40% $CaCO_3$ equivalent.

c) Extremely calcareous: more than 40% $CaCO_3$ equivalent.

Table 3. Temperature zones

1.	More than 4,000 degree-days (42 F).
2.	3,500 to 4,000 degree-days.
3.	3,000 to 3,500 degree-days.
4.	2,600 to 3,000 degree-days.
5.	2,200 to 2,600 degree-days and more than 90 frost-free days in Alberta and Saskatchewan.
6.	1,800 to 2,200 degree-days and 75 to 90 frost-free days in Alberta and Saskatchewan.
7.	Less than 1,800 degree-days and less than 75 frost-free days in Alberta and Saskatchewan.

[5] Chapman, L. J., and Brown, D. M. 1966. The climate of Canada. Report No. 3, p. 13-15. Canada Land Inventory.

Table 4. Moisture classes

Moisture class	Water deficiency (inches)	May to September precipitation (inches)	
		Over 2,600 degree-days	Under 2,600 degree-days
C	Over 12	Under 6	——
D	12 - 9	6 - 8	——
E	9 - 7	8 - 11	8 - 9
F	7 - 5	10 - 12	9 - 11
G	5 - 3	12 - 13	10 - 13
H	3 - 1	13 - 15	12 - 15
K	1 - 0	15 - 16	14 - 18
L	0	——	16 - 20
M	0	——	Over 20

Table 5. All possible combinations of temperature zones and moisture classes

1.	C, G
2.	C, F, G, H
3.	C, D, E, F, G, H, K, L, M
4.	C, D, E, F, G, H, K, L, M
5.	E, F, G, H, K, L, M
6.	E, F, G, H, K, L, M
7.	G, H

Special Horizons

These horizons are the fragipans and the compacted layers that may occur below the solum. If fragipans are not classified in the subgroup or higher levels, they would have to be considered at the family level.

The adjective fragic should be used whenever applicable at the family level.

Other Characteristics

Slope should be used as phases of families. Depending on the climatic conditions, the slope phases could vary regionally.

Stoniness is treated also as a phase separation of families. The particle-size classes given previously by using the term fragmental and skeletal cover most conditions.

Consistent Nomenclature

To have consistent nomenclature in qualifying soil families, the adjectives modifying the subgroup name are used in the following order: texture, mineralogy class and subclass, reaction, climate, depth, consistence, and the name of the soil family underlined. Examples: Degraded Dystric Brunisol, coarse-skeletal, mixed, acid, climate 3L, St. Nicholas. Depth and consistence are normal, that is without relative aberrant properties. Degraded Dystric Brunisol, coarse, mixed, acid, climate 4K, fragic, Gatineau.

SOIL SERIES

The concept of the soil series[1] has changed considerably since soils were first mapped and classified. At the beginning of the century soils were considered to be a geological phenomenon, even though both Hilgard and Shaler had earlier recognized the soil as a natural body. In 1906 the soil series was defined as consisting of material similar in many characteristics, but grading in texture from gravel to clay. In a report of field operations for 1900 by the U.S. Bureau of Soils, Whitney reported "only such conditions as are apparent in the field such as texture as determined by feel and appearance, the depth of the soil and subsoil, the amount of gravel, the conditions as to drainage, and the native vegetation or known relation to crops, are mapped." The unit of classification, called the type, had a definite geographical expression. The grouping of types into series was based on a common geologic origin of the parent material. This led to a grouping of soil types that had few true characteristics in common. In 1912, Coffey preceded Marbut in realizing that it was necessary to recognize the inherent differences in the soil itself and consider the soil as an independent natural body.

The present concept of the soil series was developed after Marbut became head of the U.S. Bureau of Soils in 1913. He examined soils in many parts of the continent and was greatly influenced by his translation of Glinka's work.[2] He adopted the concept of the soil as an independent natural body and, in 1921, proposed that, exclusive of the texture of the surface soil, the units or groups of units based on features of the soil profiles should be soil series. Each soil series would be similar in the number, color, texture, structure, relative arrangement, chemical composition, and thickness of horizons and in the geology of the soil material. Later, he added thickness of the true soil and character of the soil material to the list of differentiating criteria.

The application of these proposals led to the recognition of the soil as a three-dimensional body occupying a geographical position on the landscape. The development of improved techniques for examining soils resulted in the substitution of "mineralogical and chemical composition" for "geology of the soil material." More recently, consistence of the soil horizons was added to the list of differentiating criteria for series.

The application of these criteria in the examination and observation of the landscape gives a mental concept of the number of series present

[1] Much of the historical discussion was taken from Ableiter, J. K. 1949. Soil Classification in the United States. Soil Science 67:183-192.

[2] Glinka, K. D. 1915. Pedology. 1st ed. St. Petersburg.

and the differences between them. The U.S. Department of Agriculture Soil Survey Manual states (p. 24) that, mentally, we comprehend soils by comparison. Because the soil is a continuum, there are no sharp boundaries between series, but the concept represents a real body that is useful as a unit in soil classification. In other words, it is not necessary to have boundaries on a map in order to use the soil series as a categorical unit in the classification system. However, we need to identify, sample, and describe these bodies so that their properties can be compared and predictions can be made about their use and management. This requires that a limit be placed on the range allowed in the characteristics, or combination of characteristics, that differentiate between one series and another. Taxonomically these limits can be as narrow as desired, but this would create a very large number of series and difficulties in mapping them. Experience has indicated that the limits must be wide enough to permit reasonable uniformity over a practical-sized area. Thus, the limits must be narrow enough to keep the series as taxonomically homogeneous as possible and, at the same time, wide enough to create bodies of a size that can be readily identified and delineated on a map. No single characteristic can be allowed a range that would alter significantly the morphology, genesis, or use capability of the series from place to place.

Once the limits have been established, the boundaries between soil series may be delineated on a map. As the soil is a continuum, it is usually impractical, because of time and scale, to draw exact boundaries between the limits of one soil series and another. Usually each delineated area contains small segments of contiguous soil series. Thus, the soil series as a taxonomic unit is related to, but usually not the same as, the area delineated on a map and designated as a soil series mapping unit.

The size of a soil series on the landscape is determined by the range allowed in the differentiating characteristics. Some series have a very limited geographical extent and past practice has been to ignore these areas rather than create new series. Recently, it has been considered desirable to have a minimum limit below which the series would not be recognized. It would serve as a unit for sampling, describing, and studying the properties of the soil series. The pedon was devised for this purpose.

The pedon is the smallest volume that can be called a soil. It is a three-dimensional body large enough to permit the sampling and study of horizons. If the horizons are cyclic or intermittent within a linear distance of 2 to 7 m, the pedon may range from 1 to 10 m^2. If the horizons are continuous and the cycle is less than 2 m, the pedon occupies approximately 1 m^2. Thus the minimum size of a soil body representing a soil series is the pedon. For practical purposes the pedon is too small an area to be represented on a map, and the soil series is regarded as being composed of several contiguous pedons or polypedons. The polypedon is termed a soil individual. Its size depends on the range allowed in the characteristics used to separate series, but all of its pedons have characteristics lying within the defined range. There may be on the landscape one or several separate polypedons whose differentiating properties lie within the range defined for a given series. The same soil series name would be applied to one or several collectively.

A soil series may be one or several soil bodies. Its differentiating characteristics do not have to be similar or uniform in every part, provided they do not exceed the limits defined for the series. The soil series is defined as follows:

> A soil series is a soil body[3] such that any profile within the body either has a similar number and arrangement of horizons whose color, texture, structure, consistence, thickness, reaction, and composition, or a combination of these, are within a defined range or, in soils without horizons, any profile has the differentiating properties, except thickness, within specified depth limits.

GUIDELINES FOR SEPARATING SOIL SERIES

It is difficult to establish limits between which the differentiating characteristics are allowed to range, because the taxonomic significance of a given property is not the same for all series. Nevertheless, a few guidelines for separating soils at the series level have been established. Hue, texture, coarse fragments, consistence, and mineralogy are the properties most commonly used to separate series within families.

Generally, mappable appreciable differences in any property, or combination of properties, that have some significance in soil genesis, or influence the growth of plants, are a basis for separating series. If the differences are significant to soil use but not to soil genesis, two or more types or phases are recognized within a series.

A distinct difference in one property, such as color of the B horizon, may be sufficient basis for recognizing another series, but usually a change in one property is accompanied by a change in others.

The range of variability of the differentiating characteristics should be narrower for the series than for the family. As a rule, moderately narrow ranges are allowed for the characteristics having the greatest number of covarying or accessory properties. Relatively small changes

[3] Muir defines a soil body as a three-dimensional natural object that occurs under a cover of living vegetation and is characterized by the presence of horizons, the A horizon being in direct contact with the vegetation.

in these differentiae often produce significant changes in morphology or adaptability to plant growth. For example, texture, structure, or pH have a number of covarying properties such as exchange capacity, base saturation, water-holding capacity, or permeability.

The parent materials of all pedons in a soil series should be reasonably similar in texture and mineralogical composition.

A given series should be homogeneous, within rather narrow limits, in genesis and in all its properties, with the following main exceptions:

1. The texture of the plow layer and layers below the solum may vary, particularly in soils developed in stratified sediments.
2. Properties affected by plowing and by the use of soil amendments may vary. Soils that are acid in the natural environment may be limed, changing the reaction of the surface horizon.
3. The slope may vary within limits that are highly significant to the use of the soil.
4. Salinity is permitted to vary because changes can be very rapid and drastic under irrigation.

Additional Guidelines Suggested for Consideration

Color—One of the most easily determined characteristics for differentiating between soil series is color. It is indirectly related to the organic matter content and iron and manganese oxides and may reflect properties inherited from the parent material. A difference in hue of more than 2.5 units between corresponding horizons is suggested as a basis for separating series.

Texture—The range in texture allowable within a series depends on the effects of the texture on other properties of the soil. As a guideline, a difference of preferably one textural class, but not more than two classes, on the textural chart, should be used to differentiate between series.

Soil type—Because man can change the properties of the plow layer at will, the soil type is subject to variation from place to place. It is defined as follows:

> The soil type is a subdivision of the soil series based on significant variations in the properties of the plow layer. It is the soil unit that recognizes the maximum number of differentiating characteristics of the soil profile.

SOIL PHASE

Soil phase is a subdivision of any class in the taxonomic system, but is not in itself a category of the system. The basis of this subdivision may be any soil characteristic or combination of soil characteristics potentially significant to man's use or management of the land apart from the properties used in the taxonomic classification.

When used as a subdivision of a soil type, as it most commonly is, the phase is defined and shown on the soil map on the basis of all the characteristics of the soil type, but with a narrower definition in certain features of importance to soil use than is needed for the genetic soil type. The soil type when classified and named, for example, Fox sandy loam, stands for all its types and for the phase within the type. Therefore, if Fox sandy loam normally occurs only on one particular slope (phase) or has one particular degree (phase) of stoniness, the word phase does not appear in the type name. However, if there are a few areas where slope or stoniness differs sufficiently from the normal to affect use or management, such areas would be designated Fox sandy loam—sloping or stony phase. The phase of a soil type on detailed maps is the unit about which the greatest number of precise statements and predictions can be made concerning soil use, management, capability, and productivity.

SOIL SLOPE PHASES

In increasing order of slope gradient the classes and names of soil slope phases are as follows:

Single slopes		*Complex slopes*		
Class	*Name*	*Class*	*Name*	*Slope (%)*
A	depressional to level	a	nearly level	0.0 to 0.5
B	very gently sloping	b	gently undulating	0.5+ to 2
C	gently sloping	c	undulating	2+ to 5
D	moderately sloping	d	gently rolling	5+ to 9
E	strongly sloping	e	moderately rolling	9+ to 15
F	steeply sloping	f	strongly rolling	15+ to 30
G	very steeply sloping	g	hilly	30+ to 60
H	extremely sloping	h	very hilly	over 60

WATER-EROSION PHASES

The following water-erosion classes, as defined in the U.S. Department of Agriculture Soil Survey Manual, p. 261-264, have been accepted as phases:

Class W1

This is a slightly eroded phase. The soil has a few rills or places with thin A horizons that give evidence of accelerated erosion but not to an extent to alter greatly the thickness and character of the A horizon. Except for soils having very thin A horizons (less than 8 inches), the surface soil (Ap) consists entirely of an A horizon throughout nearly all of the delineated area. Up to about 25% of the original A horizon, or original plowed layer in soils with thin A horizons, may have been removed from most of the area. In most soils, areas with this class of erosion are not significantly different in use capabilities and management requirements from the uneroded soil. In a few soils having very shallow sola over a nonconforming layer, or in a few having a shallow A horizon over a claypan or hardpan, a significant difference may exist.

Class W2

This is a moderately eroded phase. The soil has been eroded to the extent that ordinary tillage implements reach through the remaining A horizon, or well below the depth of the original plow layer in soils with thin A horizons. Generally, the plow layer consists of a mixture of the original A horizon and underlying horizons. Mapped areas of eroded soil usually have patches in which the plow layer consists wholly of the original A horizon and others in which it consists wholly of underlying horizons. Shallow gullies may be present. Approximately 25 to 75% of the original A horizon or surface soil may have been lost from most of the area.

Class W3

This is a severely eroded phase. The soil has been eroded so that all or practically all of the original surface soil, or A horizon, has been removed. The plow layer consists essentially of materials from the B or other underlying horizons. Patches in which the plow layer is a mixture of the original A horizon and the B horizon or other underlying horizons may be included within mapped areas. Shallow gullies, or a few deep ones, are common on some soil types. More than about 75% of the original surface soil, or A horizon, and commonly part or all of the B horizon or other underlying horizons, have been lost from most of the area.

Class W4

This is a gullied land phase. The land has been eroded until it has an intricate pattern of moderately deep or deep gullies. Soil profiles have been destroyed except in small areas between the gullies. The land in its present condition is not useful for crops. Reclamation for crop production or for improved pasture is difficult, but may be practicable if the other characteristics of the soil are favorable and erosion can be controlled.

WIND-EROSION PHASES

The following wind-erosion classes, as defined in the U.S. Department of Agriculture Soil Survey Manual, p. 267, have been accepted as phases:

Class D1

This is a wind-eroded (or blown) phase. Wind has removed from the soil a sufficient amount of the A horizon so that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer. Rarely is this condition uniform throughout a mappable area, however. Usually the plow layer consists mainly of the original A horizon in some patches, whereas in others the original A horizon is removed. Generally, about 25 to 75% of the original A horizon (or surface soil in soils with thin A horizons) may have been removed.

Class D2

This is a severely wind-eroded (or blown) phase. Wind has removed all of the A horizon and part of the B or other lower lying horizon. The plow layer consists mainly of the original horizons below the A (or below the original plowed layer in soils with thin A horizons), although some patches having much of the original A horizon remain in the area. An occasional blowout area may be included.

Class D3

This is a blown-out land phase. The wind has removed most of the soil profile and the land is classified as a miscellaneous land type. Use of the land for ordinary agriculture is not feasible without extensive reclamation. Blowout holes are numerous and deeply carved into the lower soil or parent material. Areas between blowouts are deeply buried by soil material from the blowouts.

SOIL DEPOSITION PHASES

The phases for depositions as described by the U.S. Department of Agriculture Soil Survey Manual, p. 295-296, are being used temporarily. The two phases are defined as follows:

Overblown Phase

The deposit of wind-removed material on the soil is great enough to influence management but not great enough to destroy the essential characteristics of the soil series.

Overwash Phase

Deposits from water erosion lie thick enough on the soil to influence management requirements significantly, but are not deep enough to destroy the essential characteristics of the soil series.

STONINESS AND ROCKINESS PHASES

Classes of stoniness and rockiness are phase distinctions.

The phases of stoniness are defined as follows:

Stony 1

This is a slightly stony phase, having some stones, which offer only slight to no hindrance to cultivation.

