REPORT

on the

SIXTH MEETING OF THE

NATIONAL SOIL SURVEY COMMITTEE OF CANADA

Held at

LAVAL UNIVERSITY, QUEBEC

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Proceedings of the Sixth Meeting of the
National Soil Survey Committee of Canada

A. Leahey

Foreword:

The sixth meeting of the National Soil Survey Committee of Canada was held on October 18-22, 1965, at Laval University, Quebec. Unfortunately it has not been possible to publish this report on the proceedings of the meeting until this time.

The material in this publication may be grouped into several sections, namely:

1. Reports on soil horizon designations and the taxonomic soil classification.
2. Reports on analyses, soil survey reports and a discussion paper on publishing certain soil maps on a photomosaic base.
3. Discussion papers by the coordinators of the Canada Land Inventory.
4. Business matters including resolutions.
5. Certain reprinted reports from the 1963 Proceedings.

Space limitations preclude the inclusion of the discussions of the various matters considered at the meeting. However, the various subcommittee reports were written after the meeting so that results of the discussions are incorporated in them. The reports on the designation of soil horizons and the classification of mineral soils at the higher categories have been rewritten by the chairmen of these subcommittees although only the revisions of the 1963 reports were discussed at the meeting. Thus the complete reports are included here. The committee also decided that three reports from the Proceedings of the Fifth Meeting should be included in this publication. These appear in the appendices. On the other hand, reports on two important matters discussed at Laval are not included. One topic was a discussion led by L. Chapman on the climatic regions of Canada for agriculture as defined by Chapman and Brown in Canada Land Inventory Report No. 3, "Climates of Canada for Agriculture", and a discussion on the grouping of these climatic regions for capability purposes by Bowser and Lajoie. These discussions were certainly educational but did not result in definite recommendations as by common agreement it was desided that further study on this subject was necessary before the climatic regions could be grouped for capability purposes. The second topic dealt with the correlation of the American and Canadian systems of soil classification. A report on this study is not yet available but when ready it will be issued as a separate document.

The classification reports on mineral soils and soil horizon designations have been approved for use as the official system for classifying and designating soil horizons in Canada. The three reprinted reports have also been adopted by the soil survey organizations in Canada. The other reports and papers are either of an advisory nature or for information purposes.

The number of participants at this N.S.S.C. meeting was the highest on record and the interest was maintained at a high level throughout. The members of the N.S.S.C. were particularly pleased by the useful contributions made by forest soil scientists and pedologists who were invited guests. We would especially note here the assistance given to us by Dr. Roy Simonson, Principal Soil Correlator, Washington, whose presence indicated the continuing interest of the U.S.D.A. Soil Survey in our work.

On behalf of the N.S.S.C. I would express our appreciation of the excellent facilities provided by the University of Laval for our meeting and for the cooperation, hospitality and courtesies extended to us by the members of the Department of Soils of the University, the Quebec Forest Research Laboratory of the Canada Department of Forestry and the Quebec Soil Survey.

The Canadian System of Soil Classification

A. Leahey, Chairman, N.S.S.C.

The Canadian taxonomic system of soil classification has 6 levels or categories. These are the order, great group, subgroup, family, series and type. However, the classification reports presented here deal only with the definitions and partial descriptions of the soils placed in the various classes of the order, great group and subgroup categories. In addition, one report defines the family concept and discusses criteria for grouping series[1] into families.

The level of generalization or detail used for classifying soils at these 6 levels is indicated by the number of classes in each that have been recognized to date in Canada for mineral soils. These numbers are: 6 orders, 22 great groups, 112 subgroups, about 3,000 series and 4,000 types. The relatively small increase of types over series is because the majority of the series are monotypes. Since the family category of classification has not been used extensively, no reliable estimate can be made of the number of families but judging from the experience gained to date the number would be in the 600-1000 range.

Soil horizon designations and definitions must be considered as an integral part of the classification system as the soil horizons and subhorizons are used as criteria in the classification of soils. In fact a national system of soil classification would not have been developed without prior agreement between the pedologists of Canada on uniform definitions and designations for soil horizons and subhorizons. The report on soil horizon designations deals with this matter.

In the following reports on taxonomic classification certain soil horizons and subhorizons are required to meet stated minimum thicknesses and degrees of development in order for them to be diagnostic at the subgroup and great group levels of classification. However, beyond these minimums, thickness or degree of development of horizons are not considered as criteria at these levels. The importance of comparative thickness and degree of development between soils placed in the same subgroup is not underestimated but these features are used as criteria for separation of such soils at the series level.

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[1]Soil series: A group of soils having horizons similar in differentiating characteristics and arrangement in the soil profile and developed from a particular kind of parent material. A soil type is a division of a series based on the texture of the surface soil.

The Canadian taxonomic system of soil classification is of comparatively recent origin as it was first adopted for official use by the soil survey organizations of this country in 1960. However, the roots of this system extend back to the time, about 40 years ago, when the concept of the great group[2] was accepted by Canadian pedologists. Thus when sufficient knowledge of our soils had been obtained through soil surveys to permit devising a national system of classification, it was developed around the past concepts of the great group and the series as basic taxonomic groups.

Knowledge on the kinds of soils occurring in Canada and their characteristics is constantly increasing. Pedological concepts are also subject to change because of advancing knowledge. For both these reasons revision of the classification becomes necessary from time to time. Hence a classification system must have sufficient flexibility so that additions and some revisions can be made without invalidating its structure. On the other hand a classification system must be reasonably stable as too many changes either in structure or nomenclature can cause confusion. The present Canadian system appears to be a satisfactory solution to the problem of compromising between flexibility and stability. However, the time may come when it is no longer adequate for the purpose for which it was devised. In such an event it would be advisable to adopt an entirely new system rather than to drastically revise the old one.

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[2] Great soil group: A taxonomic group of soils having certain morphological features in common that reflect a similar pedogenic environment.

Outline of the Canadian System of Soil Classification at the Order, Great Group and Subgroup Categories

Note 1:

Subgroups shown with a dash after the first two numbers and an oblique stroke before the last number should be used in combination with other subgroups of the same great group not numbered in this manner. The dash indicates a missing subgroup number. For example, a Gleyed Orthic Brown Forest would be numbered 4.11/8 and a Gleyed Degraded Brown Forest 4.12/8.

Note 2:

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

Diagnostic horizons are underlined.

Non-diagnostic horizons that may be present are bracketed.

Note 3:

The Peaty subgroups as defined in the N.S.S.C. 1963 report have been dropped and a peat surface layer of less than 12 inches on certain mineral soils is now considered as a phase distinction.

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
	1.2 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
	1.3 Black	1.31	Orthic Black
		1.32	Rego Black
		1.33	Calcareous Black
		1.34	Eluviated Black
		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

Order	Great Group	Subgroup	
1. Chernozemic	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
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
	2.2 Solod	2.21	Brown Solod
		2.22	Black Solod
		2.23	Gray Solod
		2.2-/8	Gleyed Solod
3. Podzolic	3.1 Gray Brown Podzolic	3.11	Orthic Gray Brown Podzolic
		3.12	Brunisolic Gray Brown Podzolic
		3.13	Bisequa Gray Brown Podzolic
		3.1-/8	Gleyed Gray Brown Podzolic
	3.2 Dark Gray Wooded	3.21	Orthic Dark Gray Wooded
		3.21-2.2-	Solodic Dark Gray Wooded
		3.2-/8	Gleyed Dark Gray Wooded
	3.3 Gray Wooded	3.31	Orthic Gray Wooded
		3.32	Brunisolic Gray Wooded
		3.33	Bisequa Gray Wooded
		3.31-2.23	Solodic Gray Wooded
		3.3-/8	Gleyed Gray Wooded
	3.4 Humic Podzol	3.41	Orthic Humic Podzol
		3.42	Humus Podzol
		3.4-/3	Ironpan Humic(us) Podzol
		3.4-/8	Gleyed Humic(us) Podzol
	3.5 Podzol	3.51	Orthic Podzol
		3.52	Orstein Podzol
		3.53	Bisequa Podzol
		3.54	Textural Podzol
		3.55	Concretionary Podzol
		3.5-/7	Cryic Podzol
		3.5-/8	Gleyed Podzol

Order	Great Group	Subgroup	
4. Brunisolic	4.1 Brown Forest	4.11	Orthic Brown Forest
		4.12	Degraded Brown Forest
		4.1-/8	Gleyed Brown Forest
	4.2 Brown Wooded	4.21	Orthic Brown Wooded
		4.22	Degraded Brown Wooded
		4.2-/7	Cryic Brown Wooded
		4.2-/8	Gleyed Brown Wooded
	4.3 Acid Brown Wooded	4.31	Orthic Acid Brown Wooded
		4.32	Degraded Acid Brown Wooded
		4.3-/7	Cryic Acid Brown Wooded
		4.3-/8	Gleyed Acid Brown Wooded
	4.4 Acid Brown Forest	4.41	Orthic Acid Brown Forest
		4.4-/8	Gleyed Acid Brown Forest
	4.5 Concretionary Brown	4.51	Orthic Concretionary Brown
		4.5-/8	Gleyed Concretionary Brown
	4.6 Alpine Brown	4.61	Orthic Alpine Brown
		4.6-/7	Cryic Alpine Brown
		4.6-/8	Gleyed Alpine Brown
5. Regosolic	5.1 Regosol	5.11	Orthic Regosol
		5.12	Deorcic Regosol
		5.1-/5	Saline Regosol
		5.1-/7	Cryic Regosol
		5.1-/8	Gleyed Regosol
	5.2 Podzo Regosol	5.21	Arenic Podzo Regosol
		5.22	Cutanic Podzo Regosol
		5.2-/7	Cryic Podzo Regosol
		5.2-/8	Gleyed Podzo Regosol
6. Gleysolic	6.1 Humic Gleysol	6.11	Orthic Humic Gleysol
		6.12	Rego Humic Gleysol
		6.13	Fera Humic Gleysol
		6.1-/5	Saline Humic Gleysol
		6.1-/6	Carbonated Humic Gleysol
		6.1-/7	Cryic Humic Gleysol
	6.2 Gleysol	6.21	Orthic Gleysol
		6.22	Rego Gleysol
		6.23	Fera Gleysol
		6.2-/5	Saline Gleysol
		6.2-/6	Carbonated Gleysol
		6.2-/7	Cryic Gleysol
	6.3 Eluviated Gleysol	6.31	Humic Eluviated Gleysol
		6.32	Low Humic Eluviated Gleysol

Proposed Classification of Organic Soils

Order	Great Group	Subgroup	
7. Organic	7.1 Fibrisol	7.11	Fennic Fibrisol
		7.12	Mucinic Fibrisol
		7.1-/3	Stratic Fibrisol
		7.1-/4	Clasto Fibrisol
		7.1-/5	Limno Fibrisol
		7.1-/6	Cumulo Fibrisol
		7.1-/7	Cryic Fibrisol
		7.1-/8	Terric Fibrisol
		7.1-/9	Lithic Fibrisol
	7.2 Mesisol	7.21	Unic Mesisol
		7.22	Luvic Mesisol
		7.2-/3	Stratic Mesisol
		7.2-/4	Clasto Mesisol
		7.2-/5	Limno Mesisol
		7.2-/6	Cumulo Mesisol
		7.2-/7	Cryic Mesisol
		7.2-/8	Terric Mesisol
		7.2-/9	Lithic Mesisol
	7.3 Humisol	7.31	Unic Humisol
		7.32	Luvic Humisol
		7.3-/3	Stratic Humisol
		7.3-/4	Clasto Humisol
		7.3-/5	Limno Humisol
		7.3-/6	Cumulo Humisol
		7.3-/7	Cryic Humisol
		7.3-/8	Terric Humisol
		7.3-/9	Lithic Humisol

REPORT ON SOIL HORIZON DESIGNATIONS

D. W. Hoffman

Chairman, Subcommittee on Soil Horizons

In this report of the Subcommittee on Soil Horizon Designations the major change from that presented in 1963 is the more detailed definition of horizons considered to be diagnostic. Limits have been set for lower case suffixes ca, e, f, g, h, j, n, sa and t and for certain combinations of these suffixes. Two lower case suffixes (b and x) and R have been added.