Stony 2

This is a moderately stony phase, having enough stones to cause some interference with cultivation.

Stony 3

This is a very stony phase, having sufficient stones to constitute a serious handicap to cultivation; some clearing is required.

Stony 4

This is an exceedingly stony phase, having sufficient stones to prevent cultivation until considerable clearing is done.

Stony 5

This is an excessively stony phase, being too stony to permit any cultivation (boulder or stone pavement).

The phases of rockiness are defined as follows:

Rocky 1

This is a slightly rocky phase, having sufficient bedrock exposures to interfere with tillage but not to make intertilled crops impracticable. Depending on how the pattern affects tillage, rock exposures are roughly 100 to 300 feet apart and cover about 2 to 10% of the surface.

Rocky 2

This is a moderately rocky phase, having sufficient bedrock exposures to make tillage of intertilled crops impracticable, but the soil can be worked for hay crops or improved pasture if other soil characteristics are favorable. Rock exposures are roughly 30 to 100 feet apart and cover about 10 to 25% of the surface, depending on the pattern.

Rocky 3

This is a very rocky phase, having sufficient rock outcrop to make all use of machinery impracticable, except for light machinery where other soil characteristics are especially favorable for improved pasture. The land may have some use for wild pasture or forests, depending on the other soil characteristics. Rock exposures, or patches of soil too thin over rock for use, are roughly 10 to 30 feet apart and cover about 25 to 50% of the surface, depending on the pattern.

Rocky 4

This is an exceedingly rocky phase, having sufficient rock outcrop, or insufficient depth of soil over rock, to make all use of machinery impracticable. The land may have some value for poor pasture or for forestry. Rock outcrops are about 10 feet apart or less and cover 50 to 90% of the area.

Rocky 5

This is an excessively rocky phase. Over 90% of the surface of the land is exposed bedrock (rock outcrop).

PEATY PHASES

The term peaty phase should be applied to any mineral soil with a surface covering of 6 to 24 inches of fibric moss peat or 6 to 16 inches of other kinds of peat (see Gleysolic soils).

INTERNATIONAL SOIL CORRELATION

CORRELATION BETWEEN THE CANADIAN, UNITED STATES, AND WORLD SYSTEMS

REFERENCE MATERIAL

The Canadian definitions and criteria for horizons and taxonomic units are those contained in the "Proceedings of the Seventh Meeting of the National Soil Survey Committee," 1968.

The U.S. soil taxonomic criteria for mineral soils are those given in the "Supplement to Soil Classification System (7th Approximation)," U.S. Department of Agriculture, 1967, and in a draft of changes in criteria for spodic horizons and for Borolls received in April 1968. A preliminary classification for Histosols was issued in August 1968.

The draft definitions of soil units, soil phases, and criteria for diagnostic horizons as used for the FAO/UNESCO World projects are those proposed for use in World Soil Resources Report No. 33, April 1968, with minor revisions agreed on by correspondence, January 1969.

Comparisons and correlations have been made of criteria for horizon identification, and diagnostic horizons as used for classification in the higher taxonomic categories down to the subgroup levels of pedon identification.

Criteria of classification for families, series, and phases are not discussed here. The taxonomic units given in the tables are correlated to a general modal concept for practical use rather than to an absolute correlation at the outer limits of intergrade interpretation. An attempt has been made to indicate whether the correlations are identical, closely related, or only broadly related. In some instances alternative correlations are indicated where the units as defined are inclusive within broader concepts in the alternate system.

Fundamentally, soil units in different systems can only be directly correlated when the mechanisms for horizon identification are similar. Criteria for individual horizon definitions and for diagnostic horizon combinations are the building blocks for the identification of individual profiles or pedons. These are, therefore, the most important factors basic to soil correlations, and when this is achieved it is not so important that we group these individuals in precisely the same "boxes" or "shelves" in our classification or filing systems. It is impossible to do this, because it is in these respects that our classification systems differ most widely. U.S. soil taxonomy makes use of seven categories by including an order, suborder, great group, and subgroup at the higher levels of abstraction, whereas Canada uses six groups, not having a suborder. At the present stage of development the World system makes use of two category separations above the map unit level. Because of local preference or significance, a soil unit may be recognized or grouped at a higher or lower level of abstraction in one or another system. This is not serious for correlation provided that the place of the individual soil unit can be recognized across all systems. With these points in mind the tables of comparisons were prepared, beginning with the comparison of criteria for horizon identification (Tables 6 and 7) and following with tables of comparisons and correlation of the taxonomic units within the Canadian, U.S., and World systems (Tables 8 and 9).

Table 6. Correlation of horizon definitions and designations [1 2 3]

1. Canadian	2. U.S.	3. World	Comments on criteria
Of	Oi	Ol	1. Can. limits, Organic horizon >30% OM.
Om Oh	Oe Oa	Of Oh	2,3. U.S. and World limits, lower limit of Organic horizon ranges proportionately from 20% OM with 0% clay to 30% OM with > 50% clay.
L–F L–H F–H	O1 O O2	Olf Olh Ofh	1,2,3. Can., U.S., and World definitions specify dominantly aerobic accumulations and exclude peaty and Histic horizons.
A Ah Ahe	A A1 inclusive in A1	A Ah (Ah–E)	1. Limit, <30% OM. 2,3. Upper limit of OM ranges proportionately from 20% OM with 0% clay to 30% OM with clay >50%.
Ae	A2	E	3. Designation of Ae as a master E horizon.
Ap	Ap	Ap	1. 6 in. (15 cm). 2,3. Ap 7 in. (18 cm). 2. Occasionally specifies 6 in. (15 cm).
AB	A3	AB or EB	1,2,3. Gradual transition.
BA A & B	B1 A & B	EB or BE A/B	1,2,3. Indicates interfingered horizons.

[1] Proceedings of Seventh Meeting of N.S.S.C. 1968.
[2] U.S. Department of Agriculture Handbook No. 18. Soil Survey Manual 1951.
[3] International Society of Soil Science. Commission 5. Working Group. I.S.S.S. Bull. No. 31. 1967.

Table 6. Correlation of horizon definitions and designations — Cont.

1. Canadian	2. U.S.	3. World	Comments on criteria
AC	AC	AC	
B	B	B	1. B includes specifically alteration by reduction; 2,3, include it by inference.
Bt	B2t	Bt	1. Thickness limits, >2 in. (5 cm) or if in lamellae with total thickness >4 in. (10 cm) in upper 60 in. (150 cm). 2,3. Limits are 1/10 of all overlying horizons or >6 in. (15 cm) if eluvial-illuvial sequum is >60 in. (150 cm).
Bf	Bir	Bfe	1. Definition designates Bf as a horizon enriched with hydrated iron, not necessarily illuvial. 2. Specifies accumulation of illuvial iron as coatings. 3. Specifies accumulation of illuvial iron. 2,3. Criteria for spodic horizons are identical. 1. Criteria for f by chemistry differ from spodic criteria and are specifically defined with B combinations of h & f and f & g.
Bfh	B2hir	Bfeh	1. Can. >5% and <10% OM.
Bf			1. Bf alone <5% OM and with OM/oxalate Fe <20.
Bhf	B2hir	Bhfe	1. Can. >10% OM.
Bgf	B2gir	Bgfe	1. Dithionite Fe is less than in IC by 1% and Dithionite Al exceeds that in IC by less than 0.5%.
Bh	Bh or B2h	Bh	1. Bh >2% OM & OM/oxalate Fe >20 (cf, Bfh). 2. U.S. > 3% in spodic Ap. Specifically illuvial. 3. Specifically illuvial, criteria similar to U.S. spodic B. 3. Also used for illuvial h in peat.
Bn	B2 (natric)	Bna	1. Criteria, prismatic or columnar with exchangeable Ca/exchangeable Na <10. 2,3. Criteria similar. Prismatic or columnar with Na + Mg >Ca + H if C horizon is >15% exchangeable Na.

Table 6. Correlation of horizon definitions and designations — Cont.

1. Canadian	2. U.S.	3. World	Comments on criteria
Bm	B2 (cambic)	Bs (cambic)	1. Bm would qualify as inclusive within U.S. and World concepts for cambic B. 1. Note Can. use of (m) differs from U.S. and World use of m (concretionary).
Bg	Bg B2g	Bg	1,2,3. Criteria are similar, indicating strong mottling and distinctive chroma but without specific chemical criteria.
C	C	C	3. World system proposes a specific designation for a master G horizon, otherwise 1,2,3 are identical conventions.
IIC	IIC	IIC	
Cca	Cca	Cca	1. Limits 4 in. (10 cm). 2,3. Limits 6 in. (15 cm) for calcic C horizon.
Csa	Csa	Csa	1. sa includes gypsum. 2,3. sa does not include gypsum.
—	Csi	—	2. Silica cementation. 1,3. No equivalent.
—	Cs	Cs	2,3. Accumulation of $CaSO_4$. 1. No Can. equivalent.
R	R	R	1,2,3. Similar convention for consolidated bedrock.
Other suffixes			Other suffixes that are used similarly for all horizons: A, B, or C.
b	b	b	1,2,3. Buried horizons.
c	m	m	1. Symbol different from 2 and 3 for cementation.
cc	cn	cn	1. Symbol different from 2 and 3 for cemented pedogenic concretions.
g	g	g	1,2,3. Similar. Characteristics of gleying.
j	—	—	2,3. No equivalent for weakly expressed characteristic failing to meet specific limits.

Table 6. Correlation of horizon definitions and designations – Cont.

1. Canadian	2. U.S.	3. World	Comments on criteria
k	—	—	1. No equivalent in 2 and 3 for occurrence of CO_3 detectable by visible effervescence with HCl.
s	—	—	1. No equivalent in 2 and 3 for visible occurrence of salts not meeting specifications for sa.
sa	sa	sa	1. Limits include soluble gypsum and thickness >4 in. (10 cm) and mmhos/cm 4 or >4. 2,3. Based on horizon >6 in. (15 cm) and >2% salts more soluble than gypsum. cf salic horizon.
ca	ca (calcic)	ca (calcic)	1. Limits calcic >4 in. (10 cm). 2,3. Limits calcic >6 in. (15 cm).
x	x	x	1,2,3. Fragipan. Similar characteristics.
z	f	—	1. Permanently frozen layer. 2. Thought to be permanently frozen. 3. No symbol.
—	—	ox	3. Residual accumulation of sesquioxides as in Latosols. 1 & 2, no equivalent.
—	—	s	3. Accumulation of clay by alteration in situ with change in structure. 1,2. No direct equivalent although it would be included in Can. Bm or U.S. Cambic B2.

Table 8. Taxonomic correlation[4] at subgroup level

	1. Canadian	2. U.S.	3. World	Comments on criteria
1	Chernozemic	Borolls (minor Rendolls)	Kastanozems Chernozems (minor Rendzinas)	1. Chernozemic Ah 2. Mollic Epipedon 3. Melanic A
1.1	Brown (Light Chestnut)	Aridic Boroll subgroups	Kastanozems (aridic)	3. Borustic aridic climate
1.11	Orthic Brown			
	Bm,Btj	Aridic Haploboroll	Haplic Kastanozem	1. Bm; 2,3. cambic B
	Orthic Brown Bt	Aridic Argiboroll	Luvic Kastanozem	1. Bm; 2,3. textural B
1.12	Rego Brown Ah,Ck,C	Entic Aridic Haploboroll	Haplic Kastanozem	1,2,3. No cambic B
	Rego Brown Ahk,Cca,C	Aridic Calciboroll	Calcic Kastanozem	1,2,3. With calcic horizon
1.13	Calcareous Brown Ah,Bmk,Ck,C	Typic Aridic Haploboroll	Haplic Kastanozem	2,3. With cambic B
	Ah,Bmk,Cca,C	Haplic Aridic Calciboroll	Calcic Kastanozem	2,3. With cambic B & calcic C
1.14	Eluviated Brown Ah,(Ahe),Ae,Bt,C	Albic Aridic Argiboroll	Luvic Kastanozem	2. Albic; 3. E horizon
	Ah,(Ahe),AB,Bt or Btj,C (cumulic type)	Pachic Aridic Argiboroll	Luvic Kastanozem	2. Cumulic A or AB >20 in.
1.11-2.11	Solonetzic Brown Ah,Bnjt,C	Aridic Argiboroll	Luvic Kastanozem	2,3. Bnjt will not meet limits of natric B or Bna
1.14-2.21	Solodic Brown Ah,(Ahe),Ae or AB,Bnjt	Albic (Aridic) Argiboroll	Luvic Kastanozem	

1.1-/5	Saline Brown	Add Salic to above groups	Add Saline phase	1. S or Sa; 2,3. Sa horizons
1.1-/6	Carbonated Brown	Calciboroll or Aquic Calciboroll	Calcic Kastanozem	2. Aquic if mottled
1.1-/7	Grumic Brown	Ustertic Haploboroll	Chromic Vertisol	2. Dry value >4.5, >35% clay with cracking 3. If moist chroma >1.5 with cracking
1.1-/8	Gleyed Brown	Add Aquic to group	No equivalent	2. With slight mottling
1.2	Dark Brown (Dark Chestnut)	Typic Boroll subgroups	Kastanozems (typic)	3. Borustic typic climate
1.21	Orthic Dark Brown			
	Bm,Btj	Typic Haploboroll	Haplic Kastanozem	1. Bm; 2,3. with cambic B
	Bt	Typic Argiboroll	Luvic Kastanozem	1. Bt; 2,3. textural B
1.22	Rego Dark Brown			
	Ah,Ck,C	Entic Haploboroll	Haplic Kastanozem	1,2,3. No cambic B
	Ahk,Cca,C	Typic Calciboroll	Calcic Kastanozem	1,2,3. with calcic horizon
1.23	Calcareous Dark Brown			
	Ah,Bmk,Ck,C	Typic Haploboroll	Haplic Kastanozem	2,3. With cambic B
	Ah,Bmk,Cca,C	Haplic Calciboroll	Calcic Kastanozem	2,3. With cambic B & calcic C
1.24	Eluviated Dark Brown			
	Ah,(Ahe),Ae,Bt,C	Albic Argiboroll	Luvic Kastanozem	2. Albic; 3. E horizon
	Ah,(Ahe),AB,Bt or Btj, C (cumulic type)	Pachic Argiboroll	Luvic Kastanozem	2. Cumulic A or AB >20 in.

[4]Only diagnostic horizons pertinent to the appropriate correlation are underlined.

Table 8. Taxonomic correlation at subgroup level – Cont.

	1. Canadian	2. U.S.	3. World	Comments on criteria
1.21-2.11	Solonetzic Dark Brown Ah,Bnjt,C	Typic Argiboroll	Luvic Kastanozem	2,3. Bnjt will not meet limits of natric B or Bna
1.24-2.21	Solodic Dark Brown Ah,(Ahe),Ae or AB,Bnjt	Albic Argiboroll	Luvic Kastanozem	
1.2-/5	Saline Dark Brown	Add Salic to above groups	Add Saline phase	1. S or Sa; 2,3. with Sa horizon
1.2-/6	Carbonated Dark Brown	Calciboroll or Aquic Calciboroll	Calcic Kastanozem	2. Use Aquic if mottled
1.2-/7	Grumic Dark Brown	Vertic Haploboroll	Chromic Vertisol	2. Dry value < 4.5, > 35% clay with cracking 3. Moist chroma > 1.5 with cracking
1.2-/8	Gleyed Dark Brown	Add Aquic to group	No equivalent	2. With slight mottling
1.3	Black	Udic Boroll subgroups (minor Rendolls)	Chernozems (minor Rendzinas)	3. Borudic climate 2,3. Rendolls & Rendzinas if C horizon > 40% CO_3
1.31	Orthic Black Bm,Btj Orthic Black Bt	Udic Haploboroll Udic Argiboroll	Haplic Chernozem Luvic Chernozem	1. Bm; 2,3. with cambic B 1. Bt; 2,3. with textural B
1.32	Rego Black Ah,Ck,C	Entic Udic Haploboroll (minor Cryic Rendoll)	Haplic Chernozem (minor Rendzina)	1,2,3. No cambic B 2,3. C horizon > 40% CO_3
	Rego Black Ahk,Cca,C	Udic Calciboroll	Calcic Chernozem	1,2,3. With calcic horizon

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1.33	Calcareous Black Ah,Bmk,Ck,C Ah,Bmk,Cca,C	 Udic Haploboroll Haplic Udic Calciboroll	 Haplic Chernozem Calcic Chernozem	 2,3. With cambic B 2,3. With cambic B & calcic C
1.34	Eluviated Black Ah,(Ahe),Ae,Bt,C Ah,(Ahe),AB,Bt or Btj,C (cumulic type)	 Albic Udic Argiboroll Pachic Udic Argiboroll	 Luvic Chernozem Luvic Chernozem	 2. Albic; 3. E horizon 2. Cumulic A or AB > 16 in.
1.31-2.12	Solonetzic Black Ah,Bnjt,C	 Udic Argiboroll	 Luvic Chernozem	 2,3. Bnjt will not meet limits of natric B or Bna
1.34-2.22	Solodic Black Ah,(Ahe),Ae or AB,Bnjt	 Albic Udic Argiboroll	 Luvic Chernozem	
1.3-/5	Saline Black	Add Salic to above groups	Add Saline phase	1. S or Sa; 2,3. with Sa horizon
1.3-/6	Carbonated Black	Udic Calciboroll or Aquic Calciboroll	Calcic Chernozem	2. Use Aquic if mottled
1.3-/7	Grumic Black	Udertic Haploboroll	Pellic Vertisol	2,3. Moist chroma < 1.5, > 35% clay with cracking
1.3-/8	Gleyed Black	Add Aquic to group	Gleyic Chernozem	2. With slight mottling
1.4	Dark Gray	Boralfic Boroll subgroups	Greyzems	3. Borudic-udoboric transitional climate

Table 8. Taxonomic correlation at subgroup level – Cont.

	1. Canadian	2. U.S.	3. World	Comments on criteria
1.41	Orthic Dark Gray			
	(L-H),AhAhe,Bm, Btj,C	Boralfic Haploboroll	Orthic Greyzem	1. Bm; 2,3. with cambic B
	(L-H),Ah,Ahe,Ae,Bt, C	Albic Boralfic Argiboroll	Orthic Greyzem	1. Bt; 2,3. with textural B 3. May include Haplic & Luvic Phaeozems if lacking a Cca
1.42	Rego Dark Gray	Entic Boralfic		
	L-H,Ah,Ahe,Ck,C	Haploboroll	Haplic Chernozem	1,2,3. No cambic B
	L-H,Ah,Ahe,Cca,C	Boralfic Calciboroll	Calcic Chernozem	1,2,3. With calcic horizon 3. May include Calcaric Phaeozems
1.43	Calcareous Dark Gray			
	(L-H),Ah,Ahe,Bmk, Ck,C	Boralfic Haploboroll	Haplic Chernozem	2. Dry value < 5 with some expression of albic horizon
	(L-H),Ah,Ahe,Bmk, Cca,C	Haplic Boralfic Calciboroll	Calcic Chernozem	3. May include Calcaric Phaeozems
1.41-2.12	Solonetzic Dark Gray (L-H),(Ah),Ahe,(Ae), Bnjt,C	Boralfic Argiboroll	Orthic Greyzem	2,3. Bnjt will not meet limits of natric B or Bna
1.41-2.22	Solodic Dark Gray (L-H),(Ah),Ahe,Ae or AB,Bnjt	Boralfic Argiboroll	Orthic Greyzem	
1.4-/6	Carbonated Dark Gray	Boralfic Calciboroll	Calcic Chernozem	2. Use Aquic if mottled 3. May include Calcaric Phaeozems

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1.4-/8	Gleyed Dark Gray	Add Aquic to group	Gleyic Greyzem	2. With slight mottling
2	Solonetzic	Natric great groups	Solonetz	1. Bn. Ratio Ca/Na < 10 + Csa 2,3. Natric B & Saline C
2.1	Solonetz Bnt,Cs, Csa	Natric great groups	Mollic, Orthic, and Gleyic Solonetz	1. Presence of Bn,Cs,Csa 2. Presence of Natric B & Csa 3. Presence of Bna & Csa
2.11	Brown Solonetz Ah or Ahe and/or Ae,Bnt,Csa,Cs	Aridic Natriboroll Typic Natriboroll	Mollic Solonetz Mollic Solonetz	1,2,3. If Ap > 4.5 dry 1,2,3. If Ap > 3.5 dry 3. Melanic A
2.11/er.	Eroded phase (Ahe),(Ae),Bnt,Csa	Mollic Natrargid or Typic Natrargid	Orthic Solonetz Orthic Solonetz	2,3. Ap > 4 moist & > 6 dry 2,3. Ap < 4 moist & < 6 dry
2.12	Black Solonetz	Udic Natriboroll Typic Natriboroll	Mollic Solonetz	3. Melanic or Sombric A with Bna 2. Udic if chroma < 1.5 Typic if chroma > 1.5
2.13	Gray Solonetz L-H,(Ah),(Ahe),Ae, Bnt,Csa	Natriboralf	Orthic Solonetz	3. In udoboric climate phase with Ochric A
2.14	Alkaline Solonetz (Ah),Bn or Bntj,Cs,Csa	Natriboroll or Natrargid	Mollic Solonetz or Orthic Solonetz	2,3. If with Melanic A 2,3. If with Ochric A
2.1-/8	Gleyed Solonetz	Add Aquic or Aquic subgroup of Natraquolls Natralbolls	Gleyic Solonetz	2. If without Aeg 2. If with Aeg

Table 8. Taxonomic correlation at subgroup level – Cont.

	1. Canadian	2. U.S.	3. World	Comments on criteria
2.2	Solod	Glossic Natriborolls or Natralbolls	Solodic Planosols	3. If with E, EB, & Bt horizons 2. Natrabolls if with Aeg or Bng
2.21	Brown Solod Ah,Ahe,Ae,AB,Bnt, Cs,Sa	Glossic Aridic Natriboroll Glossic Natriboroll	Solodic Planosol (Mollic)	2. Aridic, dry value > 4.5 2. Typic dry value < 4.5 moist chroma > 1.5
2.22	Black Solod	Glossic Udic Natriboroll	Solodic Planosol (Mollic)	2. With moist chroma < 1.5 Ap
2.23	Gray Solod	Glossic Natriboralf	Solodic Planosol (Dystric)	3. An EB, has an eluviated columnar structure
2.2-/8	Gleyed Solod	Natralboll	Solodic Planosol	2,3. Solods are not fully worked out in U.S. and World systems
3	Luvisolic	Alfisols Boralfs, Udalfs	Luvisols Albic Luvisols	2,3. Boreal climate 2,3. Udic climate
3.1	Gray Brown Luvisol Ah,Ae,Bt,C	Hapludalfs or Glossudalfs	Albic Luvisols	2,3. Ae or interfingered AB 2. With tonguing, AB or EB
3.11	Orthic Gray Brown Luvisol (L-H),Ah,Ae,(AB), BA,Bt,C	Typic Hapludalf or Mollic Hapludalf	Albic Luvisol	2. Ap moist color value > 4 or dry color > 6 2. Ap moist color < 4, dry < 6
3.12	Brunisolic Gray Brown Luvisol	Ochreptic Hapludalf	Albic Luvisol	2,3. Udic climate 3. Intergrading to Cambisol

3.13	Bisequa Gray Brown Luvisol	Orthodic Hapludalf	Albic Luvisol	3. Intergrading to Podzol
3.1-/8	Gleyed Gray Brown Luvisol	Add Aquic to group	Gleyic Albic Luvisol	
3.2	Gray Luvisol	Boralfs 2a. Eutroboralfs 2b. Cryoboralfs 2c. Pergelic Cryoboralfs	Albic Luvisols	2. Boreal climates, MAST < 8 C 2a. MSST > 15 C 2b. MSST < 15 C 2c. MAST < 0 C
3.21	Orthic Gray Luvisol	Typic Cryoboralf	Albic Luvisol	2. Ap moist value > 3.5, dry value > 5.0
3.22	Dark Gray Luvisol	2a. Typic Cryoboralf 2b. Mollic Cryoboralf	Albic Luvisol	2a. Ap dry value > 3.5 & < 5.0 2b. Mollic if Ap moist color value < 3 or Ap 6 in. moist color value < 3.5
3.2-/3	Brunisolic Gray Luvisol	2a. Dystrochreptic Cryoboralf 2b. Dystrochreptic Mollic Cryoboralf	Albic Luvisol	3. Intergrading to Cambisol 3. Intergrading to Cambisol
3.2-/4	Bisequa Gray Luvisol	Orthodic Cryoboralf	Albic Luvisol	3. Intergrading to Podzol
3.2-/8	Gleyed Gray Luvisol	Add Aquic to group	Gleyic Albic Luvisol	
3.2-2.23	Solodic Gray Luvisol	Glossic Cryoboralf	Albic Luvisol	2. With EB or AB
4	Podzolic	Spodosols 2a. Humods 2b. Orthods	Podzols	1. With illuvial Bh,Bhf,Bfh,Bf 2,3. With Spodic B horizons
4.1	Humic Podzol Bh	Humods 2a. Cryohumods 2b. Haplohumods	Humic & Placic Podzols	1,2,3. B does not turn redder on ignition 2a. Boreal climate 2b. Udic climate

Table 8. Taxonomic correlation at subgroup level – Cont.

	1. Canadian	2. U.S.	3. World	Comments on criteria
4.11	Orthic Humic Podzol Bh	2a. Cryohumod 2b. Typic Haplohumod	Humic Podzol	
4.12	Placic Humic Podzol Bh,Bc	Placohumod	Placic Podzol	
4.1-/8	Gleyed Humic Podzol Bg	Add Aquic to group	Gleyic Podzol	
4.2	Ferro-Humic Podzol Ae,Bhf	2a. Humic Cryorthods 2b. Humic Haplorthods	Orthic Podzols	1. Bhf > 10% OM, turns red on ignition 2a. Boreal. 2b. Udic climate
4.21	Orthic Ferro-Humic Podzol Ae,Bhf	Humic Cryorthod Humic Haplorthod	Orthic Podzol	
4.22	Mini Ferro-Humic Podzol Aej,Bhf	Haplic Humic Cryorthod	Orthic Podzol	
4.23	Sombric Ferro-Humic Podzol Ah,Aej,Bhf	Umbric Humic Cryorthod	Orthic Podzol	
4.2-/4	Placic Ferro-Humic Podzol Ah,Aej,Bhf,Bc	(Humic) Placorthod	Placic Podzol	
4.2-/8	Gleyed Ferro-Humic Podzol	Add Aquic to group	Gleyic Podzol	

4.3	Humo-Ferric Podzol Bfh or Bf	Cryorthods or Haplorthods	Orthic Podzols	1. Bfh,Bf with < 10% OM, turns red on ignition
4.31	Orthic Humo-Ferric Podzol	Typic Cryorthod or Haplorthod	Orthic Podzol	
4.32	Mini Humo-Ferric Podzol Aej	Haplic Cryorthod	Orthic Podzol	1. Minimal Aej
4.33	Sombric Humo-Ferric Podzol Ah	Umbric Haplorthod	Orthic Podzol	2,3. Udic climate
4.3-/4	Placic Humo-Ferric Podzol Bfh,Bf,Bfc	Placorthod	Placic Podzol	
4.3-/5	Bisequa Humo-Ferric Podzol	Boralfic Cryorthod or Alfic Haplorthod	Orthic Podzol	1,2. With Bt
4.3-/7	Cryic Humo-Ferric Podzol	Pergelic Leptic Cryorthod	Orthic Podzol	1,2,3. Cryic climate
4.3-/8	Gleyed Humo-Ferric Podzol	Add Aquic to group	Gleyic Podzol	
5	Brunisolic	Inceptisols	Cambisols	1,2,3. Bm or cambic B excluding Mollisols
5.1	Melanic Brunisol	(Mollic) Eutrochrepts	Eutric Cambisols	2. Ap value < 4 moist, < 6 dry or Ah > 6 in. value < 3.5 moist

Table 8. Taxonomic correlation at subgroup level – Cont.

	1. Canadian	2. U.S.	3. World	Comments on criteria
5.11	Orthic Melanic Brunisol	(Mollic) Eutrochrept	Eutric Cambisol	
5.12	Degraded Melanic Brunisol Ah,Aej,Bm,Btj,Ck	(Mollic) Alfic Eutrochrept	Eutric Cambisol	
5.1-/8	Gleyed Melanic Brunisol	Add Aquic to group		
5.2	Eutric Brunisol L-H,(Ah),Bm,Ck	2a. Eutrochrepts 2b. (Eutric) Cryochrepts	Eutric Cambisols	2a. Udic climate 2b. Boreal climate
5.21	Orthic Eutric Brunisol L-H,(Ah),Bm,Ck	2a. Typic Eutrochrept 2b. (Eutric) Cryochrept	Eutric Cambisol	
5.22	Degraded Eutric Brunisol L-H,Ae,Aej,Bm,Ck	2a. Alfic Eutrochrept 2b. Alfic Cryochrept	Eutric Cambisol	†Bfj used to indicate some spodic characteristics of Bm
	L-H,(Ah),Ae,Bfj,†Ck	2b. Spodic Cryopsamment 2a. Spodic Udipsamment	Dystric Cambisol	
	L-H,(Ah),Ae,Btj,C	2b. Alfic Drystric Cryochrept 2a. Alfic Dystrochrept 2c. Alfic Eutrochrept	Dystric Cambisol	2c. If base saturation >60% and with CO_3 in some horizon
5.23	Alpine Eutric Brunisol	2a. (Eutric) Cryochrept or 2b. Lithic Pergelic Cryochrept	Eutric Cambisol	2a. Cryic climate 2b. With lithic contact <20 in.

5.2-/7	Cryic Eutric Brunisol	Pergelic Cryochrept	Gelic Cambisol	2. Cryic with permafrost
5.2-/8	Gleyed Eutric Brunisol	Add Aquic to group	Eutric Cambisol	
5.3	Sombric Brunisol	2a. Umbric Dystrochrepts 2b. Typic Eutrochrepts 2c. Dystric Eutrochrepts	Humic Cambisols	2a. Base sat. <60% with no CO_3 in any horizon 2b. Base sat. >60% with CO_3 in some horizon 2c. Base sat. >60% with no CO_3 in any horizon
5.31	Orthic Sombric Brunisol	Umbric Dystrochrept	Humic Cambisol	
5.31/8	Gleyed Sombric Brunisol	Add Aquic to group		
5.4	Dystric Brunisol	2a. Dystrochrepts 2b. Dystric Cryochrepts	Dystric Cambisols	2a. Udic climate 2b. Boreal climate
5.41	Orthic Dystric Brunisol Brunisol	2a. Typic Dystrochrept 2b. Typic Dystric Cryochrept	Dystric Cambisol	
5.42	Degraded Dystric Brunisol L-H,Aej,Ae,Bm or Bmcc,C	2b. Orthodic Cryochrept 2a. Orthodic Dystrochrept	Dystric Cambisol	2a. Spodic Cryopsamment if texture is LS or S
5.43	Alpine Dystric Brunisol	2a. Dystric Cryochrept or 2b. Lithic Pergelic Cryochrept	Dystric Cambisol	2a. Cryic climate 2b. With lithic contact <20 in.

Table 8. Taxonomic correlation at subgroup level – Cont.