Conventions Concerning the Use of Designations

1. The capital letters A and B may not be used singly in profile descriptions but must be accompanied by the lower case suffix (Ah, Bf, Bt, etc.) 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.

2. Unless otherwise specified additional lower case suffixes indicate a secondary or subordinate feature or features in addition to those characteristic of the defined major 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 light of present knowledge and definitions, thus their use should be avoided, e.g. Bmj. In some cases, such as Bgf, Bfh and Bhf, the combination of suffixes has a specific meaning differing from that of the sum of the two suffixes used singly.

3. All horizons except AB, A and B, AC, and B and A may be vertically subdivided by consecutive arabic numbers after the letter designations. The assigned arabic numeral has no meaning except that of vertical subdivision. For example, a profile may be described as having the following: Ae1, Ae2, Bt1, Bt2, Bt3, Bt4, C1 and C2.

4. 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 therefore is not written. Subsequent contrasting materials are numbered consecutively in the order in which they are encountered downward, that is, II, III, etc.

Organic Horizons

Organic horizons may be found at the surface of mineral soils, at any depth beneath the surface in buried soils or overlying geologic deposits. They contain more than 30 per cent organic matter. Three horizons are recognized.

L - An organic layer characterized by the accumulation of organic matter in which the original structures are easily discernible.

F - An organic layer characterized by the accumulation of partly decomposed organic matter. The original structures are discernible with difficulty. Fungi mycelia are often present.

H - An organic layer characterized by an accumulation of decomposed organic matter in which the original structures are undiscernible.

Note 1 - If it is not possible or advisable to subdivide the organic layer it may be referred to as L-H or other combinations.

Note 2 - It may be desirable to use lower case suffixes to differentiate kinds of organic material. However, none is suggested in this report.

Master Mineral Horizons and Layers

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

A - A mineral horizon or horizons formed at or near the surface in the zone of removal of materials in solution and suspension and/or maximum in situ accumulation of organic matter. 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, and/or organic matter (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 - 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 which exhibits pronounced coatings or stainings and with significant amounts of exchangeable sodium (Bn);

(3) an alteration by hydrolysis, reduction or oxidation to give a change in color or structure from horizons above and/or below and does not meet the requirements of (1) and (2) above (Bm, Bg).

C - A mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (1) the process of gleying, and (2) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca, Csa, Cg and C).

R - Underlying consolidated bedrock, such as granite, sandstone, limestone, etc.

Lower Case Suffixes

b - Buried soil horizon.

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

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

cc - Cemented (irreversible) pedogenic concretions.

e - A horizon characterized by removal of clay, iron, aluminum or organic matter alone or in combination. Higher in colour value by 1 or more units when dry 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) and with B and g (Bfg), etc.

The criteria for an f horizon (excepting Bgf) are that: the oxalate extractable Fe + Al exceeds that of the IC horizon by 0.8 per cent or more (ΔFe + ΔAl > 0.8%) and the organic matter to oxalate extractable Fe ratio is less than 20.

These horizons are differentiated on the basis of organic matter content into:

Bf	less than 5% organic matter
Bfh	from 5 to 10% organic matter
Bhf	greater than 10% organic matter

g - A horizon characterized by gray colors and/or prominent mottling 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); etc.
In some reddish parent materials, matrix colors of reddish hues and high chromas may persist, in spite of long periods of reduction. In such 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 and e as well as those of 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:

(1) Colors of low chroma and a change in structure from that of the C or,

(2) Matrix colors of low chroma accompanied by mottles more prominent and/or abundant than those in the C, but not satisfying the requirements of Bgf horizons.

Bg horizons occur in some Orthic Humic Gleysols and in some Orthic Gleysols. These horizons are comparable, to some extent, with the Bm horizons of soils that are not strongly gleyed.

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

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 iron in the Bgf horizon is thought to have accumulated as a result of oxidation of ferrous iron. The ferric oxide formed is not associated intimately with organic matter or with aluminum, and it is sometimes crystalline. Usually Bgf horizons are prominently mottled and more than half of the soil material occurs as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag - When g is used with C alone or C and one of the lower case suffixes k, ca, s, sa, it must meet the definitions for C and these suffixes.

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 per cent organic matter. It must show one Munsell unit of value darker than the layer immediately below or have 1 per cent more organic matter than IC.

Ahe - When used with A and e it refers to an Ah horizon which 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 per cent organic matter and the organic matter to oxalate extractable Fe ratio 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 per cent but in some cases ΔAl is great enough to exceed this value.

j - Used as a modifier of suffixes e, f, 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 and adjacent to the suffix it modifies.

Aej - When used with A and e it denotes an eluvial horizon which is thin or 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.

Bfj - When used with B and f it is a horizon with some illuviation of iron and aluminum but not enough to meet the limits of Bf. It must underlie an Ae horizon.

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

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

k - Presence of carbonate as indicated by visible effervescence with dilute HCl. May be used with any master horizon or combination of master horizon and lower case suffix. Most often is used with B and m (Bmk) or C (Ck).

m - A horizon slightly altered by hydrolysis, oxidation and/or solution to give a change in color and/or structure. The suffix is used only with B to denote a B horizon that is greater in chroma by 1 or more units than the parent material, or that has granular, blocky or prismatic structure without evidence of strong gleying, and that has Δ(Fe + Al) $<$ 0.8 per cent. It may not be used under an Ae horizon but may be used under an Aej horizon. This rule distinguishes it from a Bfj horizon. It can be used as Bm, Bmgj, Bmk, Bms.

n - A horizon in which the ratio of exchangeable calcium to exchangeable sodium 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, i.e. by cultivation and/or pasturing. It is to be used only with A.

s - A horizon with salts including gypsum which may be detected as crystals or veins, or as surface crusts of salt crystals, or by distressed crop growth, or by the presence of salt tolerant plants. Most commonly used with C and k (Csk) but can be used with any master horizon or combination of master horizon and lower case 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 10 cm (4 inches) 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) and with B and g (Btg), etc.

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 more fine clay than the eluvial horizon as follows:

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

(b) If the eluvial horizon has more than 15 per cent and less than 40 per cent 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 per cent total clay in the fine earth fraction the Bt horizon must contain at least 8 per cent 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 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 bridging the sand grains.

4. If peds are present a Bt horizon shows clay skins on some of both the vertical and horizontal ped surfaces and in the fine pores or shows oriented clays in 1 per cent 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 per cent or more of oriented clay bodies.

Btj and Btg are defined under j and g respectively.

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

z - A permanently frozen layer.

Notes:

1. Transition horizons need capitals only, and

(a) if transition gradual use e.g. AB, BC, etc.
(b) if transition interfingered use e.g. A and B, B and C, etc.
(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.

REPORT ON THE CLASSIFICATION OF CHERNOZEMIC SOILS

J. S. Clayton

Chairman, Subcommittee on Chernozemic Soils

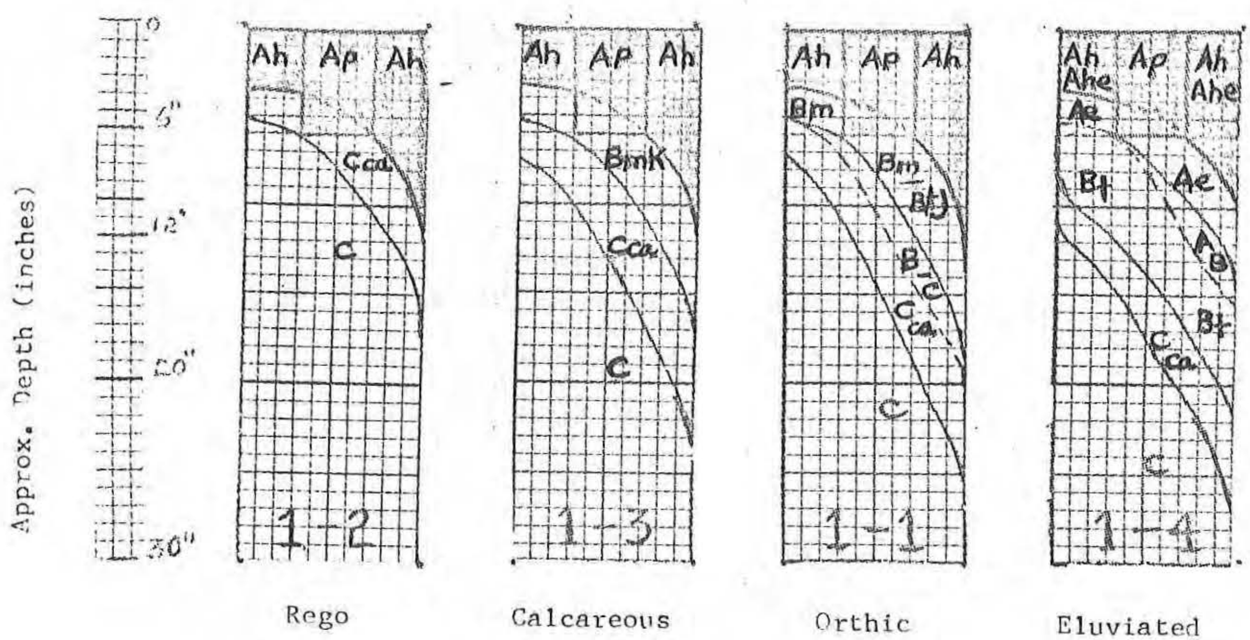
1. Chernozemic Order

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
1.2 Dark Brown	Subgroups same as for Brown except for great group name - thus 1.21 Orthic Dark Brown	
1.3 Black	Subgroups same as for Brown except for great group name - thus 1.31 Orthic 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