	1. Canadian	2. U.S.	3. World	Comments on criteria
5.4-/7	Cryic Dystric Brunisol	Pergelic Dystric Cryochrept	Gelic Cambisol	2. Cryic with permafrost
5.4-/8	Gleyed Dystric Brunisol	Add Aquic to group		
6	Regosolic	Entisols	Fluvisols & Regosols	
6.1	Regosol	Entisols	Fluvisols & Regosols	
6.11	Orthic Regosol	2a. Udorthent 2b. Cryorthent 2a. Udipsamment 2b. Cryopsamment	3a. Dystric Regosol 3b. Eutric Regosol 3c. Calcaric Regosol	2a. Udic climate 2b. Boreal climate 3a. pH (KCl) <4.2 3b. pH (KCl) >4.2 3c. If calcareous between 20 & 30 cm depth
6.12	Cumulic Regosol	2a. Udifluvent 2b. Cryofluvent	3b. Eutric Fluvisol 3a. Dystric Fluvisol 3c. Calcaric Fluvisol	
6.1-/5	Saline Regosol	Add Salic	Salic phase	
6.1-/7	Cryic Regosol	Add Pergelic	Gelic Regosol	2. Cryic climate with permafrost 3. (Definition under consideration)
6.1-/8	Gleyed Regosol	Add Aquic to group		
6.1-/9	Lithic Regosol	Add Lithic to group	3a. Lithosol or 3b. Regosol	3a. If lithic contact <25 cm (10 in.)

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7	Gleysolic	Aqu- suborders	Gleysols & Planosols	1,2,3. Characteristics associated with wetness
7.1	Humic Gleysol	2a. Aquolls 2b. Humaquepts	3a. Mollic Gleysols 3b. Humic Gleysols 3c. Calcaric Gleysols (Humic)	2a-3a. High base status, Mollic 2b-3b. Low base status, Humic 3c. If calcareous between 20 & 50 cm depth
7.11	Orthic Humic Gleysol Ah,Bg,Cg	2a. Haplaquoll 2b. Cryaquoll 2c. Humaquept	Mollic or Humic Gleysol Mollic or Humic Gleysol Humic Gleysol	2a. Udic climate 2b. Boreal climate 2c. Low base status, Umbric
7.12	Rego Humic Gleysol a. Ah,Cg or b. Ah,Ckg	2a. Typic Aquoll or Typic Humaquept 2b. Calcic Aquoll	Mollic Gleysol	2a. Cryaquoll or Haplaquoll
7.13	Fera Humic Gleysol Ah,Bgf,Cg	2a. Sideric Humaquept or 2b. Sideric Aquoll	Humic Gleysol	2ab. Assuming that Bgf is cambic, not spodic
7.1-/5	Saline Humic Gleysol	Add Salic to group	Saline phase	
7.1-/6	Carbonated Humic Gleysol	2a. Calciaquoll 2b. Calcic Cryaquoll	Calcaric Gleysol	2a. Udic climate 2b. Boreal climate
7.1-/7	Cryic Humic Gleysol	2. Pergelic Cryaquoll	Humic or Mollic Gleysol	2. Cryic with permafrost
7.2	Gleysol	Aquents, Fluvents, Aquepts	Eutric or Dystric Gleysols	2,3. Ochric Epipedon or Ochric A; Fluvents if coarse texture 3. Eutric pH >5.5, Dystric pH <5.5

Table 8. Taxonomic correlation at subgroup level – Cont.

	1. Canadian	2. U.S.	3. World	Comments on criteria
7.21	Orthic Gleysol	Typic Cryaquept or Typic Haplaquept	Eutric or Dystric Gleysol	Boreal or temperate climate
7.22	Rego Gleysol	Entic or Calcic Cryaquept or Haplaquept	Eutric or Dystric Gleysol 3. Calcaric Gleysol	2. Boreal or Udic climate, no cambic B 3. If calcareous between 20 & 50 cm depth
7.23	Fera Gleysol	2a. Sideric Cryaquept 2b. Sideraquod or Sideric Cryaquod	Dystric Gleysol	2a. Bgf cambic 2b. Bgf illuvial, spodic
7.2-/5	Saline Gleysol	Add Salic to group	3a. Gleyic Solonchak 3b. Gleyic Solonchak sodic phase	3a. With Cg Sa 3b. With Cn-natric horizon
7.2-/6	Carbonated Gleysol	Calcic Cryaquent or Calcic Haplaquent	Calcaric Gleysol	
7.2-/7	Cryic Gleysol	Add Pergelic to group	Gelic Gleysol	2. Cryic climate with permafrost
7.3	Eluviated Gleysol	Albolls, Aquolls, Aqualfs	Planosols	2,3. Occurrence of Albic or E horizons
7.31	Humic Eluviated Gleysol	2a. Typic Argialboll 2b. Argic Cryaquoll or Cryic Argialboll 2c. Mollic Albaqualf	Mollic or Humic Planosol	2a. With abrupt textural B 2b. Boreal climate 2c. With Mollic Ap moist value <4. 3. Mollic with high base saturation; Humic with low base sturation

7.32	Low Humic Eluviated Gleysol	Typic Albaqualf or Glossaqualf	Eutric or Dystric Planosol	3. Eutric with high base saturation; Dystric with low base saturation
7.33	Fera Eluviated Gleysol	2a. Sideric Cryaquod 2b. Sideric Glossaqualf or Sideric Albaqualf	Dystric Planosol	If illuvial Bgf with Btgf
Peaty Phases of Gleysols		Add Histic to above groups	Histic Gleysols	
8	Organic	Histosols	Histosols 3a. Dystric 3b. Eutric	 3a. pH in water < 5.5 3b. pH in water > 5.5
8.1	Fibrisol	Fibrist 2a. Medifibrist 2b. Borofibrist 2c. Cryofibrist 2d. Sphagnofibrist		 2a. MAST > 8 C 2b. MAST < 8 C 2c. MAST < 8 C and have permafrost 2d. 90 cm or more of sphagnum peat on the surface
8.1-1a	Fenno-Fibrisol			
8.1-1b	Silvo-Fibrisol	____fibrist		
8.1-1c	Sphagno-Fibrisol	Typic Sphagnofibrist		

Table 8. Taxonomic correlation at subgroup level – Cont.

	1. Canadian	2. U.S.	3. World	Comments on criteria
8.1-2	Mesic Fibrisol	Hemic ____ fibrist		
8.1-3	Humic Fibrisol	Sapric ____ fibrist		
8.1-4	Limno Fibrisol	Limnic ____ fibrist		
8.1-5	Cumulo Fibrisol	Fluventic ____ fibrist		
8.1-6	Terric Fibrisol	Terric ____ fibrist		
8.1-7	Terric Mesic Fibrisol	Terric Hemic ____ fibrist		
8.1-8	Terric Humic Fibrisol	Terric Sapric ____ fibrist		
8.1.9	Cryic Fibrisol	Pergelic Cryofibrist		Cryic with permafrost
8.1-10	Hydric Fibrisol	Hydric ____ fibrist		
8.1-11	Lithic Fibrisol	Lithic ____ fibrist		
8.2	Mesisol	Hemist 2a. Medihemist 2b. Borohemist 2c. Cryohemist		
8.2-1	Typic Mesisol	Typic ____ hemist		
8.2-2	Fibric Mesisol	Fibric ____ hemist		
8.2-3	Humic Mesisol	Sapric ____ hemist		
8.2-7	Terric Fibric Mesisol	Fibric terric ____ hemist		
8.2-8	Terric Humic Mesisol	Sapric terric ____ hemist		
8.2-4, -5, -6, -9, -10, -11 As above				

8.3	Humisol	Saprist 2a. Medisaprist 2b. Borosaprist 2c. Cryosaprist
8.3-1	Typic Humisol	Typic ____ saprist
8.3-2	Fibric Humisol	Fibric ____ saprist
8.3-3	Mesic Humisol	Hemic ____ saprist
8.3-7	Terric Fibric Humisol	Fibric Terric ____ saprist
8.3-8	Terric Mesic Humisol	Hemic Terric ____ saprist
8.3-4, -5, -6, -9, -10, -11 As above		
8.4	Folisol	Folist 2b. Borofolist 2c. Cryofolist
8.4-1	Typic Folisol	Typic ____ folist
8.4-11	Lithic Folisol	Lithic ____ folist

Table 9. Taxonomic correlation at great group level

1. Canadian		2. U.S.	3. World	Comments
1	Chernozemic	Borolls	Kastanozems 3a Chernozems 3b	Boreal semiarid Boreal subhumid
1.1	Brown (Light Chestnut)	Aridic Borolls	Aridic Kastanozems	Borusticaridic
1.2	Dark Brown (Dark Chestnut)	Typic Borolls	Typic Kastanozems	Borustictypic
1.3	Black	Udic Borolls	Chernozems	Borudic climate
1.4	Dark Gray	Boralfic Borolls	Greyzems	BorudicUdoboric
2	Solonetzic	Natric great groups	Solonetz	Boreal and
2.1	Solonetz	Natric great groups	Mollic, Orthic, and Gleyic Solonetz	Ustic climates
2.2	Solod	Glossic Natribolls and Natralbolls	Solodic Planosols	
3	Luvisolic	Alfisols	Luvisols	
3.1	Gray Brown Luvisol	Udalfs	Albic Luvisols	Moist Udic climate
3.2	Gray Luvisol	Boralfs	Albic Luvisols	Boreal climate
4	Podzolic	Spodosols	Podzols	Boreal and
4.1	Humic Podzol	Humods	Humic & Placic Podzols	Udic climates
4.2	Ferro-Humic Podzol	(Humic) Orthods	Orthic Podzols & Placic Podzols	

4.3	Humo-Ferric Podzol	Orthods	Orthic Podzols & Placic Podzols	
5	Brunisolic	Inceptisols	Cambisols	Boreal and
5.1	Melanic Brunisol	(Mollic) Eutrochrepts	Eutric Cambisols	Udic climates
5.2	Eutric Brunisol	Eutrochrepts and Cryochrepts	Eutric Cambisols	
5.3	Sombric Brunisol	Umbric Dystrochrepts	Humic Cambisols	
5.4	Dystric Brunisol	Dystrochrepts	Dystric Cambisols	
6	Regosolic	Entisols	Fluvisols & Regosols	All climates
6.1	Regosol	Fluvents, Orthents, & Psamments	Fluvisols & Regosols	
7	Gleysolic	Aqu- suborders	Gleysols & Planosols	All climates
7.1	Humic Gleysol	Aquolls and Humaquepts	Mollic, Humic, and Calcaric Gleysols	
7.2	Gleysol	Aquents, Fluvents, and Aquepts	Eutric or Dystric Gleysols	
7.3	Eluviated Gleysol	Albolls, Aquolls, Aqualfs, and Aquods	Planosols	
8	Organic	Histosols	Histosols	Boreal and Udic
8.1	Fibrisol	Fibrist	Eutric and Dystric	climates
8.2	Mesisol	Hemist	Histosols	
8.3	Humisol	Saprist		
8.4	Folisol	Folist		

TERMINOLOGY FOR DESCRIBING SOILS

Many terms are used to describe soils and their environment. In order to draw this material into one document, the various groups of terms are presented in two broad categories; those which characterize the land or a pedon, and those which characterize the soil horizon.

LAND SURFACE TERMINOLOGY

LAND FORMS AND TOPOGRAPHIC CLASSES

The following are the topographic classes and symbols:

	Simple topography Single slopes (regular surface)		*Complex topography Multiple slopes (irregular surface)*	*Slope %*
A	depressional to level	a	nearly level	0 to 0.5
B	very gently sloping	b	gently undulating	0.5+ to 2
C	gently sloping	c	undulating	2+ to 5
D	moderately sloping	d	gently rolling	5+ to 9
E	strongly sloping	e	moderately rolling	9+ to 15
F	steeply sloping	f	strongly rolling	15+ to 30
G	very steeply sloping	g	hilly	30+ to 60
H	extremely sloping	h	very hilly	over 60

WATER EROSION

The water-erosion classes, as defined in the U.S. Department of Agriculture Soil Survey Manual, are being used. The four classes are designated on the map as W1, W2, W3, and W4.

W1 (Slightly eroded land) The soil has a few rills or places with thin A horizons that give evidence of accelerated erosion, but not to an extent to alter greatly the thickness and character of the A horizon. Except for soils having very thin A horizons (less than 8 inches), the surface soil (Ap) consists entirely of A horizon throughout nearly all of the delineated area. Up to about 25% of the original A horizon, or original plowed layer in soils with thin A horizons, may have been removed from most of the area. In most soils, areas with this class of erosion are not significantly different in use capabilities and management requirements from the uneroded soil. In a few soils having very shallow sola over a nonconforming layer, or in a few having a shallow A horizon over a claypan or hardpan, a significant difference may exist.

W2 (Moderately eroded land)—The soil has been eroded to the extent that ordinary tillage implements reach through the remaining A horizon, or well below the depth of the original plowed layer in soils with a thin A horizon. Generally, the plow layer consists of a mixture of the original A horizons and underlying horizons. Mapped areas of eroded soil usually have patches in which the plow layer consists wholly of underlying horizons. Shallow gullies may be present. Approximately 25 to 75% of the original A horizon or surface soil may have been lost from most of the area.

W3 (Severely eroded land)—The soil has been eroded to the extent that all or practically all of the original surface soil, or A horizon, has been removed. The plow layer consists essentially of materials from the B or other underlying horizons. Patches in which the plow layer is a mixture of the original A horizon and the B horizon or other underlying horizons may be included within mapped areas. Shallow gullies, or a few deep ones, are common on some soil types. More than 75% of the original surface soil, or A horizon, and commonly part or all of the B horizon or other underlying horizons, have been lost from most of the area.

W4 (Gullied land)—The land has been eroded until it has an intricate pattern of moderately deep or deep gullies. Soil profiles have been destroyed except in small areas between gullies. Such land is not useful for crops in its present condition. Reclamation for crop production or for improved pasture is difficult, but may be practicable if the other characteristics of the soil are favorable and erosion can be controlled.

The following classes of gully erosion are being used:

E1) These are shallow occasional gullies that may be crossed by mechanized implements and are more than 100 feet apart.

E2) These are shallow frequent gullies that may be crossed by mechanized implements, but are less than 100 feet apart.

E3) These are deep occasional gullies that cannot be crossed by mechanized implements. A change of land use is indicated.

E4) These are deep frequent gullies that cannot be crossed by mechanized implements. A change of land use is indicated.

The following special symbol is used for the accumulation of water-eroded materials.

+ Recent accumulations less than 12 inches thick resulting from accelerated erosion, and not including normal floodplain deposits.

1+2+ Thickness of accumulations in feet.

WIND EROSION

The wind-erosion classes, as defined in the U.S. Department of

Agriculture Soil Survey Manual, are designated on the map as D1, D2, and D3. The classes are defined as follows:

D1 [Wind-eroded (or blown) land]—Wind has removed from the soil a sufficient amount of the A horizon that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer. Rarely is this condition uniform throughout a mappable area, however. Usually the plow layer consists mainly of the original A horizon in some patches, whereas in others the original A horizon is removed. Generally, about 25 to 75% of the original A horizon (or surface soil in soils with thin A horizons) may have been removed.

D2 [Severely wind-eroded (or blown) land]—Wind has removed all of the A horizon and part of the B or other lower lying horizon. The plow layer consists mainly of the original horizons below the A (or below the original plowed layer in soils with thin A horizons), although some patches having much of the original A horizon remain in the area. An occasional blowout area may be included.

D3 (Blown-out land)—The wind has removed most of the soil profile and the land is classified as a miscellaneous land type. Use of the land for ordinary agriculture is not feasible without extensive reclamation. Blowout holes are numerous and deeply carved into the lower soil or parent materials. Areas between blowouts are deeply buried by soil material from the blowouts.

The following special symbols were adopted for use in wind-eroded areas:

- 4 Blow-pit removal. The number indicates the depth in feet.
- 5 Recent dune or dunelike accumulations. The number indicates the height in feet.
- /\/\/ Hummocky area of mixed removal and accumulation.

STONINESS, ROCKINESS, AND COARSE FRAGMENTS

The classes of stoniness, rockiness, and coarse fragments defined below were adopted in 1955. The agricultural significance and the description of the classes of stoniness and rockiness should be determined by each regional organization.

The classes of stoniness are defined as follows:

Stones 1 (Slightly stony land)—There are some stones, but they offer only slight to no hindrance to cultivation.

Stones 2 (Moderately stony land)—There are enough stones to cause some interference with cultivation.

Stones 3 (Very stony land)—There are enough stones to constitute a serious handicap to cultivation and some clearing is required.

Stones 4 (Exceedingly stony land)—There are enough stones to prevent cultivation until considerable clearing is done.

Stones 5 (Excessively stony land)—This land is too stony to permit any cultivation (Boulder or stone pavement).

The classes of rockiness are defined as follows:

Rocky 1 (Slightly rocky land)—Sufficient bedrock exposures to interfere with tillage but not to make intertilled crops impracticable. Depending upon how the pattern affects tillage, rock exposures are roughly 100 to 300 feet apart and cover 2 to 10% of the surface.

Rocky 2 (Moderately rocky land)—Sufficient bedrock exposures to make tillage of intertilled crops impracticable, but soil can be worked for hay crops or improved pasture if other soil characteristics are favorable. Rock exposures are roughly 30 to 100 feet apart and cover 10 to 25% of the surface, depending upon the pattern.

Rocky 3 (Very rocky land)—Sufficient rock outcrop to make use of machinery impracticable, except for light machinery where other soil characteristics are especially favorable for improved pasture. The land may have some use for wild pasture or forests, depending on the other soil characteristics. Rock exposures, or patches of soil too thin over rock for use, are roughly 10 to 30 feet apart and cover 25 to 50% of the surface, depending on the pattern.

Rocky 4 (Exceedingly rocky land)—Sufficient rock outcrop (or very thin soil over rock) to make all use of machinery impracticable. The land may have some value for poor pasture or for forestry. Rock outcrops are about 10 feet or less apart and cover 50 to 90% of the area.

Rocky 5 (Excessively rock land)—Land on which over 90% of the surface is exposed bedrock (rock outcrop).

As a guideline, land with more than 50% bedrock exposed is a complex of Rockland and a soil series.

The names, sizes, shapes, and kinds of fragments are designated as follows:

Shape and kind of fragments	*Size and name of fragments*		
	Up to 3 inches in diameter	*3 to 10 inches in diameter*	*10 + inches in diameter*
Rounded and subrounded fragments (all kinds of rock)	Gravelly[1]	Cobbly	Stony (or bouldery)[2]
Irregularly shaped angular fragments			
Chert	Cherty	Coarse cherty	Stony
Other than chert	Angular gravelly	Angular cobbly[3]	Stony
	Up to 6 inches in length	*6 to 15 inches in length*	*15 + inches in length*
Thin flat fragments			
Thin flat sandstone, limestone, and schist	Channery	Flaggy	Stony
Slate	Slaty	Flaggy	Stony
Shale	Shaly	Flaggy	Stony

[1] The individual classes are not always differentiating characteristics of mapping units.
[2] Bouldery is sometimes used where stones are larger than 24 inches.
[3] Formerly called "stony".

SOIL DRAINAGE CLASSES

The soil drainage classes are defined in terms of (i) actual moisture content in excess of field moisture capacity, and (ii) the extent of the period during which such excess water is present in the plant-root zone.

It is recognized that permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the field, they cannot be used generally as criteria of moisture status.

It is further recognized that soil profile morphology, for example mottling, normally, but not always, reflects soil moisture status. Although soil morphology may be a valuable field indication of moisture status, it should not be the overriding criterion. For example, a soil may exhibit the morphology of a poorly drained soil, but recent changes (either natural or artificial) may have established the moisture status as defined for imperfectly drained soils. Such a soil should be classified as imperfectly drained regardless of its morphology. Some soils that are considered to be well drained are mottled within their sola during the early spring and unmottled throughout most of the year. Other well-drained soils are permanently mottled in their sola because of the nature and the distribution of minerals within them. Soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation as well as soil morphology are useful field criteria for assessing soil moisture status.

The recommended definitions of the soil drainage classes are in italics. As a guide to surveyors, additional comments under each class indicate some of the pertinent morphological features that commonly, but not necessarily, are found in soils having the particular moisture status. The word "significant" as used in the definitions is to be considered in relation to plant growth.

1) Rapidly drained—*The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.*

Soils are free from any evidence of gleying throughout the profile. Rapidly drained soils are commonly soils of coarse texture or soils on steep slopes.

2) Well drained—*The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year.*

Soils are usually free from mottling in the upper 3 ft, but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish.

3) Moderately well drained—*The soil moisture in excess of field capacity remains for a small but significant period of the year.*

Soils are commonly mottled in the lower B and C horizons or below a depth of 2 ft. The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium-textured soils that have a slowly permeable layer below the solum. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark.

4) Imperfectly drained—*The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.*

Soils are commonly mottled in the B and C horizons; the Ae horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

5) Poorly drained—*The soil moisture in excess of field capacity remains in all horizons for a large part of the year.*

The soils are usually very strongly gleyed. Except in high-chroma parent materials the B, if present, and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout.

6) Very poorly drained—*Free water remains at or within 12 inches of the surface most of the year.*

The soils are usually very strongly gleyed. Subsurface horizons usually are of low chroma and yellowish to bluish hues. Mottling may be present but at depth in the profile. Very poorly drained soils usually have a mucky or peaty surface horizon.

Note: In some instances it may be desirable to indicate whether the moisture status is a result of high groundwater level, low permeability, seepage, or telluric water. If so, an appropriate notation can be made following the drainage class designation, for example D4TW (telluric water), D6GW (groundwater), and D5P (permeability).

SOIL PROFILE TERMINOLOGY

Individual horizons are described in terms of dry or moist color, texture, mottles (dry or moist color), structure, consistence (dry, moist, or wet), roots and pores, additional features, lower boundary, thickness range, and reaction. Describe these features for each horizon in the order listed to facilitate comparisons among horizons and among series. All of these may not need to be recorded for every horizon, but most of them will. Describe the features insofar as possible in standard terminology.

COLOR

Color descriptions should include Munsell notations, with few exceptions. The few exceptions are fine mottles, some of which are too small for exact matching with the standards. These are, therefore, more correctly described by color names alone.

For individual horizons, color may be given for moist conditions, dry conditions, and preferably for both conditions. Indicate moisture conditions for the individual color identification or for the whole profile, as already specified.

If there are differences between the color of the soil material in place and that of the crushed mass, or between ped faces and interiors, record these in the description of a horizon. Give the dominant color as the first one, which is one that marks the matrix or major mass of the specimen. Changes in color when the mass is crushed, or in the color of ped coats as contrasted with the color of ped interiors, should follow. Identify the positions of individual colors unless the context makes this obvious.

Most horizons have a dominant color, which changes in value and less commonly in hue and chroma with a change in moisture conditions. Specify the colors of both moist and dry conditions if both are known. When both are given, identify them in the individual horizon descriptions. Give the color of the usual moisture condition first.

TEXTURE

The textural classes are defined wholly in terms of size distribution of the primary particles. These are as follows:

Name of separate	*Diameter, mm*
very coarse sand	2.0 -1.0
coarse sand	1.0 -0.5
medium sand	0.5 -0.25
fine sand	0.25-0.10

very fine sand	0.10–0.05
silt	0.05–0.002
clay	0.002–0.0002
heavy clay	less than 0.0002

Verbal definitions of the soil textural classes, according to size distribution of mineral particles less than 2 mm in diameter, are as follows:

Sands

Sand is a soil material that contains 85% or more sand; percentage of silt, plus 1½ times the percentage of clay, shall not exceed 15.

Coarse sand—25% or more very coarse and coarse sand, and less than 50% any other one grade of sand.

Sand—25% or more very coarse, coarse, and medium sand, and less than 50% fine or very fine sand.

Fine sand—50% or more fine sand, or less than 25% very coarse, coarse, and medium sand and less than 50% very fine sand.

Very fine sand—50% or more very fine sand.

Loamy Sands

Loamy sand is a soil material that contains at the upper limit 85 to 90% sand, and the percentage of silt plus 1½ times the percentage of clay is not less than 15; at the lower limit it contains not less than 70 to 85% sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.

Loamy coarse sand—25% or more very coarse and coarse sand, and less than 50% any other one grade of sand.

Loamy sand—25% or more very coarse, coarse, and medium sand, and less than 50% fine or very fine sand.

Loamy fine sand—50% or more fine sand, or less than 25% very coarse, coarse, and medium sand and less than 50% very fine sand.

Loamy very fine sand—50% or more very fine sand.

Sandy Loams

Sandy loam is a soil material that contains either 20% clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30, and 52% or more sand; or less than 7% clay, less than 50% silt, and between 43% and 52% sand.

Coarse sandy loam—25% or more very coarse and coarse sand and less than 50% any other one grade of sand.

Sandy loam—30% or more very coarse, coarse, and medium sand, but less than 25% very coarse sand, and less than 30% very fine or fine sand.

Fine sandy loam—30% or more fine sand and less than 30% very fine sand, or between 15 and 30% very coarse, coarse, and medium sand.

Very fine sandy loam—30% or more very fine sand, or more than 40% fine and very fine sand, at least half of which is very fine sand and less than 15% very coarse, coarse, and medium sand.

Loam

Loam is a soil material that contains 7 to 27% clay, 28 to 50% silt, and less than 52% sand.

Silt Loam

Silt loam is a soil material that contains 50% or more silt and 12 to 27% clay, or 50 to 80% silt and less than 12% clay.

Silt

Silt is a soil material that contains 80% or more silt and less than 12% clay.

Sandy Clay Loam

Sandy clay loam is a soil material that contains 20 to 35% clay, less than 28% silt, and 45% or more sand.

Clay Loam

Clay loam is a soil material that contains 27 to 40% clay and 20 to 45% sand.

Silty Clay Loam

Silty clay loam is a soil material that contains 27 to 40% clay and less than 20% sand.

Sandy Clay

Sandy clay is a soil material that contains 35% or more clay and 45% or more sand.

Silty Clay

Silty clay is a soil material that contains 40% or more clay and 40% or more silt.

Clay

Clay is soil material that contains 40% or more clay, less than 45% sand, and less than 40% silt.

Heavy Clay

Heavy clay is a soil material that contains 60% or more clay.

In addition to these basic soil textural class names, modified according to the size group of the sand fraction, other modifiers are added. The word "mucky" is used as an adjective on the textural class name for horizons of mineral soils, especially of Humic Gleysols, that contain between 15 and 30% organic matter.

The gravelly class names are added to the textural class names according to the following rule:

% gravel by volume	
less than 20	–use textural class name only
20–50	–gravelly and texture
50–90	–very gravelly and texture
more than 90 in surface 8 inches	–cobble land type.

Phase names for stoniness and rockiness, although not a part of textural soil class names, are used to modify the soil-class part of a soil-type name, as for example Gibraltar stony sandy loam. In the description of all soil horizons, particles larger than 10 inches are excluded from the soil textural class name.

MOTTLES

Mottling in soils is described by noting (i) the color of the matrix and the color or colors of the principal mottles, and (ii) the pattern of the mottling. It is usually sufficient to use the standard Munsell color names rather than the Munsell notation, because the precise color measurement of the color of the mottles is rarely significant. In fact, descriptions of soil horizons containing several Munsell notations are difficult to read rapidly.

The pattern and size of mottles is conveniently described by three sets of notations: abundance, size, and contrast (as defined in the U.S. Dep. Agr. Soil Survey Manual).

Abundance

Few: Mottles occupy less than 2% of the exposed surface.

Common: Mottles occupy 2 to 20% of the exposed surface.

Many: Mottles occupy more than 20% of the exposed surface.

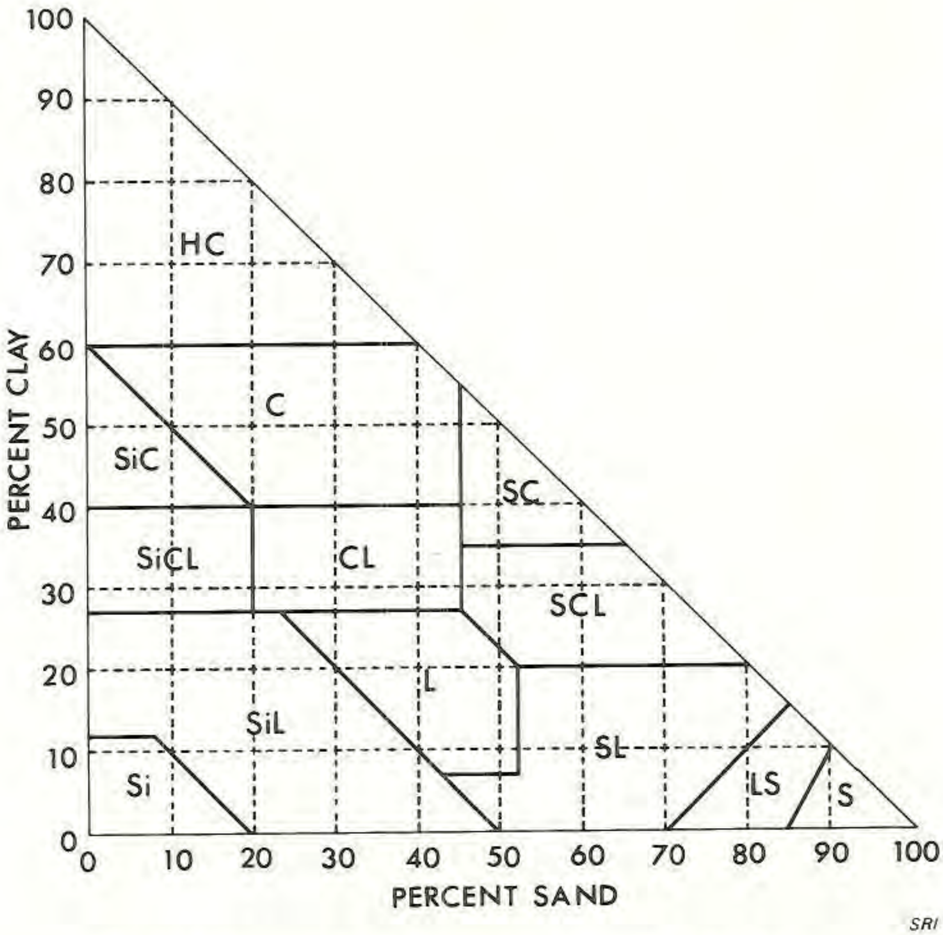

Fig. 34. Soil textural classes. Percentages of clay and sand in the main textural classes of soils; the remainder of each class is silt.

Size

Fine: Less than 5 mm in width or diameter.
Medium: 5 to 15 mm.
Coarse: More than 15 mm.

Contrast

Faint: The hue and chroma of the matrix and mottles are similar.
Distinct: The mottles are more than 2.5 units of hue (e.g., 10YR matrix, 7.5YR mottles), or more than 1 unit of value or chroma, different from the matrix.
Prominent: The matrix and mottles vary by 5 units of hue (10YR matrix, 5Y mottles) or by 3 or more units of value or chroma.

The sequence of terms is abundance, size, contrast, and color, for example, "few, fine, faint yellowish brown mottles."

STRUCTURE

Soil structure refers to the aggregation of the primary soil particles into compound particles or clusters of primary particles, which are separated from adjoining aggregates by surfaces of weakness. The exteriors of some aggregates have thin, often dark-colored surface films that may serve to keep the aggregates apart. Other aggregates have surfaces and interiors of like color, and the forces holding the aggregates together appear to be wholly internal.