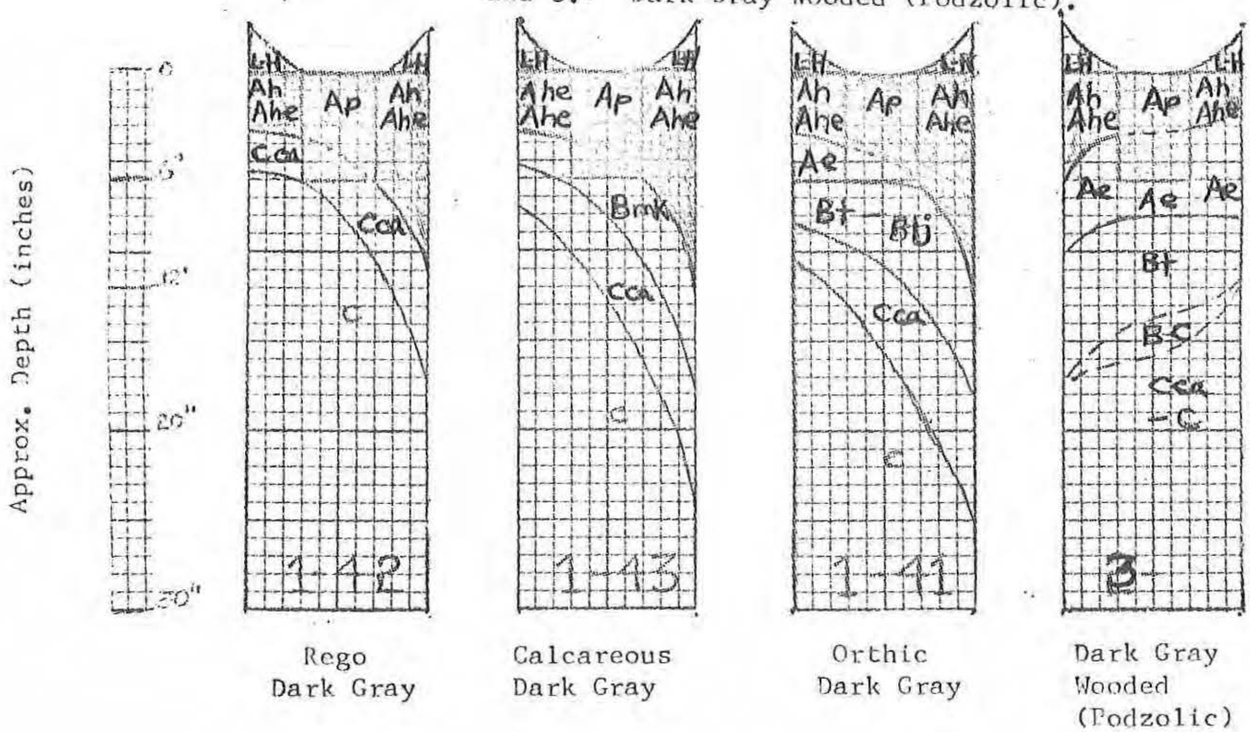
A diagrammatic representation of the horizon pattern of the main subgroup profiles in the Chernozemic Order is shown on the next page.

Fig. 1 Diagrammatic horizon pattern and relationships of the key profiles of the Chernozemic Order.

1.1, 1.2, 1.3 - Brown, Dark Brown and Black Great Groups.



1.4. Dark Gray Great Group (Degraded Chernozem) and 3.- Dark Gray Wooded (Podzolic).



National Soil Survey Committee, 1966.

1. Chernozemic Order

Definitions and Criteria at the Order Level

Well to imperfectly drained 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, usually calcium being dominant. Chernozemic soils occur under cool (mean annual temperature usually less than 42°F), semi-arid to subhumid continental climates with the characteristics of the A horizons developed and maintained from the accumulation and decomposition of a cyclic growth of xero- or mesophytic 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 Order of Mollisols, in the suborders of Borolls and Ustolls as defined in the American Comprehensive System of Classification. However, a number of other soils with dark colored surface horizons are excluded from the Chernozemic Order by definition. These include:

1. Dark surface soils with distinct solonetzic, n, horizons as defined within the Solonetzic Order.
2. Dark surface soils developed under hydrophytic vegetation and exhibiting horizons with strongly gleyed characteristic as defined within the Gleysolic Order.
3. Dark surface soils developed under cold climatic conditions and under characteristic vegetative communities of the Subarctic, Arctic, Subalpine, and Alpine regions.
4. Dark surface soils developed under deciduous or mixed-forest vegetation of moderate climatic regions (M.A.T. > 42°F) or under Boreal forest vegetation where prominent light colored Ae horizons > 2½ inches (6 cm) in thickness have developed due to podzolization. The latter will include some Dark Gray Wooded and some Gray Brown Podzolic soils as defined in the Podzolic Order.

Definition. A Chernozemic A horizon should conform to the following characteristics:

The thickness of the Ah horizon in virgin soils should be not less than 3½ inches (9 cm), with color values darker than 3.5 when moist or 5.5 when dry, and with chroma of 4.0 or less, moist or dry. In soils disturbed by man's activities, i.e. cultivation and/or pasturing, the Ap horizon should be of sufficient thickness and darkness to provide 6 inches (15 cm) of surface horizon with the above color criteria. The color of 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 virgin soils will usually have an organic matter content in excess of 1.5% organic matter for 6 inches (15 cm) when mixed or disturbed and with a carbon-nitrogen ratio of 17 or less. It cannot exceed 30% in organic matter content.

Normally 6 inches (15 cm) of Ap horizons may be expected to meet the requirements of 1.5% organic matter content specified for the Ah. However, where the original Ah was thin or where the present Ap horizon is thin or partially eroded, this requirement is waived, and the Chernozemic surface soil may contain as little as 1% organic matter. If resting on consolidated bedrock (R), the 6 inch thickness specified for a Chernozemic surface may be reduced to 4 inches (10 cm).

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

1.1 Brown Great Group

Chernozemic soils with Ah horizons of value darker than 3.5 moist and 5.5 dry of sufficient thickness to produce 6 inches (15 cm) of mixed surface or Ap horizons with the following ranges of moist and dry color. Value darker than 3.5 moist and from 4.5 to 5.5 dry. Chroma usually greater than 1.5 dry. In virgin Brown Chernozemic soils the surface layer of the Ah horizon is usually as light or lighter in value than the lower portion of the Ah or of the upper B horizon.

Brown soils are associated with and developed from the decomposition of a cyclic growth of mixed xero- to mesophytic grasses and forbs.

1.11 Orthic Brown Profile type Ah, Bm, Btj or Bt, C, (Cca), (Ck)

Soils with 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 horizons are free of primary carbonates, and range in reaction from slightly alkaline to slightly acidic.

The B horizon is normally medium to fine prismatic in macro-structure, breaking to medium and fine blocky or to coarse granular aggregates. Coarse prismatic structure is usually associated with coarse textured fabric. Decreasing size of macro-prismatic structure and an increasing tendency to break into finer blocky and granular aggregates is apparently associated with increasing clay content of 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 by eye, they may be observed with a hand lens or in thin section. The occurrence of textural B horizons in orthic Chernozemic soils may reflect simple gravitational movement and colloidal flow through pores and cleavages, or trends towards minimal development of solonetzic or podzolic characteristics. A thin weakly developed Bm horizon or a transitional BC horizon is frequently present between the Bt and C horizons. A lighter colored horizon of carbonate accumulation, Cca, is usually present but is not an essential criterion.

Orthic profiles with minimal grumic characteristics occur in soils of high clay content, and are characterized by granular to fine subangular blocky peds in the A horizon and massive to angular blocky structure in the B horizon. Frequently dark tongues of A horizon 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 Ah, C, (Cca), (Ck)

Soils with Ah or Ap horizons as defined in the order and great group, underlain by C horizons. Profiles in which no major leaching of primary alkaline earth carbonates has occurred below the A horizons. Transition AC horizons may occur. No distinctive development of a B horizon is permitted in Rego Chernozemic soils.

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

In profiles with limited internal drainage, or in those occurring on sites of imperfect drainage and excessive moisture accumulation, the A horizons may be infused with secondary carbonates, or salts, due to precipitation from solution of lime or salt bearing waters. Carbonated rego profiles may usually be detected by visual observation of strings or beads of carbonate crystals occurring in the Ah horizon and confirmable by an effervescence test with acid (Ahk). Under cultivation such soils usually have a distinctly grayish surface cast or color.

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

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 frequently show evidences of gleying.

1.13 Calcareous Brown Profile type Ah, Bmk, Cca or Ck

Soils with 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).

The B is usually medium to fine prismatic in macro-structure, brownish in color, and slightly to moderately alkaline in reaction. Coarse prismatic structure is usually associated with coarser textures. A lighter colored Cca horizon of carbonate accumulation is usually present above the C.

In profiles occurring on sites with moderate to excessive surface drainage, the primary carbonates in the B horizon are present through 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 occurring on sites of imperfect drainage and excessive moisture accumulation, the occurrence of carbonates or salts above the C horizon may be primary due to retardation of leaching (Bmk), or an expression of upward moisture movement and precipitation of secondary carbonates. In this latter circumstance both carbonated and gleyed phases may be recognized where significant. It is not considered 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 per cent 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 A horizon frequently extend into the B and C horizons due to sloughing into cracks. Slickensides may be frequently observed in the C horizons. Gleyed Calcareous Brown profiles may be recognized by mottling in the A or Bmk horizons.

1.14 <u>Eluviated Brown</u> 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)

Soils with Ah or Ap horizons as defined in the order and great group, underlain by significant horizons of leaching or eluviation, 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 B horizons. The leached horizons are characterized by the development of slight to moderate acidity and a minor reduction in base saturation.

Two subtypes are recognized. These are:

A. A profile type in which eluviation is characterized by light colored relic macro-prismatic structure below the Ah or Ap, which breaks into coarse to medium platy peds which frequently 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 macro-prismatic structure breaking to blocky peds of lower color value and slightly higher chroma than the Ae. The development of coatings on the surface of the peds, if present, is less strongly expressed than in Solonetzic Bn or Bnj horizons and the cationic ratio of calcium to other ions usually remains high.

B. A "cumulic" eluviated type in which the accumulative effects of surficial deposition of transported soil material, merge and overlap the horizon differentiation due to leaching within the profile. Such soils are characterized by thick horizons of partially leached accumulated materials, overlying former A or transitional AB horizons. They are usually found in lower concave slope positions where accumulation of excess run-off and sediments may be expected to occur. Such profiles are frequently imperfectly drained and may be weakly gleyed. This profile type may be referred to as Cumulic Eluviated. A suggested criteria for recognition of this type is when the depth from the surface to what is considered original B horizon exceeds 16 inches.

Eluviated Gleyed Brown profiles, 1.14/8, are of frequent occurrence. 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.

Finer 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. These profiles are to be considered as intergrades between Solonetzic and Chernozemic soils rather than as typical subgroups within either order. Such soils are characterized by the occurrence of 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, i.e., ratio of exchangeable calcium to exchangeable Na of 10 or less, but would have a significant amount of Na or Na + Mg present, above that considered normal for Chernozemic soils.

1.11-2.11 Solonetzic Brown Profile type Ah, Bnjt, C, (Cca), (Csk)

Soils with Ah or Ap horizons as defined in the order and Brown 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 underlay the Bnjt. They may be considered as intergrades between Orthic Brown and Brown Solonetz profiles.

1.14-2.21 Solodic Brown Profile type Ah, (Ahe), Ae or AB, Bnjt, C, (Cca), (Csk)

Soils with Ah or Ap horizons as defined in the order and Brown Great Group, underlain by a sequence of eluvial Ahe, Ae, or transitional AB horizon underlaid by a prismatic or blocky Bnjt horizon with pronounced coatings. The eluvial Ae or AB horizons are frequently characterized by macro-prismatic structure breaking into coarse to medium platy peds. They 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 and gleyed modifications of all major Brown Subgroup profiles may occur and are identified with the following horizons:

1.1-/5	Saline Brown	Saline A and/or B and C horizons s or sa. Salinity may be detected by visual evidence of salt crystals and confirmable by 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.