An individual natural soil aggregate is called a ped and should not be confused with (i) a clod, formed as a result of some disturbance, such as plowing or digging, that molds the soil to a transient mass that changes with alternating wetting and drying, (ii) a fragment, formed by a rupture of a soil mass across natural surfaces of weakness, or (iii) a concretion, formed by local concentrations of compounds that irreversibly cement the soil grains together.

The classification of structure involves consideration of (i) the shape and arrangement, (ii) the size, and (iii) the distinctness of the visible aggregates or peds. The terminology of structure consists of separate sets of terms designating each of these categories, which by combination form the names of the structure. Shape and arrangement of peds is designated as type of soil structure. This in turn is subdivided into kinds on the basis of the character of the faces and edges of the aggregates. The size of the peds is considered under the class of soil structure, whereas the degree of distinctness is expressed in the grades.

The table indicates four principal types of structure: (i) structureless, in which there is no observable aggregation or no definite orderly arrangement of natural lines of weakness; (ii) blocklike, in which the soil particles are arranged around a point and bounded by flat or rounded surfaces; (iii) platelike, in which the soil particles are arranged around a horizontal plane and generally bounded by relatively flat horizontal surfaces; and (iv) prismlike, in which the soil particles are arranged around a vertical axis and bounded by relatively flat vertical surfaces. Most of these types are subdivided into kinds or subtypes. Thus, under structureless, the single grain kind consists of an incoherent mass of individual particles whereas amorphous (massive) consists of a coherent mass showing no evidence of any distinct arrangement along natural lines of weakness. The blocklike type includes three kinds: the angular blocky, whose faces are rectangular and flattened, bounded by planes intersecting at relatively sharp angles; the subangular blocky, whose faces are subrectangular, or consist of mixed rounded; and the granular that are spheroidal, characterized by rounded vertices. Each type of structure includes peds that vary in shape, and detailed soil descriptions may require supplemental statements about the shape of the individual peds.

The classes recognized are indicated by their name and their size limits. The size limits vary with the shape and arrangement. The oblique dimension is inferred for the blocklike type, the vertical dimension for the platelike, and the horizontal dimension for the prismlike type.

Grade of structure is the degree of distinctness of aggregation. It expresses the differential between cohesion within the aggregates and adhesion between aggregates and is determined mainly by noting the durability of the aggregates and the proportions of aggregated and unaggregated material when the aggregates are displaced or gently crushed. Grade of structure varies with the moistening of the soil and should be described at the most important soil moisture content of the soil horizon. The principal description of the structure of a soil horizon should refer to its normal moisture content, although attention should be called to any striking contrasts in structure under other moisture conditions to which the soil is subject. If grade is designated at an unstated moisture content, it is assumed that the soil is nearly dry or slightly moist, which is commonly that part of the range in soil moisture in which soil structure is most strongly expressed. Terms for grade of structure are as follows:

Weak–Weak is the grade of structure characterized by weakly formed peds that are barely observable in place.

Moderate–Moderate is the grade of structure characterized by moderately well formed peds that are moderately evident in place. Soil material of this grade, when disturbed, breaks down into a mixture of many distinct entire peds, some broken peds, and little unaggregated material.

Strong–Strong is the grade of structure characterized by strongly formed peds that are quite evident in undisplaced soil. They adhere to one another and withstand displacement and separation when the soil is disturbed. When displaced, soil material of this grade consists very largely of entire peds and includes few broken peds and little unaggregated material.

The sequence followed in combining the terms to characterize the structure is (i) grade (distinctness), (ii) class (size), and (iii) kind (shape). Thus the designation for the soil structure in which the peds are loosely packed and roundish, dominantly below 2 mm in diameter, and quite distinct is strong fine granular. The designation of structure by grade, class, and kind can be modified with any other appropriate terms wherever necessary to describe other characteristics of the peds.

Many soil horizons have compound structure consisting of one or more sets of smaller peds held together as larger peds. Such compound structures may be described as follows: compound moderate very coarse prismatic and moderate medium granular. Soil that has one structural form when in place may assume some other form when disturbed. When removed, the larger peds may fall into smaller peds, such as large prisms into medium blocks.

In the parent material of soils, the material with structural shapes may be designated as pseudoblocky, pseudoplaty, and pseudoprismatic.

Reference to geological terms in the description of parent materials should apply to accepted terminology. Many of the terms used in stratigraphy have different definitions. Generally the arrangement of sediments in layers is referred to as stratification. If these layers are not parallel to the dip of the formation they may be referred to as cross-stratified.

A stratum is a layer with certain unifying characteristics, properties, or attributes that distinguish it from adjacent layers. However, bedding and lamination connote a thickness of the strata. A bed is a unit layer in a stratified sequence that is visually or physically more or less distinctly separable from other layers above and below and is 1 cm or more in thickness. A lamina is a unit layer of thickness less than 1 cm. When thickness is implied, reference to cross-stratification will involve consideration of cross-bedding or cross-lamination.

CONSISTENCE

Soil consistence comprises the attributes of soil materials that are expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation and rupture. Every soil material has

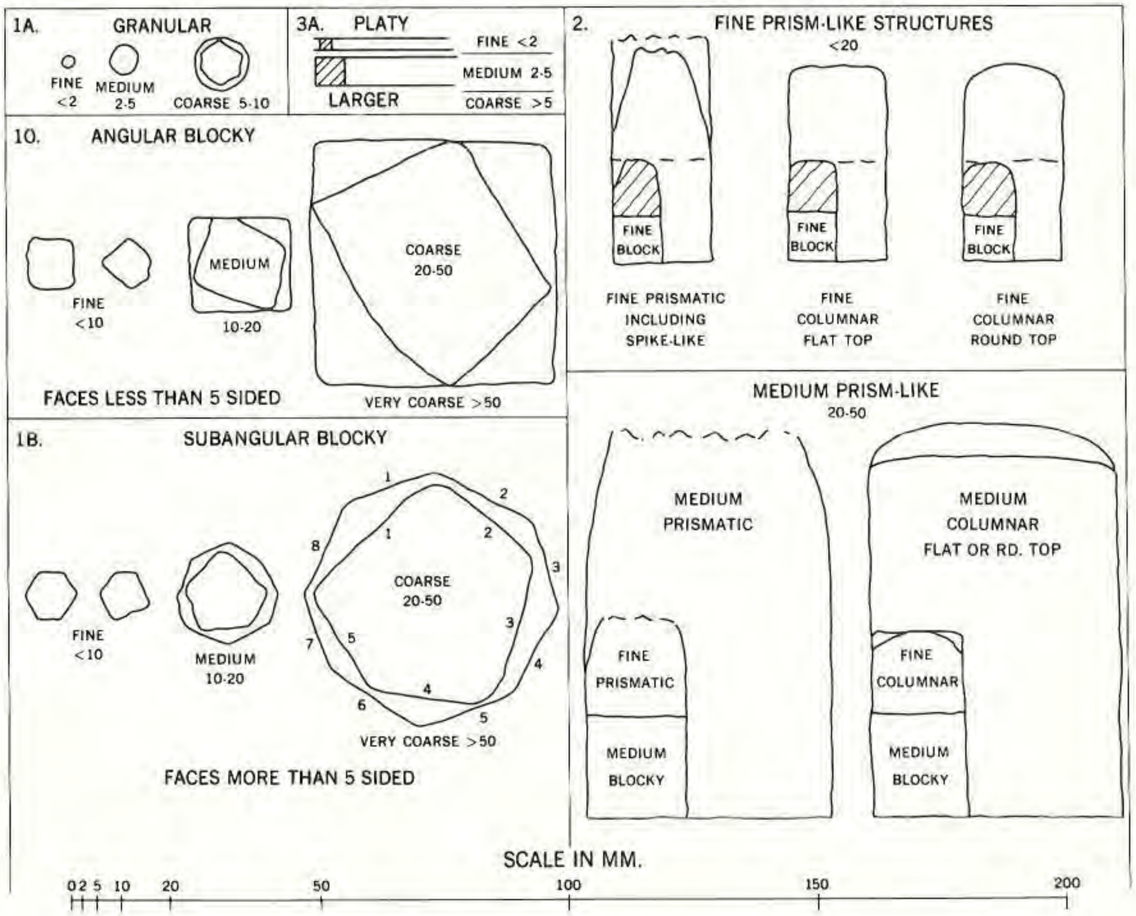

Fig. 35. Types, kinds, and classes of soil structure.

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Table 10 Types and classes of soil structure

Type	Kind	Class	Size mm
1. Structureless: no observable aggregation or no definite orderly arrangement around natural lines of weakness.	A. Single grain structure: loose, incoherent mass of individual particles as in sands.		
	B. Amorphous (massive) structure: a coherent mass showing no evidence of any distinct arrangement of soil particles.		
2. Blocklike: soil particles are arranged around a point and bounded by flat or rounded surfaces.	A. Blocky (angular blocky): faces rectangular and flattened, vertices sharply angular.	Fine blocky	<10
		Medium blocky	10-20
		Coarse blocky	20-50
		Very coarse blocky	>50
	B. Subangular blocky: faces subrectangular, vertices mostly oblique, or subrounded.	Fine subangular blocky	<10
		Medium subangular blocky	10-20
		Coarse subangular blocky	20-50
		Very coarse subangular blocky	>50
	C. Granular: spheroidal and characterized by rounded vertices.	Fine granular	<2
		Medium granular	2-5
		Coarse granular	5-10
3. Platelike: soil particles are arranged around a horizontal plane and generally bounded by relatively flat horizontal surfaces.	A. Platy structure: horizontal planes more or less developed.	Fine platy	2-5
		Medium platy	5
		Coarse platy	
4. Prismlike: soil particles are arranged around a vertical axis and bounded by relatively flat vertical surfaces.	A. Prismatic structure: vertical faces well-defined, and edges sharp.	Fine prismatic	<20
		Medium prismatic	20-50
		Coarse prismatic	50-100
		Very coarse prismatic	>100
	B. Columnar structure: vertical edges near top of columns are not sharp. (Columns may be flat-topped, round-topped, or irregular.)	Fine columnar	<20
		Medium columnar	20-50
		Coarse columnar	50-100
		Very coarse columnar	>100

consistence irrespective of whether the mass is large or small, in a natural condition or greatly disturbed, aggregated or structureless, or moist or dry. Although consistence and structure are interrelated, structure deals with the shape, size, and definition of natural aggregates that result from variations in the forces of attraction within a soil mass, whereas consistence deals with the strength and nature of the forces themselves.

The terminology for consistence includes separate terms for description at three standard moisture contents (dry, moist, and wet). If moisture conditions are not stated in using any consistence term, the moisture condition is that under which the particular term is defined. Thus friable, used without a statement of the moisture content, indicates friable when moist; hard, used alone, means hard when dry, and plastic means plastic when wet. If a term is used to describe consistence at some moisture content other than the standard condition under which the term is defined, a statement of the moisture condition is essential. Usually it is desirable to describe consistence at all three standard moisture conditions.

Although evaluation of consistence involves some disturbance, unless otherwise stated descriptions of consistence customarily refer to that of soil from undisturbed horizons. In addition, descriptions of consistence under moist or dry conditions carry an implication that disturbance causes little modification of consistence, or that the original consistence can be almost restored by pressing the material together. Where such an implication is misleading, as in compacted layers, the consistence both before and after disturbance may require separate descriptions. Furthermore, compound consistences occur as in a loose mass of hard granules. In a detailed description of soils having compound structure, the consistence of the mass as a whole and of its parts should be stated.

The terms used in soil descriptions for consistence follow.

Consistence when Wet

Consistence when wet is determined at moisture levels at or slightly above field capacity.

Stickiness is the quality of adhesion to other objects. For field evaluation of stickiness, soil material is pressed between the thumb and finger and its adherence is noted. Degrees of stickiness are described as follows:

0. *Nonsticky*—After the release of pressure, practically no soil material adheres to the thumb and finger.

1. *Slightly sticky*—After pressure is applied, the soil material adheres to both the thumb and finger, but comes off one or the other

rather cleanly. The soil is not appreciably stretched when the digits are separated.

2. *Sticky*—After pressure is applied, the soil material adheres strongly to both the thumb and forefinger and tends to stretch somewhat and pulls apart rather than pulling free from either digit.

3. *Very sticky*—After pressure is applied, the soil material adheres strongly to both the thumb and forefinger and is decidedly stretched when they are separated.

Plasticity is the ability to change shape continuously under the influence of an applied stress and to retain the impressed shape on removal of the stress. For field determination of plasticity, roll the soil material between the thumb and finger and observe whether or not a wire or thin rod of soil can be formed. If helpful to the reader of particular descriptions, state the range of moisture content within which plasticity continues, for example plastic when slightly moist or wetter, plastic when moderately moist or wetter, and plastic only when wet, or plastic with a wide, medium, or narrow range of moisture content. Express the degree of resistance to deformation at or slightly above field capacity as follows:

0. *Nonplastic*—No wire is formable.

1. *Slightly plastic*—Wire is formable, but the soil mass is easily deformable.

2. *Plastic*—Wire is formable and moderate pressure is required for the deformation of the soil mass.

3. *Very plastic*—Wire is formable and much pressure is required for the deformation of the soil mass.

Consistence when Moist

Consistence when moist is determined at a moisture content approximately midway between air-dry and field capacity. At this moisture content most soil materials exhibit a form of consistence characterized by (i) tendency to break into smaller masses rather than into powder, (ii) some deformation prior to rupture, (iii) absence of brittleness, and (iv) ability of the material after disturbance to cohere again when pressed together. The resistance decreases with moisture content, and the accuracy of field descriptions of this consistence is limited by the accuracy of estimating moisture content. To evaluate this consistence, select and attempt to crush in the hand a mass that appears slightly moist.

0. *Loose*—Noncoherent.

1. *Very friable*—The soil material is crushed under very gentle pressure, but coheres when pressed together.

2. *Friable*—The soil material crushes easily under gentle to

moderate pressure between the thumb and forefinger and coheres when pressed together.

3. *Firm*–The soil material crushes under moderate pressure between the thumb and forefinger, but resistance is distinctly noticeable.

4. *Very firm*–The soil material crushes under strong pressure, and is barely crushable between the thumb and forefinger.

(The term "compact" denotes a combination of firm consistence and a close packing or arrangement of particles and should be used only in this sense. It can be given degrees by the use of "very" and "extremely".)

Consistence when Dry

The consistence of soil materials when dry is characterized by rigidity, brittleness, maximum resistance to pressure, more or less tendency to crush to a powder or to fragments with rather sharp edges, and inability of crushed material to cohere again when pressed together. To evaluate, select an air-dry mass and break it in the hand.

0. *Loose*–Noncoherent.

1. *Soft*–The soil mass is weakly coherent and fragile, and breaks to a powder or individual grains under very slight pressure.

2. *Slightly hard*–The soil mass is weakly resistant to pressure, and easily broken between the thumb and forefinger.

3. *Hard*–The soil mass is moderately resistant to pressure; it can be broken in the hands without difficulty, but it is rarely breakable between the thumb and forefinger.

4. *Very hard*–The soil mass is very resistant to pressure; it can be broken in the hands only with difficulty, and is not breakable between thumb and forefinger.

5. *Extremely hard*–The soil mass is extremely resistant to pressure and cannot be broken in the hands.

Cementation

Cementation of soil materials refers to a brittle hard consistence caused by some cementing substance other than clay minerals, such as calcium carbonate, silica, oxides, or salts of iron and aluminum. Typically, the cementation is altered little, if any, by moistening; the hardness and brittleness persist in the wet condition. Semireversible cements, which generally resist moistening but soften under prolonged wetting, occur in some soils and give rise to soil layers having a cementation that is pronounced when dry but very weak when wet. Some layers cemented with calcium carbonate soften somewhat with wetting. Unless stated to the contrary, descriptions of cementation imply that the condition is altered little, if any, by wetting. If the cementation is greatly altered by moistening, it should be so stated. Cementation may be either continuous or discontinuous within a given horizon.