1.2 Dark Brown Great Group

A soil with an Ah horizon of value darker than 3.5 moist and 4.5 dry; and with chroma usually greater than 1.5 dry of sufficient thickness to produce 6 inches (15 cm) of mixed surface or an Ap horizon with the following ranges of moist and dry color. Values darker than 3.5 moist and between 3.5 and 4.5 dry with chroma greater than 1.5 dry, or with values from 2.5 to 4.5 if the chroma is greater than 2.5. In virgin Dark Brown Chernozemic soils the Ah horizon is usually darkest in value at the surface and becomes 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.

1.21 Orthic Dark Brown Profile type Ah, Bm, Btj or Bt, C, (Cca), (Ck)

Soils with Ah or Ap horizons as defined in the order and Dark Brown Great Group underlain by a Bm, or a weak to moderately textural Btj or Bt. The B horizon is free of 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)

Soils with Ah or Ap horizons as defined in the order and Dark Brown 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

Soils with Ah or Ap horizons as defined in the order and Dark Brown Great Group, underlain by Bm horizons, from which primary alkaline earth carbonates are not 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)

Soils with Ah or Ap horizons as defined in the order and Dark Brown 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)

Soils with an Ah or Ap horizon as defined in the order and Dark Brown 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 underlay the Bnjt. They 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)

Soils with an Ah or Ap as defined in the order and Dark Brown 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 frequently characterized by macro-prismatic 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 and gleyed modifications of all major Dark Brown Subgroup profiles may occur and are identified with the following horizons:

1.2-/5	Saline Dark Brown	Saline A and/or 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

1.3 Black Great Group

A soil with an Ah horizon of value darker than 3.5 moist or dry, and with chroma of 1.5 or less moist, of sufficient thickness to produce 6 inches (15 cm) of mixed surface or an Ap horizon of value less than 4.0 dry and with chroma less than 2.0 dry.

Although Thin Black soils with Ah horizons less than 6 inches in depth are quite common, many Black soils have deeper Ah horizons extending 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.

1.31 Orthic Black Profile type Ah, Bm or Btj, C, (Cca), (Ck)

Soils with Ah or Ap horizons as defined in the order and Black Great Group, underlain by a color Bm, or a weak to moderately textured Btj or Bt. The B horizon is free of 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)

Soils with Ah or Ap horizons as defined in the order and Black 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

Soils with Ah or Ap horizons as defined in the order and Black Great Group, underlain by color 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)

Soils with Ah or Ap horizons as defined in the order and Black 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.

Solonetzic and Solodic Black

1.31-2.12 Solonetzic Black (Intergrade) Profile type Ah, Bnjt, C (Cca), (Ck), (Cs)

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

1.34-2.22 Solodic Black (Intergrade) Profile type Ah, (Ahe), Ae or AB, Bnjt, C, (Cca), (Csk)

Soils with an Ah or Ap horizon as defined in the order and Black 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 frequently 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 and gleyed modifications of all major Black Subgroup profiles may occur and are identified with the following horizons.

1.3-/5	Saline Black	Saline A and/or B, and C horizons 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

1.4 Dark Gray Great Group (Formerly termed Degraded Black)

A soil with a Chernozemic A horizon by order definition, but with significant characteristics indicative of degradation or other modification resulting from the accumulation and decomposition of forest vegetation including leaf mats, (L-H horizons). Such soils in their original or undisturbed state 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 frequently have leaf mats, (L-H horizons), overlying Ah and Ahe horizons. The peds of the A horizons may have relatively dark colored surfaces but these will usually crush or rub out to grayer or browner colors of higher value or chroma. A "salt and pepper effect", i.e. lighter grayish spots or bands may be observable in Ahe 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 frequently 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 color value darker than 3.5 moist and 4.5 dry and chroma of less than 2. The Ahe horizon has peds which 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 3½ inches (9 cm) or must be of sufficient thickness and darkness to produce 6 inches (15 cm) of a mixed surface or Ap horizon of color values darker than 3.5 moist and 4.5 dry, and with chroma of 2 or less dry. A minimal development of a lighter colored Ae horizon less than 2½ inches (6 cm) is allowable providing that the Ap or mixed horizon meets the above requirements for Dark Gray soil. Where a distinct Ae horizon greater than 2½ inches (6 cm) in thickness, and a Bt occurs beneath a Dark Gray Chernozemic surface (Ah Ahe), the soil is considered to have undergone sufficient podzolization to be classified with the Dark Gray Wooded Great Group of the Podzolic Order.

Other soils with dark colored Ah or Ahe horizons developed under a forest leaf mat with moist values of 3.5 or less, but of insufficient thickness 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 Podzolic, Brunisolic or Regosolic orders as defined.

1.41 Orthic Dark Gray Profile type (L-H), (Ah), Ahe (Ae), Bm or Bt, C, (Cca),(Ck)

Soils with L-H, Ah-Ahe, L-H, Ahe or Ap horizons as defined in the order and Dark Gray Great Group, underlain by a color Bm or textural Bt horizon, free of primary carbonates.

A minimal development of Ae horizon of less than 2½ inches (6 cm) is allowable within the 6 inches (15 cm) of surface horizons of orthic profiles providing that the mixed combination will meet the criteria for a Chernozemic A horizon, and that no undisturbed or continuous Ae horizon is present below this depth.

A Bt horizon is more commonly associated with Orthic Dark Gray soil than a Bm horizon, and becomes more pronounced with increasing degradation of the A horizons. These textural horizons are frequently 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.

Salinized (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 of frequent occurrence.

1.42 Rego Dark Gray Profile type (L-H), (Ah), Ahe, C, (Cca), (Ck)

Soils with L-H, Ah-Ahe, L-H-Ahe, or Ap horizons as defined in the order and Dark Gray Great Group underlain by C horizons, usually moderately to strongly calcareous. In Rego Dark Gray soils the evidences of degradation in the Ahe are frequently 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 frequently found in sites of limited internal drainage or in imperfectly drained positions and gleyed (1.42/8) profiles are common. Rego Dark Gray soils are less commonly associated with sites of moderate to excessive surface drainage.

Salinized modifications (1.42/5) of Rego Dark Gray profiles are of doubtful occurrence, carbonated modifications (1.42/6) of Rego Dark Gray profiles with slight to moderate occurrence of carbonates in the Ah, Ahe below the leaf mat are common but carbonate accumulations in excess of that in the C horizon (ca) are infrequent. Grumic modifications of Rego Dark Gray soils (1.42/7) have not been observed under virgin conditions but may develop in cultivated clay soils after the L-H layers are 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

Soils with L-H, Ah-Ahe, L-H, Ahe, or Ap horizons as defined in the order and Dark Gray 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 frequently 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.

Salinized modifications of Calcareous Dark Gray soils (1.43/5) are of doubtful occurrence. Carbonated modifications (1.43/6) are uncommon in virgin sites but are more evident under cultivation. Grumic modifications (1.43/7) have not been observed. Gleyed modifications (1.43/8) are of common occurrence.

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

Eluviated Dark Gray - Dark Gray Wooded

A "degraded" type, in which pronounced leaching and eluviation has resulted due to the genetic influence of accumulation and decomposition of wooded vegetation including leaf mats was formerly classified as the Eluviated Dark Gray (degraded) Subgroup, and recognized as intergrading towards the Podzolic Order.

The separation of these soils (which were also formerly designated as moderately degraded black) from Podzolic soils has presented some difficulties and it has been decided that they will now be classified and described with the Dark Gray Wooded Great Group in the Podzolic Order. It should be noted that Dark Gray profiles with an Ae horizon of less than 2½ inches (6 cm) are included with the Orthic Dark Gray Subgroup. Virgin soils with less than 3½ 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 Wooded Subgroup of the Podzolic Order.

Solonetzic and Solodic Dark Gray

1.41-2.12 Solonetzic Dark Gray Profile type (L-H), (Ah), Ahe, (Ae), Bnjt, C, (Cca), (Csk)

Soils with L-H, Ah-Ahe, L-H, Ahe, or Ap as defined in the order and Dark Gray Great Group underlain by a prismatic structured Bnjt horizon with hard consistence and with subangular blocky secondary structure characterized by distinct dark coatings on the peds. A Cca, Ck, or Cs horizon may underlay the Bnjt. An Ae horizon less than 2½ inches (6 cm) is frequently found in this intergrade type within the upper 6 inches of surface horizon below the leaf mat. If, however, the Ae horizon is thicker than 2½ inches or extends to more than 6 inches (15 cm) below the leaf mat, the soil must be classified as a Solodic Dark Gray Wooded (3.21-2.22).

1.41-2.22 Solodic Dark Gray (Intergrade) Profile type (L-H), (Ah), Ahe, (Ae), AB, Bnjt, C, (Cca), (Csk)

Soils with L-H, Ah Ahe; L-H (Ahe), or Ap as defined in the order and Dark Gray 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 transitional AB horizon, or an Ae, AB sequence, overlying a prismatic or blocky structured Bnjt horizon with pronounced coatings. Such a soil can be considered as an intergrade between an Orthic Dark Gray and a Gray Solod, or as an intergrade between a Dark Gray Wooded and Gray Solod. An Ae horizon if present should be less than 2½ inches (6 cm) in thickness.

Salinized modifications of all Dark Gray Chernozemic soils (1.4-/5) are of doubtful occurrence. 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.

REPORT ON THE CLASSIFICATION OF SOLONETZIC SOILS

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Chairman, Subcommittee on Solonetzic Soils

2. 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
2.2 Solod	2.21 Brown Solod
	2.22 Black Solod
	2.23 Gray Solod
	2.2-/8 Gleyed Solod

Foreword:

The following classification of the soils of the Solonetzic Order differs from the previous classification in two respects: the great groups have been reduced from three to two, and the primary subgroups have been reduced from 14 to 7.

The Solodized Solonetz Great Group has been eliminated. The term solodized solonetz does not have universal acceptance and the literal translation of the term is, in fact, synonymous with the term 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 shows visible evidence of breakdown. This point can be seen in the field, can be precisely defined, and can be uniformly interpreted by the field surveyor. It is suggested that this is the only break that should be recognized at the great group level. Practically all the soils "above" this point have an A horizon that is neutral to slightly acidic, showing varying degrees of leaching, and is abruptly separated from the Bnt horizon. All the soils "below" this point have an acidic A horizon with a well developed Ae subhorizon and there is usually a well defined AB horizon.

Since there are varying degrees of leaching in the A horizon the color of this horizon is much less amenable to precise definition than in 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, since the characteristics of the Bnt horizon are dominant in these soils, the color, and hence the organic content, of the A horizon is subdominant. It is suggested that three color (zonal) separations are all that can be satisfactorily defined at the subgroup level.

2. Solonetzic Order

Soils with solonetzic B and saline C horizons. Morphologically a solonetzic B horizon is characterized by a columnar or prismatic macro structure that can be broken into a blocky meso-structure. 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 calcium to exchangeable sodium 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 salinised. This material was, and still is, subjected to leaching by rainwater. This leaching caused desalinisation and an increase of alkali peptised 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 can be 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 of limited occurrence in Canada. Practically all the Solonetzic soils of this region have a neutral to acidic A horizon indicating that solodization has become operative. It is also 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 ground water is within capillary reach of the solum. 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.

It is recognized there are soils that are intergrades between the Solonetzic Order and the soils of the Chernozemic and Podzolic orders. These are to be classified in the latter orders. In general, these intergrades fall into two categories: (a) soils with weak solonetzic characteristics that will usually intergrade towards the Chernozemic Order, and (b) soils with relic solodic characteristics that will intergrade towards either the Chernozemic or Podzolic orders.

2.1 Solonetz Great Group

Soils with 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 portion of the Bnt columns is massive (intact) when removed from the profile. See 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 portion 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.

This great group includes the Solonetz and most of the Solodized Solonetz great groups of the previous (1963) report.

2.11 Brown Solonetz

Profile type: Ah or Ahe and/or Ae, an intact Bnt, (Bs), (Bk), (Csa), (Cs), (Cca), (Ck)

A soil associated with a grass and forb vegetation and a semiarid climate. The mixed A subhorizons have a color value of more than 3.5 (dry) (usually more than 4.5) and a chroma 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 a very sparse vegetative growth.

2.12 Black Solonetz

Profile type: Ah, Ahe and/or Ae, an intact Bnt, (Bs), (Bk), (Csa) (Cs), (Cca), (Ck)

A soil associated with a mesophytic grass and forb, shrub, or discontinuous tree vegetation and a subhumid climate. The mixed A subhorizons have a color value of less than 4.5 (dry) and a chroma of less than 2.5.

There may occasionally be a thin L-H horizon in those profiles that are intergrading to the Gray Subgroup. The differential erosion of the A horizon, common in the areas of the Brown Subgroup, is usually of limited occurrence in the Black Subgroup. Those that do exist are generally fairly well covered with grass.

2.13 Gray Solonetz

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

A soil associated with a scattered or stunted forest vegetation and a subhumid climate. The mixed A subhorizons have a color value of more than 4.5 (dry) and a chroma of less than 2.5.

2.14 Alkaline Solonetz

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

A soil associated with a 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 is of rare occurrence in Western Canada. It differs from the other subgroups of the Solonetz Great Group in that the Ah 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

Soils with the same differentiating characteristics as any of the above subgroups but with the addition of some mottling and duller colors in the A, B, and/or C horizons.

Mottling in the A horizon (usually in the lower portion) 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 non gleyed subgroups.

2.2 Solod Great Group

Soils with A horizons with a color as defined in the subgroups. There is either a distinct (more than one inch) AB transition horizon or there is a prominent (more than two inches) Bntl 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 centre of the blocks retain the dark color of the former B horizon. The Bnt horizon is usually similar to the lower Bnt of the associated Solonetz soils. It therefore may not have well developed columnar structure. The Cs horizon is often below the Ck horizon.

2.21 Brown Solod

Profile type: Ah and/or Ahe, Ae, AB, Bnt, (Cca), (Ck), (Csa), (Cs)

A soil associated with a xero-to-mesophytic grass and forb vegetation and a semiarid climate. The mixed Ah and Ahe has a color value of more than 3.5 (dry) (usually more than 4.5) 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), Ah and/or Ahe, Ae, AB, Bnt, (Cca), (Ck), (Cs), (Csa)

A soil associated with a mesophytic grass and forb, shrub, or discontinuous tree vegetation and a 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), Ae, AB, Bnt, Cs, (Csa), Ck (Cca)

A soil associated with a forest vegetation and a subhumid climate. The mixed A subhorizons have a color value of more than 4.5 (dry) and a chroma less than 2.5.

2.2-/8 Gleyed Solod

Soils with the same differentiating characteristics as any of the above subgroups but with the addition of some mottling and duller colors in the AB and/or C horizons.

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.

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 value of the geographically associated Chernozemic or Podzolic soils - specifically it is usually of slightly higher value. Since 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 Podzolic 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. It should also be stated that there is, going from Brown-to Black-to Gray or from semiarid to subhumid, generally an increase in depth of A horizon and in depth of soil development. Finer subdivisions on the basis of the color of the A horizon can be recognized at the series level.

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:

Profiles 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 k. There are insufficient data available as yet to define a specific subgroup.

REPORT ON THE CLASSIFICATION OF PODZOLIC SOILS

P. C. Stobbe

Chairman, Classification of Podzolic Soils

The soils of the Podzolic Order are divided into 5 great groups and into a number of subgroups as shown below.

3. Podzolic Order

3.1	Gray Brown Podzolic (with Bt and mull-type Ah)	3.11	Orthic Gray Brown Podzolic
		3.12	Brunisolic Gray Brown Podzolic
		3.13	Bisequa Gray Brown Podzolic
		3.1-/8	Gleyed Gray Brown Podzolic
3.2	Dark Gray Wooded (with Bt and with degraded chernozemic-like Ah or Ahe)	3.21	Orthic Dark Gray Wooded
		3.21-2.2-	Solodic Dark Gray Wooded
		3.2-/8	Gleyed Dark Gray Wooded
3.3	Gray Wooded (with Bt and no Ah)	3.31	Orthic Gray Wooded
		3.32	Brunisolic Gray Wooded
		3.33	Bisequa Gray Wooded
		3.31-2.23	Solodic Gray Wooded
		3.3-/8	Gleyed Gray Wooded
3.4	Humic Podzol (with Bh or Bhf)	3.41	Orthic Humic Podzol
		3.42	Humus Podzol
		3.4-/3	Ironpan Humic(us) Podzol
		3.4-/8	Gleyed Humic(us) Podzol
3.5	Podzol (with Bfh or Bf)	3.51	Orthic Podzol
		3.52	Ortstein Podzol
		3.53	Bisequa Podzol
		3.54	Textural Podzol
		3.55	Concretionary Podzol
		3.5-/7	Cryic Podzol
		3.5-/8	Gleyed Podzol

A diagrammatic representation of the horizon pattern of the main subgroup profiles is given in Figures 1 and 2.

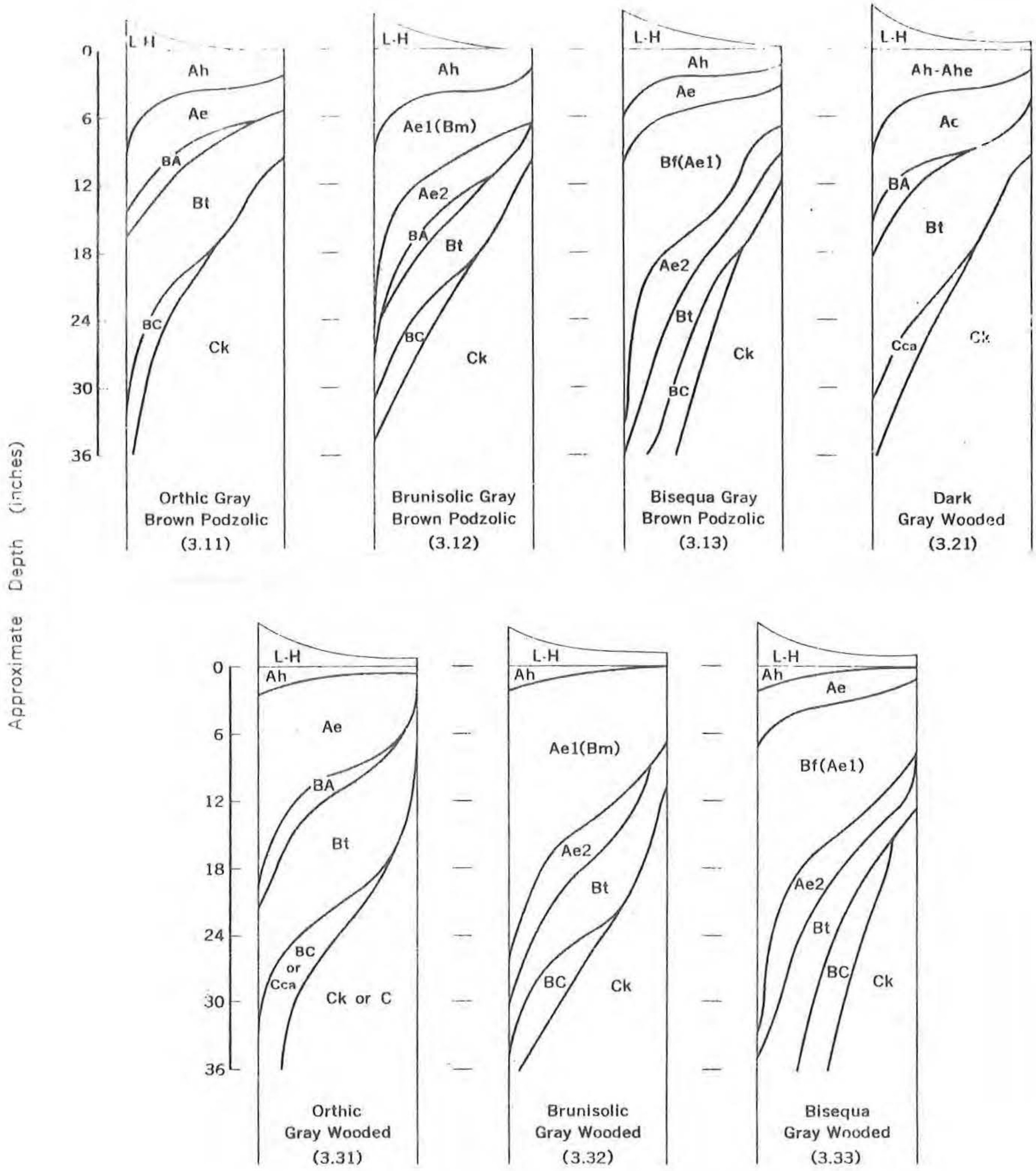

Fig. 1 Diagrammatic pattern of horizons in the Gray Brown Podzolic, Dark Gray wooded and Gray wooded great soil groups.