Weakly cemented—The cemented mass is brittle and hard, but can be broken in the hands.

Strongly cemented—The cemented mass is brittle and too hard to be broken in the hands, but is easily broken with a hammer.

Indurated—The mass is very strongly cemented and brittle, and does not soften under prolonged wetting. It is so hard that a sharp blow with a hammer is required to break it. The hammer generally rings as a result of the blow.

Soil consistence should be described at all three moisture states (dry, moist, and wet), the first given being that most frequently observed, but one should be sure that the moisture state first referred to is the same for color, structure, and consistence.

ROOTS AND PORES

The terminology for roots and pores is borrowed (J. E. McClelland, unpublished data). The abundance, size, orientation, and distribution within peds for both roots and pores are similar. In addition, to fully describe pores, continuity classes and morphology must be recorded.

Abundance Classes

Roots	*Pores*	*Number per unit area of surface*
very few	very few	less than 1
few	few	1 to 3
plentiful	common	4 to 14
abundant	many	more than 14

Unit is a square inch for fine, very fine, and micro roots and pores, a square yard for medium and coarse roots and pores.

Diameter Classes

Micro: less than 0.075 mm
Very fine: 0.075 to 1 mm
Fine: 1 to 2 mm
Medium: 2 to 5 mm
Coarse: more than 5 mm

Continuity Classes (for tubular pores)

Continuous: Individual pores extend throughout the horizon
Discontinuous: Individual pores extend only part way through the horizon

Orientation Classes (for roots and tubular pores)

Vertical: Orientation mainly vertical
Horizontal: Orientation mainly horizontal
Oblique: Orientation mainly oblique
Random: Orientation in all directions

Distribution Classes (within horizons)

Inped: Most roots and pores are within peds
Exped: Most roots and pores follow ped interfaces

Morphology Classes (for individual pores)

Simple: Tubular pores not branched
Dendritic: Tubular pores branched, pores are open at least at the upper end or at one horizontal end
Closed: Both ends of the pores are sealed from access to air and water by organic or organic-mineral particles or clay flows

Types of Pores

Vesicular: Roughly spherical or ellipsoidal in shape, not appreciably elongated in any direction
Interstitial: Irregular in shape with faces that are curved inward; formed by curved or angular faces of adjacent mineral grains or peds, or both
Tubular: More or less cylindrical in shape, elongated in one direction

ADDITIONAL FEATURES

Additional features are listed under this heading because not all of them are characteristics of every horizon. Additional features include such things as clay films, concretions, carbonates, salts, pebbles, and stones. No mention of such features in the description of a horizon indicates their absence. If these features are described, the kinds and numbers of concretions, stones, and pebbles; the thickness, extent, and position of clay films; and the relative amounts and distribution pattern of such things as carbonates and salts should be indicated.

Clay Films

Clay films are described by recording their frequency of occurrence, thickness, and locations. The following thickness and frequency classes are taken from the U.S. Department of Agriculture Work-Planning Conference, Chicago, 1963.

A complete description of clay films should include their frequency, thickness, and location with respect to other morphological features. Other properties of clay films, such as color and continuity (whether existing as patches or a continuous network), may need to be described to adequately characterize the morphology of some soils. Standard classes for the description of frequency and thickness of clay films follow.

Frequency classes–The objective is to indicate the estimated percentage of the natural soil surfaces that are coated with clay films. The description may refer to the total surface of ped faces, or the total surface of tubular or interstitial pores, or to the combined surfaces of peds and pores in the soil material. The description of frequency of clay films is intended to reflect not the total volume of clay films but simply the percentage of ped faces or pore surfaces, or both, that are coated.

Class	*Percent of surface covered*	*Remarks*
Few	Present on less than 2% of surface	Patches of clay film are identifiable, but their frequency is so low that the significance of their presence may be nil or doubtful. The class includes occasional small patches of clay film not regularly associated with other morphological features.
Common	2 to 20	Patches of clay film regularly associated with other morphological features. Most of the surfaces of peds or pores, or both, are not coated with clay film.
Many	20 to 80	Clay films regularly associated with other morphological features. May occur as discrete patches or as a continuous network.
Continuous	More than 80	Most or all ped or pore surfaces, or both, are covered with clay films. Patches of natural surfaces may be free of clay films, but the films are essentially continuous.

Thickness classes–Thickness of clay films often varies appreciably within distances of a few millimeters. In such cases estimate the average thickness. If appreciable variations in thickness occur over distances of a centimeter or more, or are related to other morphological features, and the variations are judged to be significant to description of the morphology, describe the variation.

Very thin	<0.005 mm	Visible only when viewed normal to surface; hand lens needed for identification; not visible in cross section with a 10× hand lens; if present, very fine sand grains protrude through the film and are readily apparent.
Thin	0.005 to 0.05 mm	Hand lens usually needed for identification; visible in cross section with 10× lens but not to unaided eye; if present, very fine sand grains are enveloped by the film or their outlines are indistinct; fine sand grains protrude through the film or are only thinly coated and are readily apparent.
Moderately thick	0.05 to 0.5 mm	Visible in cross section to unaided eye; fine sand grains are enveloped by the film or other outlines are indistinct; film surfaces are relatively smooth.
Thick	0.5 to 1.0 mm	Clay films and their broken edges are readily visible without magnification; film surfaces are smooth; sand grains are enveloped by the film or their outlines are indistinct.
Very thick	>1.0 mm	

Conventions –The convention for describing frequency, thickness, and location of clay films is illustrated in the following examples:

a) Common thin clay films on ped faces;
b) Continuous moderately thick clay films in common medium tubular pores;
c) Common moderately thick clay films on ped and pore surfaces;
d) Continuous moderately thick clay films on vertical prism faces and common thin clay films on blocky peds (compound structure of coarse prisms and medium blocky peds).

The thickness and frequency classes seem most useful for description of films on ped and tubular pore surfaces. They may also be useful for description of films of clay that occur in interstitial pore space in coarse or moderately coarse textured soils, as illustrated in the following examples:

a) Continuous thin clay films in interstitial pores as coatings on grains and as bridges between grains;
b) Common thin clay films in interstitial pores as bridges between grains but rarely coating grains.

Concretions

Concretions are hardened local concentrations of certain chemical compounds that form indurated grains or nodules of various shapes, sizes, and colors. They are commonly formed from iron and manganese oxides. The size, shape, color, and location of the concretions should be described.

Carbonates

The presence of free carbonates in the soil and parent material may be tested for with 10% HCl. The relative effervescence is as follows:

Very weakly effervescent:	a few bubbles
Weakly effervescent:	bubbles readily observed
Moderately effervescent:	bubbles form a low foam
Strongly effervescent:	bubbles form a thick foam

The calcareous grades are:

Weakly calcareous:	1- 5% as $CaCO_3$ equivalent
Moderately calcareous:	6-15% as $CaCO_3$ equivalent
Strongly calcareous:	16-25% as $CaCO_3$ equivalent
Very strongly calcareous:	26-40% as $CaCO_3$ equivalent
Extremely calcareous:	$>40\%$ as $CaCO_3$ equivalent

The size of carbonate accumulation is described as for mottles:

Fine:	<5 mm in diameter or width
Medium:	5-15 mm in diameter or width
Coarse:	>15 mm in diameter or width

The shape and degree of segregation of the lime accumulation are described in plain words.

Salts

The presence of salts in the soil and parent material should be described. The salts may occur as crystals or veins, or as surface crusts of salt crystals. Inhibited crop growth and the presence of salt-tolerant plants are indications of salts in the soil.

The salinity grades suggested are as follows (U.S. Department of Agriculture Soil Survey Manual):

Weakly saline—These soils are slightly affected by salt or alkali. The growth of sensitive crops is inhibited, but that of salt-tolerant crops may not be. The salt content is 0.15 to 0.35% and the conductivity 4 to 8 mmhos/cm.

Moderately saline–These soils are moderately affected by salt or alkali. Crop growth is inhibited and no crop does well. The salt content is 0.35 to 0.65% and the conductivity 8 to 15 mmhos/cm.

Strongly saline–These soils are strongly affected by salt or alkali. Only a few kinds of plants survive. The salt content is greater than 0.65% and the conductivity is greater than 15 mmhos/cm.

Stones and Pebbles

Describe the stones and pebbles in terms of their abundance, size, type, shape, and orientation. Describe the size and the shape using the terms listed previously under "Stoniness, Rockiness, and Coarse Fragments." Report the abundance as percentage by area of the surface exposed.

HORIZON BOUNDARIES

The lower boundary of each horizon is described by indicating its distinctness and form, as suggested in the U.S. Department of Agriculture Soil Survey Manual.

Distinctness

Abrupt:	less than 1 inch wide
Clear:	1 to 2.5 inches wide
Gradual:	2.5 to 5 inches wide
Diffuse:	more than 5 inches wide

Form

Smooth:	nearly a plane
Wavy:	pockets are wider than deep
Irregular:	pockets are deeper than wide
Broken:	parts of the horizon are unconnected with other parts

For example: clear, smooth boundary; clear, irregular boundary.

THICKNESS RANGE

The thickness range is stated in plain language. Although thickness range is part of the range in characteristics for the series, it should be included after each horizon description in the typifying pedon because it can be stated more briefly in this section.

REACTION CLASSES

The reaction classes and terminology are as follows:

	pH (H_2O)		pH (H_2O)
Extremely acid	4.5 or lower	Neutral	6.6–7.3
Very strongly acid	4.6–5.0	Mildly alkaline	7.4–7.8
Strongly acid	5.1–5.5	Moderately alkaline	7.9–8.4
Medium acid	5.6–6.0	Strongly alkaline	8.5–9.0
Slightly acid	6.1–6.5	Very strongly alkaline	higher than 9.0

Give the reaction as a descriptive term or pH value.

SAMPLE PROFILE DESCRIPTION

It is recommended that the various properties of soil profiles be described in the following order: color (moist or dry, or both), texture, mottles, structure, consistence, roots, pores, clay films, concretions, carbonates or salts, stones, horizon boundary, thickness range, and pH in water.

A sample description of a profile follows; show the depth of the horizons in inches and centimetres.

Horizon	*Depth* *inches*	*cm*	*Description*
L-H	3 – 0	7.5 – 0	Black (10YR 2/1 m), dark grayish brown (10YR 4/1 d) semidecomposed organic matter; fibrous, abundant fine and medium roots; abrupt, smooth boundary; 2 to 4 inches thick; pH 3.8.
Ae	0 – 4	0 – 10	Gray (5YR 6/1 m), light gray (5YR 7/1 d) sandy loam; single grain; loose, friable; few, fine and medium roots; few, fine, vesicular pores; clear, wavy boundary with some fine tongues into underlying horizon; 2 to 5 inches thick; pH 4.3.
Bfhgj	4 – 12	10 – 30	Reddish brown (5YR 4/4 m, 5/4 d) sandy loam; common, medium, distinct strong brown (7.5YR 5/6) mottles; amorphous; friable; few, fine and very fine roots; few, medium and fine pores; some gravel; clear, smooth boundary; 6 to 10 inches thick; pH 4.7.
Bfg	12 – 24	30 – 61	Reddish brown (5YR 4/3 m, 5/3 d) sandy loam; many, medium to coarse, prominent strong brown (7.5YR 5/6) mottles; amorphous; firm, few stones; clear, smooth boundary; 8 to 15 inches thick; pH 4.9.
C	24+	61+	Reddish brown (2.5YR 4/4 m, 5/4 d) sandy loam; amorphous; firm; slightly plastic; some stones; pH 4.8.

ADDITIONAL CONSIDERATION

Give the location of soil profiles in latitude and longitude to the nearest one-tenth minute in areas covered by maps of 1:50,000 scale, or to the nearest minute in areas covered only by maps of 1:250,000 scale.

SOIL CAPABILITY CLASSIFICATION FOR AGRICULTURE[1]

The soil capability classification for agricultural purposes is one of a number of interpretive groupings that may be made from soil survey data. As with all interpretive groupings, the capability classification is developed from the soil-mapping units. In the classification the mineral soils are grouped into seven classes according to their potentialities and limitations for agricultural use. The first three classes are considered capable of sustained production of common cultivated crops, the fourth is marginal for sustained arable culture, the fifth is capable of use only for permanent pasture and hay, the sixth is capable of use only for wild pasture, and the seventh class is for soils and land types (including rock outcrop and small unmappable bodies of water) considered incapable of use for arable culture or permanent pasture. While the soil areas in classes one to four are capable of use for cultivated crops, they are also capable of use for perennial forage crops. Soil areas in all classes may be suitable for forestry, wildlife, and recreation. For the purposes of this classification, trees, tree fruits, cranberries, blueberries, and ornamental plants that require little or no cultivation are not considered as cultivated or common field crops.

The capability classification, applied in Canada, consists of two main categories: (1) the capability class, and (2) the capability subclass.

The *class*, the broadest category in this classification, is a grouping of subclasses that have the same *relative degree of limitation or hazard*. The limitation or hazard becomes progressively greater from Class 1 to Class 7. The class indicates the general suitability of the soils for agricultural use.

The *subclass* is a grouping of soils with *similar kinds of limitations and hazards*. It provides information on the kind of conservation problem or limitation. The class and subclass together provide information about the degree and kind of limitation for broad land-use planning, and for the assessment of conservation needs.

The capability classification is applied to virgin as well as to currently cultivated lands, with the exception of organic soils. Research data, recorded observations, and experience are used as the basis for placing soils in capability classes and subclasses. In areas where such

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[1] Reprinted from The Canada Land Inventory Report No. 2, 1965.

information is lacking, soils are placed in capability classes by interpretation of soil characteristics in accordance with experience gained on similar soils elsewhere. The level of generalization of the soil capability classification is indicated by the map scale on which the information is published.

This classification is not a guide to the most profitable use of land, but it is an inventory of our agricultural soil resources and a guide to better land use in Canada.

Assumptions

This soil capability classification is based on certain assumptions that must be understood by those using the soil capability maps and statistical data derived from these maps if they are to obtain full benefit from such information and avoid making erroneous deductions.

1. The soil capability classification is an interpretive classification based on the effects of combinations of climate and soil characteristics, on limitations in use of the soils for agriculture, and on their general productive capacity for common field crops. Shrubs, trees, or stumps are not considered as limitations to use unless it is unfeasible to remove them.
2. Good soil management practices that are feasible and practical under a largely mechanized system of agriculture are assumed.
3. The soils within a capability class are similar with respect to degree but not to kind of limitations in soil use for agricultural purposes. Each class includes many different kinds of soil and many of the soils within any one class require unlike management and treatment. The subclass provides information on the kind of limitation and the class indicates the intensity of the limitation. Capability Class 1 has no subclasses. Information for specific soils is included in soil survey reports and in other sources of information.
4. Soils considered feasible for improvement by draining, by irrigating, by removing stones, by altering soil structure, or by protecting from overflow are classified according to their continuing limitations or hazards in use after the improvements have been made. The term "feasible" implies that it is within present-day economic possibility for the farmer to make such improvements and it does not require a major reclamation project to do so. Where such major projects have been installed, the soils are grouped according to the soil and climatic limitations that continue to exist. A general guide to what is considered a major reclamation project is that such projects require cooperative action among farmers or

between farmers and governments. (Minor dams, small dykes, or field conservation measures are not included.)

5. The capability classification of the soils in an area may be changed when major reclamation works are installed that permanently change the limitations in use for agriculture.
6. Distance to market, kind of roads, location, size of farms, characteristics of landownership and cultural patterns, and the skill or resources of individual operators are not criteria for capability groupings.
7. Capability groupings are subject to change as new information about the behavior and responses of the soils becomes available.

Capability Classes

Class 1–Soils in this class have no significant limitations in use for crops.