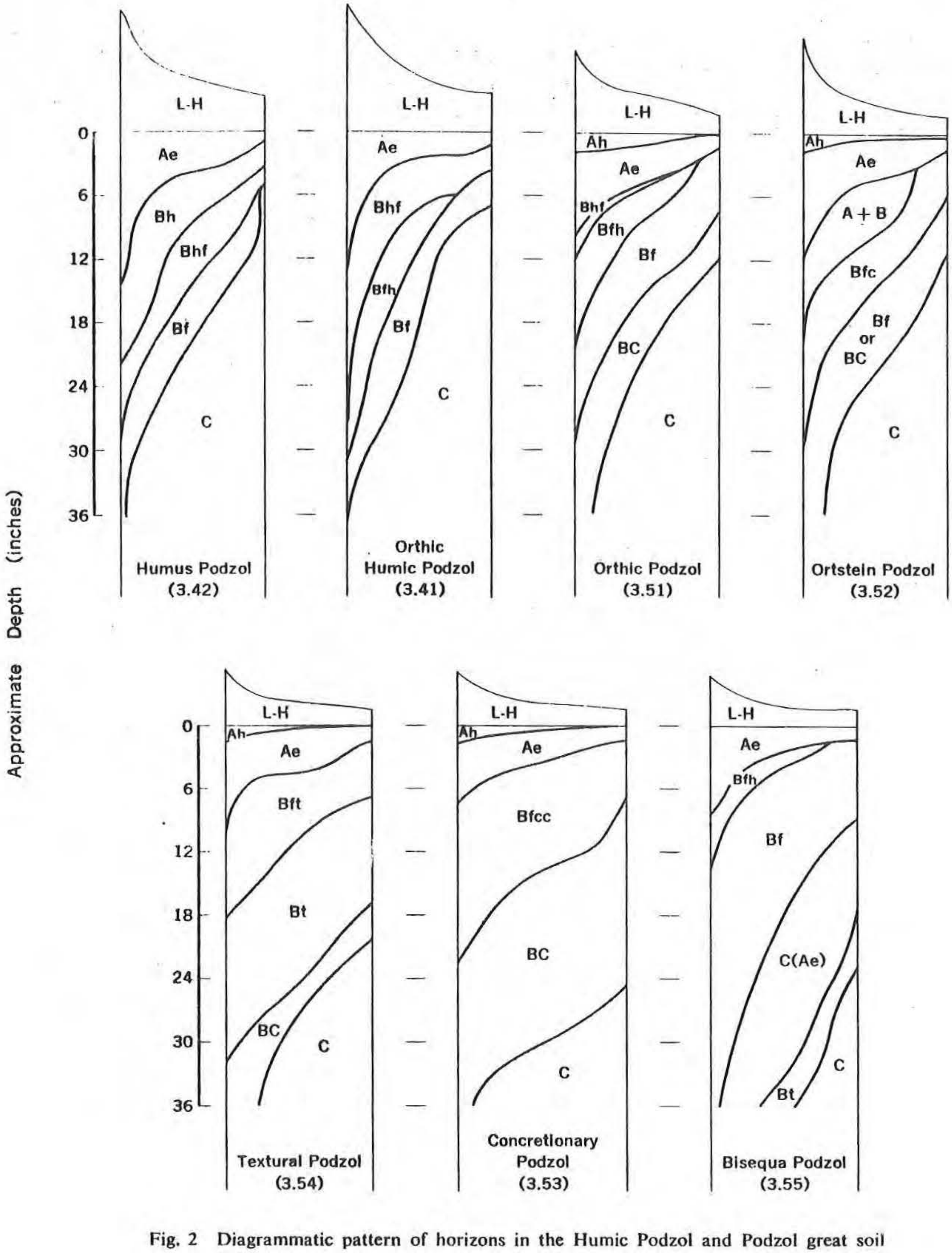

Fig. 2 Diagrammatic pattern of horizons in the Humic Podzol and Podzol great soil groups.

3. Podzolic Order

Well and imperfectly drained soils developed under forest or heath, having under virgin condition organic surface horizons (L-H), light colored eluviated horizons (Ae) and illuvial (B) horizons with accumulations of organic matter, sesquioxides or clay; or any combination of these. These soils may also have mineral-organic (Ah) horizons below the organic surface.

Under cultivated conditions the L-H, Ah, Ae and the upper part of the B horizons may be partly destroyed and mixed. Under such conditions the soils of this order may be recognized by remnants, if any, of the A horizons and by the underlying B horizons, i.e., Bh, Bhf, Bfh, Bf or Bt horizons, as defined. The Ap horizons may vary considerably in physical and chemical characteristics depending on the nature and thickness of the original horizons and on management practices. However, they do not, in general, meet the color requirements of the Chernozemic surface horizons, as defined. In cases where they meet the color requirement they are generally underlain by prominent light colored Ae horizons.

The Podzolic Order as defined may be closely correlated to the Alfisols and Spodosols. The Gray Brown Podzolic, Dark Gray Wooded and Gray Wooded great soil groups, all of which have a Bt horizon, may be correlated with the Alfisols, while the Humic Podzol and Podzol great groups, which have Bh, Bhf, Bfh or Bf (spodic) horizons, may be correlated with the Spodosols.

3.1 Gray Brown Podzolic Great Group

Soils with dark colored forest mull-type surface horizons (Ah), more than 2" (5 cm) thick, with lighter colored eluviated horizons (Ae) and with illuvial horizons in which clay is the main product of accumulation (Bt). An increase of dithionate extractable iron and small increases of organic matter are usually associated with the accumulation of clay. The soil has developed on basic or calcareous parent materials and the solum has a high degree of base saturation (by neutral salt extraction).

The soils have developed under deciduous or mixed forest vegetation and under moderate climatic conditions, generally having mean annual temperatures $> 42^{o}F$ ($5.5^{o}C$). Under undisturbed conditions the soils may have L, F and H horizons but due to high biological activity and abundance of earthworms the leaf litter usually is quickly incorporated into the soil and humified.

A transitional 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 parent materials a transitional BC horizon, free of lime, may be present. These transitional horizons are not diagnostic for the group.

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" in depth.

The soils of this group differ from the Degraded Brown Forest soils 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 Wooded soils, which have developed under cooler climatic conditions (generally < $42^{o}F$ ($5.5^{o}C$) mean annual temperature), mainly in the nature of the A horizons. Whereas the Gray Brown Podzolic soils have a forest-mull type of Ah, with well developed granular structure (texture permitting), the Dark Gray Wooded soils have a chernozemic-like Ah which has been degraded as evidenced by gray streaks and splotches; it lacks strongly developed granular structure and may be platy. The Gray Wooded soils lack or have only a very thin Ah and when cultivated are distinctly lighter in color (values of 5.5 or higher) than the Gray Brown Podzolic soils.

The subgroups of the Gray Brown Podzolic groups 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 Podzolic

Soils with the general characteristics of the great group and having well-developed Ah, Ae and Bt horizons. The Ae is light colored, with values of 4.5 or higher and with chromas of 3 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 prominent clay skins or by a BA horizon in which the blocky aggregates have gray coatings and tend to disintegrate. Faint mottling may occur immediately above the Bt or in the lower part of the B horizon.

The cultivated surface soil usually has a color value between 3.5 and 5.5 dry and a chroma of less than 3. The color value may vary considerably with relative thickness of original Ah and with management practices.

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

3.12 Brunisolic Gray Brown Podzolic

Soils with the general characteristics of the great group and having well-developed Ah, Ae and Bt horizons. The upper Ae1 is brown (chroma of 3 or more) and grades to a lighter colored lower Ae2. The difference in chroma between the upper Ae1 and the lower Ae2 is 1 or more. The thickness of the upper Ae1 (or Bm) should be sufficient that it can be recognized under a cultivated (Ap) layer.

The upper Ae1 is generally granular, while the lower Ae is often platy and friable when moist but it may be hard, often vesicular, when dry. When texture permits the Bt is blocky, and the aggregates have distinct clay coatings. An AB horizon having gray structural coatings is often present. Faint mottling may occur in the lower B horizon or immediately above the Bt.

This subgroup represents early stages of bisequa development in which the upper sequum tends towards an Acid Brown Wooded or Acid Brown Forest soil. The Ae1 may be considered as a Bm horizon and the lower Ae2 as the C horizon of the upper sequum. The degree of base saturation of the upper solum is more typical of the Gray Brown Podzolic soils than of the Acid Brown Wooded.

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

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

3.13 Bisequa Gray Brown Podzolic

Gray Brown Podzolic soils in which a Podzol sequence of horizons (Ae and Bfh or Bf) has developed in the Ae of the Gray Brown Podzolic soil and which is underlain by a continuous textural Bt horizon, as defined.

The depth and degree of development of the Podzol sequence may vary greatly relative to the development of the Bt. When the depth of the Podzol sequence to the Bt is greater than 36" the soil should be classified as Bisequa Podzol. At depth between 18 and 36" the soil may be classified as Bisequa Podzol or Bisequa Gray Brown, depending on the degree of development of the Podzol sequence relative to the degree of development of Bt.

These soils differ from the Bisequa Gray Wooded soils in that the latter lack a mull-type Ah; when the Ah does not meet the requirements of the Gray Brown Podzolic group, the soil should be classified in the Bisequa Gray Wooded Subgroup.

Coarse-textured soils with profiles resembling Bisequa Gray Brown Podzolic but in which the Podzol sequence does not meet the minimal requirements of a Podzol should be classified as Brunisolic Gray Brown Podzolic; if both the Podzol sequence and the textural B do not meet the respective requirements the soil should be classified in the Brunisolic or Regosolic Order.

Under cultivated conditions these soils may be distinguished from the Brunisolic Subgroup by the presence of the podzolic B horizon (Bfh or Bf) under the Ap horizon.

Profile type: (L-H), Ah, Ae, Bfh or Bf, (Ae), (AB or A+B), Bt, (Ck), C

3.1-/8 Gleyed Gray Brown Podzolic

Soils with the same type of profile as any of the above subgroups but with mottling and commonly with duller colors due to periodic wetness in the Ae and Bt horizons than in the associated well-drained soils.

The Gleyed Gray Brown Podzolic soils generally have thicker and darker Ah horizons than the well-drained subgroups on similar 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 12" of muck, compacted peat, or both over the Ah horizon may occur in the gleyed subgroup.

Specific profile types may be indicated as 3.11/8; 3.13/8; etc.

Profile type: (L-H), Ah, Aegj, Btgj, (Ck), C

3.2 Dark Gray Wooded Great Group

Soils with L-H horizons, with chernozemic-like Ah and/or Ahe horizons, more than 2 inches (5 cm) thick which have been degraded as evidenced by gray streaks and splotches and often by platy structure, with prominent Ae horizons (distinct Ae more than 2½ inches thick and generally extends to a depth of more than 6 inches) and with Bt horizons in which clay is the main accumulation product but which also may contain dithionate extractable iron associated with the accumulations of clay. The solum generally has a high degree of base saturation as measured by neutral salt extraction. The parent material is generally basic.

An AB or BA horizon, having gray coatings on the structural aggregates is often present. The Bt horizon may be underlain by a BC, Cca, Ck or C horizon. These transitional and lime horizons are not diagnostic at the great group level.

Under cultivated conditions the mixed surface layer (Ap) 6 inches thick generally has a color value between 3.5 and 5.5 when dry. The Ap is underlain by remnants of Ae.

The soils of this group represent various stages of advanced podzolic (lessivé) degradation and they may be considered as intergrades between the Dark Gray Chernozemic and the Gray Wooded groups. They have formed in moderately cool climates (< 42°F M.A.T.) and under boreal forest or under forest in the forest-grassland transition zone. They correspond to the Gray Brown Podzolic soils which have formed in warmer climates (generally > 42°F M.A.T.) and which have a forest-mull type of Ah. Earthworms, which are abundant in the Gray Brown Podzolic soils, are generally scarce in the Dark Gray Wooded soils.

The separation of the Dark Gray Wooded and Dark Gray Chernozemic groups may present some difficulties. It is based on the degree of degradation and the thickness and color of the Ah and Ahe, or color of Ap, relative to the thickness of Ae. In general, when the Ae is less than 2½ inches (6 cm) the soils are classed with the Dark Gray Chernozemic group, provided the Ah and Ahe are thick enough to form an Ap (6 inches thick) with a color value darker than 4.5 dry. When the Ae is thicker than 2½ inches (6 cm) or when the Ap has a color value between 4.5 and 5.5 the soil is classified with the Dark Gray Wooded group.

The Dark Gray Wooded soils are separated from the Gray Wooded soils on the basis of the Ah horizon or color of the Ap horizon. The Gray Wooded soils lack or have a very thin (generally less than 2 inches (5 cm)) Ah horizon. The cultivated surface soil (6 inch depth) has a color value lighter than 5.5 dry.

3.21 Orthic Dark Gray Wooded

Soils with the general characteristics of the great group and having L-H, Ah and/or Ahe more than 2 inches thick, prominent Ae horizons more than 2½ inches thick, and Bt horizons as defined. The solum has a high degree of base saturation.

The soils of this subgroup may be slightly mottled above the Bt or in the lower B horizon.

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

3.21-2.2- Solodic Dark Gray Wooded (Intergrade)

Soils with the general characteristics of the great group but with hard prismatic or blocky Btnj horizons with pronounced dark coatings instead of the Bt horizon characteristic of the great group.