Soils in Class 1 are level or have very gentle slopes, are deep and well to imperfectly drained, and have a good water-holding capacity. They are easily maintained in good tilth and productivity, and damage from erosion is slight. They are moderately high to high in productivity for a wide range of field crops adapted to the region.

Class 2–Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.

Soils in Class 2 are deep and have a good water-holding capacity. The limitations are moderate and the soils can be managed and cropped with little difficulty. The soils are moderately high to high in productivity for a fairly wide range of field crops adapted to the region.

The limitation of soils in this class may be any one of the following: adverse regional climate; moderate effects of accumulative undesirable characteristics; moderate effects of erosion; poor soil structure or slow permeability; low fertility correctable with consistent moderate applications of fertilizers and usually lime; gentle to moderate slopes; occasional damaging overflow; and wetness correctable by drainage but continuing as a moderate limitation.

Soils in this class are not generally suited to as wide a range of crops as the soils in Class 1. Also more intensive conservation measures, tillage practices, or special soil-conserving systems may be required. The combinations of practices vary from place to place depending on the climate, soil, and regional cropping systems.

Class 3–Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices.

Soils in Class 3 have more severe limitations than those in Class 2 and conservation practices are more difficult to apply and maintain. Under good management these soils are fair to moderately high in productivity for a fairly wide range of field crops adapted to the region.

In this class the limitations that restrict cultivation, ease of tillage, planting and harvesting, the choice of crops, and the application and maintenance of conservation practices are a combination of two of those described under Class 2 or one of the following: moderate climatic limitations including frost pockets; moderately severe effects of erosion; intractable soil mass or very slow permeability; low fertility correctable with consistent heavy applications of fertilizers and usually lime; moderate to strong slopes; frequent overflow accompanied by crop damage; poor drainage resulting in crop failures in some years; low water-holding capacity or slowness in release of water to plants; stoniness sufficiently severe to seriously handicap cultivation and necessitating some clearing; restricted rooting zone; or moderate salinity.

Each soil in this class may have one or more alternative uses or practices required for use, but the alternatives may be fewer than for soils in Class 2.

Class 4—Soils in this class have severe limitations that restrict the range of crops or require special conservation practices, or both.

Soils in Class 4 have such limitations that they are only suitable for a few crops, the yield for a range of crops is low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops, but may have higher productivity for a specially adapted crop.

The limitations include the adverse effects of a combination of two or more of those described in Classes 2 and 3, or one of the following: moderately severe climate; very low water-holding capacity; low fertility difficult or unfeasible to correct; strong slopes; severe past erosion; very intractable mass of soil or extremely slow permeability; frequent overflow with severe effects on crops; severe salinity causing some crop failures; extreme stoniness requiring considerable clearing to permit annual cultivation; or very restricted rooting zone, but more than 1 foot of soil over bedrock or an impermeable layer.

Class 4 soils in subhumid and some arid regions may produce good yields of regionally cultivated crops in years of high rainfall, low yields in years of average rainfall, and failures in years of below-average rainfall. During years of low precipitation even though no crop is expected, special management practices are required to minimize wind erosion, maintain productivity, and conserve moisture. These measures include emergency tillage and crops used only to prevent soil deterioration. These treatments and others must be applied more frequently and more intensively than to soils in Class 3.

Class 5—Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible.

Soils in Class 5 have such serious soil, climatic, or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing, and water control.

The limitations in Class 5 include the adverse effects of one or more of the following: severe climate; low water-holding capacity; severe past erosion; steep slopes; very poor drainage; very frequent overflow; severe salinity permitting only salt-tolerant forage crops to grow; or stoniness or shallowness to bedrock that makes annual cultivation impractical.

Some soils in Class 5 can be used for cultivated field crops, provided unusually intensive management is used. Some of the soils in this class are also adapted to special crops such as blueberries, orchard crops, or the like, requiring soil conditions unlike those needed by the common crops. Cultivated field crops may be grown in Class 5 areas where adverse climate is the main limitation but crop failures occur under average conditions.

Class 6—Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible.

Soils in Class 6 have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic, or other limitations as to make impractical the application of improvement practices that can be carried out in Class 5. Soils may be placed in this class because their physical nature prevents improvement through the use of farm machinery, the soils are not responsive to improvement practices, there is a short grazing season, or stock watering facilities are inadequate. Such improvement as may be effected by seeding and fertilizing by hand or by aerial methods shall not change the classification of these soil areas.

The limitations in Class 6 include the adverse effects of one or more of the following: very severe climate; very low water-holding capacity; very steep slopes; very severely eroded land with gullies too numerous and too deep for working with machinery; severely saline land producing only edible, salt-tolerant, native plants; very frequent overflow allowing less than 10 weeks effective grazing; water on the surface of the soil for most of the year; or stoniness or shallowness to bedrock that makes any cultivation impractical.

Class 7–Soils in this class have no capability for arable culture or permanent pasture.

The soils or lands in Class 7 have limitations so severe that they are not capable of use for arable culture or permanent pasture. All classified areas (except organic soils) not included in Classes 1 to 6 shall be placed in this class. Bodies of water too small to delineate on the map are included in this class.

Class 7 soils may or may not have a high capability for trees, native fruits, wildlife, and recreation. Hence, no inferences can be made as to the capability of the soils and land types in this class beyond the scope of their capability for agriculture.

Capability Subclasses

Subclasses are divisions within classes that have the same kind of limitations for agricultural use. Thirteen different kinds of limitations are recognized at the subclass level. A brief description of these subclasses and their designation on maps follows.

Adverse climate (C)–This subclass denotes a significant adverse climate for crop production as compared with the "median" climate, which is defined as one with sufficiently high growing-season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

Undesirable soil structure or low permeability, or both (D)–This subclass is used for soils difficult to till, or which absorb water very slowly, or in which the depth of the rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

Erosion (E)–Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

Low fertility (F)–This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates, or the presence of toxic compounds.

Inundation by streams or lakes (I)–This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

Moisture limitation (M)–This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

Salinity (N)--This subclass includes soils with enough soluble salts to adversely affect crop growth or restrict the range of crops that may be grown. Such soils are not placed higher than Class 3.

Stoniness (P)--This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable nonstony soils.

Consolidated bedrock (R)--This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 3 feet from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

Adverse soil characteristics (S)--On the 1:250,000 scale capability maps this subclass will be used in place of subclasses D, F, M, and N, either individually or collectively. On larger scale maps it may be used in a collective sense for two or more of these subclasses (see guidelines).

Topography (T)--This subclass is made up of soils where topography is a limitation. Both the percentage of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

Excess water (W)--Subclass W is made up of soils where excess water other than that brought about by inundation is a limititation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, or seepage or runoff from surrounding areas.

Cumulative minor adverse characteristics (X)--This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics that singly are not serious enough to affect the class rating.

Conventions in use of subclass and map symbols.

1. A subclass is used only when the limitation it represents has been a factor in determining the class. However, on published maps no more than two subclasses are shown.

2. On maps, large arabic numerals denote the capability classes and small capital letters placed after the class numerals denote the subclasses. In map units comprising more than one class, small arabic numerals placed after each class numeral as superscripts denote the proportion of each class out of a total of 10.

Organic Soils[2]

The interpretive soil capability classification is not applied to organic soils because, in general, there is insufficient information on these organic soil areas for such an interpretive judgment to be made.

Organic soils are designated by the letter O alone.

[2] The definition of organic soils as prepared by the Canada Soil Survey Committee reads as follows: Soils that contain 30 percent or more of organic matter and have a depth of 12 inches or more of consolidated organic material.

APPENDIX 1

Guidelines for Placing Soils in Capability Classes

Guidelines for placing soils in classes and subclasses in a country as diverse as Canada are required at both national and regional levels. For this purpose the regions agreed on are Eastern Canada, Western Canada, and the West Coastal area. The guidelines presented here are national in scope, but some of them may require modification for regional application.

Subclass "C" is made up of soils where climate (temperature and precipitation) is a major limitation. Hazards of crop damage due to hail, rain, snow, and winds are not included. This subclass denotes a significant adverse departure from what is considered as the median climate of the region. Subclass "C" may be used either on a subregional or a local basis.

The soils placed in this subclass because of adverse subregional climate will be those soils that have no limitations except climate. Hence, they will be the highest class soils of the subregion. Soils with other significant limitations or hazards to use will be placed in lower classes, as the subregional climate will affect all of them. Subregions are large areas of land that can be clearly defined as having adverse climates compared with the median climate.

Locally, crop-damaging frosts will be the chief climatic factor in placing soils in this subclass. The evaluation of local adverse temperature effects on class designations must be based on both intensity and frequency. Because there is no way to indicate local frosty areas except by the subclass symbol "C" and because soils in such areas may have other serious limitations, there is no restriction on using the symbol "C" with symbols for other limitations for local areas with adverse climates.

The median climate may be broadly defined as one with sufficiently high growing-season temperatures to bring field crops to maturity in a frost-free period exceeding 90 days and with sufficient precipitation to permit crops to be grown each year on the same land without a high risk of crop failure. Precise guidelines for significant departures from the median as they affect the class designations have yet to be established, but the following general subregional guidelines have been adopted.

Western Canada:

Median climate—most of the Black and Dark Gray soil zones.
Brown soil zone—generally highest class 3c.
Dark Brown soil zone—generally highest class 2c.

Gray Luvisol soil zone below 3,000 feet– generally highest class 2c.

Eastern Canada:

Median climate–the Acadian, Great Lakes-St. Lawrence, and Deciduous forest regions.

Boreal Forest Region–generally highest class 2c.

There are a number of areas having a significant adverse departure from the median climate, but these may be regarded as local variations.

Subclass "D" is made up of soils adversely affected by soil structure or permeability, or both. It includes soils where the depth of rooting zone is restricted by soil conditions other than wetness (high water table) or consolidated bedrock. No guidelines were established for class designations.

Subclass "E" is made up of soils where actual damage from erosion is a limitation to agricultural use. Damage is to be assessed on the loss in productivity or the difficulties imposed by gullies in farming the affected areas, or both. No attempt was made to develop specific guidelines for class designations.

Subclass "F" is made up of soils having low fertility that either is correctable with constant and careful management in the use of fertilizers and amendments or is difficult to correct in a feasible way. The limitations may be due to lack of available nutrients, high acidity or alkalinity, high levels of carbonates, toxic elements, inadequate cation exchange capacity, or high fixation of plant nutrients.

The following guidelines are suggested for class designations.

Class 2: Soils highly responsive to fertilizers and amendments.

Class 3: Soils only moderately responsive to fertilizers and amendments.

Class 4: Soils in which the low fertility status cannot be improved with feasible management practices.

Class 7: Soils containing elements toxic to vegetation, or plants poisonous to farm animals that cannot be removed with feasible management practices.

Subclass "I" is made up of soils subjected to inundation by streams or lakes.

The following limits were adopted subject to regional interpretation.

Class 2I: Occasional damaging overflow.

Class 3I: Frequent overflow with some crop damage.

Class 4I: Frequent overflow with severe crop damage including some years without a crop.

Class 5I: Very frequent overflow with effective grazing period longer than 10 weeks.

Class 6I: Very frequent overflow with effective grazing period shorter than 10 weeks and longer than 5 weeks.

Class 7I: Land inundated for most of the growth period.

Subclass "M" is a group of soils adversely affected by droughtiness owing to inherent soil characteristics. These are usually coarse-textured soils with low water-holding capacity, but some fine-textured soils with high water-holding capacity may be placed in this subclass. Droughtiness caused by soil characteristics must not be confused with climatic drought.

The following general guidelines are accepted.

This subclass will not be used for Class 2 soils.

As compared with soils under the same climatic conditions that do not have this limitation, the following general rules will apply.

Soils moderately affected by droughtiness–downgrade one class

Soils moderately severely affected by droughtiness–downgrade two classes

Soils severely affected by droughtiness–downgrade three classes

Soils very severely affected by droughtiness–downgrade four classes.

Subclass "N" is made up of soils adversely affected by the presence of soluble salts. Soils with enough salts to adversely affect crop growth or the range of crops that may be grown will not be placed in Class 1 or Class 2.

Class 3: Crops moderately affected. (Class 4 in those subregions where top class is 3c.)

Class 4: Crops seriously affected with crop failure in some years.

Class 5: Crops seriously affected on cultivated land with crop failures in most years, but salt-tolerant forage crops can be established and maintained.

Class 6: Soils too salty except for native salt-tolerant grasses. If poisonous plants are present, place in Class 7.

Class 7: Growth of useful native vegetation impossible.

Subclass "P" is made up of soils sufficiently stony to significantly increase the difficulty of tillage, planting, and harvesting.

The stoniness classes accepted by the N.S.S.C. in 1955 and 1963 will be used in establishing capability classes, except that stoniness classes 1 and 2 would not be considered as limitations.

Stoniness 3: Class 3 or Class 4

Stoniness 4: Class 4 or Class 5

Stoniness 5: Class 6 or Class 7.

Sublcass "R" is made up of soils where the depth of the rooting zone is restricted by consolidated bedrock.

The effect of consolidated bedrock near the surface on crop production is variable in intensity in different climatic regions. Hence, precise guidelines for all of Canada cannot be established. As a general guide, where depth to bedrock is less than 12 inches the soil will not be rated higher than Class 5, and where depth to bedrock is more than 3 feet the class rating will not be affected except under irrigation.

Subclass "S"—On the 1:250,000 scale capability maps this subclass is used in place of D, F, M, and N. On larger scale maps, "S" should only be used: (1) for two of these limitations when some other limitation also is present, and (2) when more than two of them are present. The reason for this convention on the use of "S" on maps having a greater scale than 1:250,000 is that, while it is desirable to denote the limitations as specifically as possible, it is usually impractical to show more than two subclasses for each class. The following examples may serve to illustrate this convention:

2_{F} not 2_{S}

$3\substack{F\\ \\M}$ preferred to 3_{S}

but $4\substack{F\\M\\T}$ should be $4\substack{S\\ \\T}$.

Subclass "T" is made up of soils where the topography (slope and pattern) is a limitation in agricultural use.

The following guidelines for subregions with median climates are based on topographic classes and symbols adopted by the N.S.S.C. in 1963. In this system capital letters are used for single slopes (regular surface) and lowercase letters are used for multiple slopes (irregular surface).

Class 1: 0–5% Aa, Bb, C
Class 2T: 2–5% c; 6–9% D
Class 3T: 6–9% d; 10–15% E
Class 4T: 10–15% Ee
Class 5T: 16–30% Ff
Class 6T: 31–60% Gg
Class 7T: 60 + % Hh

In subregions having adverse climates compared with the median climate, the effect of topography as it affects the class placement above

Class 6 is subject to regional interpretation. For example, in 3c subregions, soil areas with topography d, E, and e have topographic limitations and hence would have to be placed in Class 4 or Class 5. Topography Gg places the affected soil areas in Class 6 irrespective of climate.

Subclass "W" is made up of soils where excess water, apart from that brought about by inundation, is a limitation in their use for agriculture. Excess water may be the result of poor soil drainage, high water table, seepage, or runoff from surrounding areas. Usually soils needing drainage have some permanent limitation that precludes placing them in Class 1 even after drainage.

If drainage is considered feasible at the farm level, wet soils will be classified according to their continuing limitations or hazards after drainage. If drainage cannot be effected without community action, then wet soils will be classified on the basis of their present limitations.

Because the problem of classifying wet soils will require regional application of the C.S.S.C. Soil Moisture Classes, no national guidelines are proposed. With further study regional guidelines may be developed.

Subclass "X" is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics that singly are not serious enough to affect the class rating. This subclass should only be used for soils that have no other limitation except subregional climatic limitations. Hence this subclass will be used alone and, because it only represents a moderate limitation, the soils will only be downgraded one capability class from the best possible soils in a climatic region. Thus, with this subclass the capability classes will be as follows: Median climatic subregions 2x

2c	"	"	3x
3c	"	"	4x

(See guidelines for subclass c, subregional climates)