These soils resemble the Solod structurally but they contain somewhat less exchangeable sodium than is required for Bn horizons characteristic of Solonetzic soils.

They may be considered as intergrades between the Dark Gray Wooded and the Solods.

Profile type: L-H, Ah or Ahe, Ae, (AB), Btnj, C, (Cca), (Csk)

3.2-/8 Gleyed Dark Gray Wooded

Soils with the same type of profile as the orthic subgroup but with mottling and commonly with duller colors, due to periodic wetness, in the Ae and Bt horizons than in the associated well-drained soils.

Peaty and mucky phases, having less than 12 inches of muck or consolidated peat, or both, over the Ah horizon may occur in this subgroup.

3.3 Gray Wooded Great Group

Soils with organic surface horizons (L-H), with light colored eluvial horizons (Ae) and with illuvial horizons (Bt) in which clay is the main accumulation product. An increase of dithionate extractable iron and small increases of organic matter are often associated with the accumulation of clay but increases of oxalate extractable iron and aluminum are not significant. The solum is generally slightly to moderately acid but the degree of base saturation, based on neutral salt extractions, is generally high.

An Ah horizon is generally absent or, if present, is generally less than 2 inches (5 cm) thick. An AB or BA horizon, having gray coatings on the structural aggregates is often present. The Bt horizon may be underlain by a ca horizon, by a BC horizon or directly by a Ck and C horizon. These transitional horizons are not diagnostic at the great group level.

The cultivated soils (Ap 6 inches thick) are light in color, with color values of 5.5 or higher when dry, and low in organic matter. They are often underlain by remnants of Ae and by Bt horizons.

The Gray Wooded soils have developed under moderately cool climatic conditions (usually less than 42°F of M.A.T.) and under Boreal forest or under mixed forest in the grassland-forest transition zone. They generally have formed on basic materials.

The Gray Wooded soils differ from the Dark Gray Wooded and Gray Brown

Podzolic soils mainly in lacking or having only very thin (less than 2 inches) Ah horizons and under cultivated conditions the Ap horizons have less organic matter and lighter colors (dry color value of 5.5 or higher). They differ from the Podzols which may be found under similar climatic and vegetative conditions in that the latter have Bfh or Bf horizons.

3.31 Orthic Gray Wooded

Soils with the general characteristics of the great group, having organic surface horizons (L-H), light colored Ae and Bt horizons. An Ah, if present, is very thin (generally less than 2 inches). The lower part of the Ae horizon may be slightly mottled and frequently overlies a marked AB or BA horizon. The Ae, when dry, has a color value of 5.5 or higher and usually a chroma of less than 3, although some higher chromas may be associated with some parent materials. The cultivated surface soils (Ap 6 inches thick) have a color value of 5.5 or higher.

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

3.32 Brunisolic Gray Wooded

Soils with the general characteristics of the great group, having organic surface horizons (L-H), brown (chroma of 3 or higher) upper Ae1 horizons, which generally grade into lower Ae2 horizons with lower chromas. The thickness of the brown upper Ae1 horizons should be sufficient that they can be recognized under the cultivated layers (Ap 6 inches thick). The underlying Bt horizons are characteristic of the Gray Wooded soils. AB horizons having gray coatings on the structural aggregates are often present. Faint mottling may occur in the lower Ae or in the lower Bt horizons.

This subgroup may be considered as representing early stages of a bisequa development in which the upper sequence tends towards an Acid Brown Wooded soil. The upper Ae1 may be considered as the Bm or Bf horizon and the lower Ae2 as the C horizon of the upper sequence. The degree of base saturation is generally higher than in comparable Acid Brown Wooded soils.

In some soils with chroma of 3 or more there is no appreciable difference in chroma between upper and lower Ae. They represent either advanced stages of development in which the Bm has developed throughout the entire depth of Ae to the Bt, or they represent normal Ae development in which the high chroma has been inherited from the parent material. The soils in which the high chroma has been inherited from the parent material should be classified with the orthic subgroup, regardless of anything stated above. Where the Bt development is too weak to meet the requirement of a textural B, the soil should be classified on the basis of the upper sequum in the Brunisolic or Regosolic order.

The cultivated surface soil of this subgroup has a slightly higher chroma than the cultivated soil of the orthic subgroup on similar materials.

Profile type: L-H, Ae1 or Bm, (Ae2), (AB), Bt, (Ck), C

3.33 Bisequa Gray Wooded

Gray Wooded soils in which a Podzol sequence of horizons (Ae and Bfh) has developed in the Ae of the Gray Wooded soil and which is underlain by a continuous textural (Bt) horizon.

The development of the Podzol sequence relative to the development of the Bt may vary greatly in intensity and in depth, resulting in a range of profiles that approach the Brunisolic Gray Wooded soil on the one hand and the Bisequa Podzol on the other.

The following arbitrary limits are suggested as a guide for the separation of the two subgroups. All soils in which the depth to a well-developed Bt is less than 18 inches should be classified as Bisequa Gray Wooded. All soils in which the depth to a Bt is greater than 36 inches should be classified as Bisequa Podzols. In cases where the depth to the Bt is between 18 to 36 inches, the classification as Bisequa Podzol or Bisequa Gray Wooded is based upon the degree of development of the Podzol sequence in relation to the degree of development of the Bt.

Coarse-textured soils with profiles resembling Bisequa Gray Wooded but in which the Podzol sequence does not meet the minimal requirements of a Podzol should be classified as Brunisolic Gray Wooded; if both the Podzol sequence and the textural B do not meet the respective requirements the soil should be classified in the Brunisolic or Regosolic order.

Profile type: L-H, Ae, Bf or Bfh, (Ae2), (AB or A+B), Bt, (Ck), C

3.31-2.23 Solodic Gray Wooded (Intergrade)

Soils with the general characteristics of the great group but with hard prismatic, or blocky Btnj horizons with pronounced dark coatings, instead of the Bt horizons characteristic of the Gray Wooded soils.

These soils resemble the Solod structurally but they contain somewhat less exchangeable sodium than is required for Bn horizons characteristic of the Solonetzic soils. They may be considered as intergrades between the Gray Wooded and the Solod.

Profile type: L-H, (Ah) or (Ahe), Ae, (AB), Btnj, (Cca), (Csk), C

3.3-/8 Gleyed Gray Wooded

Soils with the same type of profile as any of the above subgroups but with mottling and commonly with duller colors due to periodic wetness in the Ae and Bt horizons than the associated well-drained soils.

The Gleyed Gray Wooded soils generally have thicker L-H horizons than the well-drained subgroups and peaty or mucky phases with less than 12 inches of consolidated peat or muck 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 Gray Wooded and grassland transition zones. In more humid regions, on level land, particularly on less permeable materials, the gleyed members may have less-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.

Profile type: L-H, Aeg, Aegj, Btg, Btgj, C

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

3.4 Humic Podzol Great Group

Soils with thick organic surface horizons (L, F, H), with light colored eluviated horizons (Ae) and with dark colored (generally with a value and chroma of 3 or less) illuvial horizons (Bh or Bhf) in which organic matter is the main accumulation product. Under virgin conditions the Ae horizon is more than 1 inch thick and the upper 4 inches (10 cm) or more, of B horizon, either contain an average of more than 10% organic matter as well as appreciable amounts of oxalate extractable iron (Bhf), or it contains very little iron, with an organic matter to iron ratio of more than 20 to 1, and with more than 2% of organic matter (Bh). The degree of base saturation is very low and the cation exchange capacity (NH_4 acetate) is very high.

The Bh may be underlain by Bhf horizon and these in turn by Bfh or Bf horizons. A thin or a series of very thin (total thickness of less than 1 inch), involute, impervious, hard, dark reddish brown ironpan may occur in the solum.

These soils have developed under heath or forest with heath and sphagnum undercover; consequently, the L-H horizons are generally thick and peaty. They are known to occur in cool, moist coastal regions, in cool moist locations at higher altitudes inland and locally in some peaty depressions in warmer and less moist regions.

3.41 Orthic Humic Podzol

Soils with organic surface horizons (L, F, H), with light colored eluviated horizons (Ae) more than 1 inch thick, and with dark (generally with value and chroma of 3 or less) illuvial B horizon. The upper 4 inches of B horizon contain more than 10% of organic matter and the organic matter to oxalate extractable iron ratio is $<$ 20:1. The Bhf horizon is generally underlain by Bfh or Bf horizons. The B horizons may vary from friable to very firm. Humic Podzols with cemented B horizons should be integrated with the Ortstein Podzols, 3.41/3.52. A thin, involute, impervious, hard, dark reddish brown ironpan is lacking. Faint mottling may occur in the Ae and in the lower Bf horizons.

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

3.42 Humus Podzol

Soils with organic surface horizons (L, F, H), with light colored eluviated horizons (Ae) and with dark (color value and chroma of 3 or less) illuvial (Bh) horizons. The Bh contains more than 2% of organic matter and has an organic matter to oxalate extractable iron ratio of 20:1 or higher. The Bh horizon generally contains less than 0.35% of oxalate extractable Fe and does not turn redder on ignition. It generally contains free aluminum. The Bh may or may not be underlain by Bhf and Bf horizons. The B horizons may vary from soft and friable to very firm and hard in consistence. A thin, involute, hard, dark reddish brown ironpan is lacking.

These soils generally have formed on parent materials low in iron or on materials from which the iron has been removed by pedogenic processes.

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

3.4-/3 Ironpan Podzol

3.41/3 Ironpan Humic Podzol

3.42/3 Ironpan Humus Podzol

Soils with profiles like 3.41 and 3.42 but with thin "ironpan", generally less than ½ inch thick. The pan consists of a single or of a series of very thin (generally about 1/8 inch thick) strands, which are irregular or involute, hard and impervious, often vitreous, and dark reddish brown in color. The ironpans studied to date contain considerable amounts of organic matter, as well as "free" Fe. The free iron content usually ranges from 5 to 15%. The ironpan may occur in any of the B horizons, except the Bh of the Humus Podzol, and often extends into the C horizon.

Due to the impermeability of the ironpan some gleying generally occurs immediately above the pan, particularly in the troughs of the involute pans, while below the pan the soil may be well drained. Due to the irregular and wavy nature of the pan, the overlying profiles may vary greatly in their moisture regime. Orthic Humic or Humus profiles occur above the crests and on the upper slopes of the pan, while gleyed Humic and Humus profiles may occur on the lower slopes and troughs of the pan and in extreme cases Peaty Gleysols occur over the deeper troughs of the pan. Whenever possible the ironpan designation should be used with the appropriate subgroup, i.e., 3.42/3 Ironpan Humus Podzol; 3.41/8/3 Gleyed Ironpan Humic Podzol.

Profile type: Same as 3.41 and 3.42 but with thin ironpan Bfc or Bhfc

3.4-/8 Gleyed Subgroups

3.41/8 Gleyed Humic Podzol

3.42/8 Gleyed Humus Podzol

Podzol soils with the same general types of profiles as either of the above subgroups but with indications of excessive wetness. In the Gleyed Humic Podzols mottling and iron staining is evident in the Ae and B horizons. In the dark colored Bh horizons mottling and iron staining is often only visible along root channels but is prominent in the underlying Bhf and Bf horizons if these horizons are present. The Bh horizons may be splotched black and gray; they may have diffuse or sharp upper and lower boundaries, depending on the alternating water levels.

The free iron in the Gleyed Humus Podzols has been removed under extreme reducing conditions in reduced form or in complexed form with organic matter from the upper part or from the entire solum. The thick organic surface horizons yield large quantities of humus which accumulate in the Bh horizon.

Profile types: 3.41/8 L-H, Aeg, Bhfgj, (Bfgj), C

3.42/8 L-H, Aeg, Bhgj, (Bhfgj), (Bfg), C

3.5 Podzol Great Group

Soils with organic surface horizons (L-H), with light colored eluviated horizon (Ae) and with illuvial horizons (Bfh and Bf) of higher chroma in which organic matter and sesquioxides are the main accumulation products. Under virgin conditions the Ae is more than 1 inch thick and the upper 4 inches of the B horizon contain an average of less than 10% of organic matter. The organic matter to oxalate Fe ratio is <20, and Fe + Al (oxalate extraction) exceed that of the C horizon by about 0.8% or more. The solum generally has a low degree of base saturation, based on permanent charge and the B horizons have a high pH-dependent charge. Some sandy Podzols may have moderate to high base saturation. The color of the B horizon generally has values of 3 or more and chromas of 4 or more. The difference in color value or chroma between the Ae and B should be two, or more.

The Bfh or Bhf, if present, may also contain more clay than the Ae or C horizons (possibly due to infiltration or translocation with organo-mineral complexes). The clay is not, or only very weakly, oriented and does not form clay skins. Although the increases of clay in the B may be as great as those required for textural B horizons, due to a lack of orientation they do not meet the requirements of textural B horizons. Thin, involute, hard, impervious dark reddish ironpans are absent. A fragipan may underlie the Bf horizons.

Under cultivated conditions the upper horizons, L-H, Ae and upper Bfh, are generally mixed. Such soils may be recognized by unmixed remnants of Ae and Bfh in the Ap or by undisturbed remnants of Bfh, Bf and occasionally Ae, below the plowed layer.

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

The major processes of development involve the accumulation of organic surface layers, the formation and translocation of organo-sesquioxide complexes and their deposition and accumulation in the B horizon and the decomposition of the clay minerals in the Ae.

3.51 Orthic Podzol

Podzol soils with organic surface horizons (L, F, H), with light colored eluvial horizons, more than 1 inch thick and with friable Bfh and Bf horizons, generally having a chroma of 4 or more. The difference in chroma or value between the Ae and Bfh or Bf is 2 or more. A thin Bhf horizon may be present but the average organic matter content of the upper 4 inches of B is less than 10%. In the Bfh and Bf horizons Fe + Al (oxalate extraction) exceed that of the C horizon by about 0.8% or more. 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 immediately below the Ae in the horizon of greatest organic matter and sesquioxide accumulation. Some mottling may occur in the lower B horizon, particularly if the latter is underlain by a fragipan.

Profile type: L-H, Ae, (Bhf), Bfh and/or Bf, (Bfg), (BC), C

3.52 Ortstein Podzol

Soils with organic surface horizons (L-H), with light colored eluviated horizons (Ae) and with cemented Bfh or Bf horizons of high chroma. The cemented B horizons may be discontinuous or interrupted, and generally but not always, lie immediately below the Ae horizon and are underlain by friable Bf horizons. Tongues of Ae horizon often extend into the B forming an A + B layer.

The Ortstein Podzols are frequently gleyed or have some evidence of former gleying conditions.

Profile type: L-H, Ae, (A + B), Bfhc or Bfc, (Bf), C

3.53 Bisequa Podzol

Soils with Podzol sola which have developed in the Ae horizons of Gray Wooded or Gray Brown Podzolic soils and which are underlain by a textural (Bt) horizon at depth of 36 inches, or more, or at shallower depth (18 to 36 inches) depending on the relative degree of Podzol and textural B development.

The Podzol development should at least meet the minimal requirements of the group (difference in color between Ae and B should have a value and chroma of 2, or more, or difference in Fe + Al (oxalate extractable) between B and C should be about 0.8%, or more), and the Bt should meet the requirement of textural B.

Soils in which the development of the upper solum is too weak to meet the requirement of Podzols, but with a Bt horizon as defined, may be classified as Bisequa Gray Wooded; while soils in which the Podzol sequence meets the requirements of the group but in which the lower B does not meet the requirements of textural B may be classified with the other appropriate Podzol subgroup. Soils having the general appearance of Podzols but in which neither the Podzol nor the textural B meet the respective requirements, as defined, should be classified in the Brunisolic or Regosolic Order.

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

3.54 Textural Podzol (Podzol - Gray Wooded Intergrade)

Soils with organic surface horizons (L-H), a light colored eluviated horizon and illuvial horizons containing accumulations of organic matter, free sesquioxides (oxalate extractable) and more clay than the Ae. The organic matter and free sesquioxide accumulation is greatest in the upper B and drops rapidly with depth. The difference in oxalate extractable Fe + Al between Bf and C is generally about 0.8%. The clay content increases significantly from the Ae to the upper B and generally continues to increase slightly to the lower Bt2 or Bt3. There is no appreciable decrease of total or fine clay in the C horizon, and there is no appreciable difference in dithionite extractable Fe in the B and C horizons. There is evidence of some orientation of clay on ped surfaces and clay flows may be evident to considerable depth in the parent material.

This subgroup may be considered as an intergrade between the Podzol and Gray Wooded groups as the B horizon has some characteristics of both. It differs from the Bisequa Podzols in which the podzol B horizon (Bfh) overlies a textural (Bt) B horizon.

These soils have formed on medium to fine textured acidic materials in which the clay disperses rapidly, as evidenced by clay flows, to considerable depth. Soils having lithologic discontinuities in which the Podzol solum has been developed in coarser material but is underlain by finer material should be classified with the Orthic Subgroup.

Profile type: L-H, Ae, (Bfht), Bft, Bt, (BC), C

3.55 Concretionary Podzol

Soils with organic surface horizons (L-H), a light colored eluviated horizon (Ae), more than 1 inch thick and an illuvial horizon with high chroma containing numerous hard magnetic, rounded concretions (Bcc) in addition to illuviated organic matter and sesquioxides. Degrading concretions with gray coatings may occur in the Ae; some mottling may occur in the lower B. The solum is generally moderately to strongly acid and unsaturated.

These soils occur in the west coast region in a climate characterized by mild wet winters and cool dry summers. They have developed under a coniferous vegetation of hemlock, red cedar and Douglas fir with a dense understory of ferns, bracken, salal and Oregon grape on moderately coarse- to fine-textured materials.

Soils with an Ae less than 1 inch thick and with a weak B development (difference in chroma or value between Ae and B less than 2 or thickness of Bcc less than 8 inches) are classed with the Concretionary Brown soils.

Profile type: L-H, Ae, Bhfcc or Bfcc, (Bccg), C

3.5-/7 Cryic Podzol (with permafrost)

Podzol soils underlain by permafrost within 1 metre of the mineral soil surface. This subgroup may form intergrades with any of the other subgroups, i.e., 3.51/7; 3.51/7/8; etc. The soils with permafrost may be gleyed in the lower part of the solum.

Profile type: L-H, Ae, Bf, (Bfg), Cz

3.5-/8 Gleyed Podzol

Podzol soils with the general characteristics of any of the above subgroups but with mottling and duller colors due to periodic wetness in the Ae and B horizons. The L, F and H horizons in the gleyed subgroups are generally thicker than in the catenary well-drained subgroups and a thin, dark, mucky Ah horizon is often present.

The Gleyed Podzols resemble somewhat in appearance the Fera Gleysols. The latter have Bgf horizons containing marked accumulation of dithionite extractable iron, but only small amounts of oxalate extractable Fe and of free Al and a comparatively low organic matter content. In the field the Fera Gleysols may be recognized by strongly mottled Bgf in which the mottles are of high chroma. The color value of the B does not increase with depth as it does in most Gleyed Podzols.

Peaty or mucky phases with less than 12 inches (30 cm) of muck or consolidated peat on the surface of the mineral soil may occur in this subgroup.

Profile type: L-H, (Ah), Aegj, Bfhgj or Bfg, C

REPORT ON THE CLASSIFICATION OF BRUNISOLIC SOILS

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Chairman, Subcommittee on Brunisolic Soils

4. Brunisolic Order

Great Group		Subgroup	
4.1	Brown Forest	4.11	Orthic Brown Forest
		4.12	Degraded Brown Forest
		4.1-/8	Gleyed Brown Forest
4.2	Brown Wooded	4.21	Orthic Brown Wooded
		4.22	Degraded Brown Wooded
		4.2-/7	Cryic Brown Wooded
		4.2-/8	Gleyed Brown Wooded
4.3	Acid Brown Wooded	4.31	Orthic Acid Brown Wooded
		4.32	Degraded Acid Brown Wooded
		4.3-/7	Cryic Acid Brown Wooded
		4.3-/8	Gleyed Acid Brown Wooded
4.4	Acid Brown Forest	4.41	Orthic Acid Brown Forest
		4.4-/8	Gleyed Acid Brown Forest
4.5	Concretionary Brown	4.51	Orthic Concretionary Brown
		4.5-/8	Gleyed Concretionary Brown
4.6	Alpine Brown	4.61	Orthic Alpine Brown
		4.6-/7	Cryic Alpine Brown
		4.6-/8	Gleyed Alpine Brown

4. Brunisolic Order

Well to imperfectly drained soils developed under forest, mixed forest and grass, grass and fern, or heath and tundra vegetation, with brownish colored sola and without marked eluvial horizons. They may or may not have a distinct Ah horizon as defined below.

A distinct Ah in this order is a horizon more than 2 inches thick with a Munsell color value of 3.5 or less when moist and is lower in value by one unit or more, or lower in chroma by 2 units or more than the next underlying horizon.

4.1 Brown Forest Great Group

Brunisolic soils with a distinct mineral-organic (Ah) surface horizon, a brownish B horizon and a weakly acid to mildly alkaline solum.

These soils may or may not have an (L-H) horizon; usually the leaf litter is incorporated into the mineral soil through the action of earthworms. The sola have pH values (in water) ranging generally between 5.5 and 7.8, and a base saturation of 100 percent as determined by neutral salt (NaCl). The C horizon is usually of calcareous nature.

The Brown Forest soils occur mainly in the Great Lakes - St. Lawrence Lowlands where the mean annual atmospheric temperature is higher than 42°F (5.5°C). They have developed under climatic and biotic conditions similar to those of the Gray-Brown Podzolics and they appear to represent a stage of soil development between a Regosol and a Gray-Brown Podzolic soil. Their lack of distinct eluvial or illuvial horizons may be due to their youthfulness, high lime parent material, or a combination of both.

Subgroups:

4.11 Orthic Brown Forest - (L-H), Ah, Bm or Bf, Ck, (Cca)

Well drained soils with no apparent eluvial or illuvial horizons.

4.12 Degraded Brown Forest - (L-H), Ah, Bm or Bf, Btj, Ck or (L-H), Ah,(Aej), Bm or Bf, Btj, Ck

Well drained soils that may or may not have an Aej horizon and always have a Btj horizon.

4.1-/8 Gleyed Brown Forest

Imperfectly drained soils with mottling and duller colors present in the lower solum and in the parent material.

4.2 Brown Wooded Great Group

Brunisolic soils with organic surface horizons (L-H), with a brownish Bm or Bf horizon, a weakly acid to mildly alkaline solum, but without a distinct mineral-organic (Ah) surface horizon.

The chroma, the organic matter content and the oxalate-extractable iron and aluminum content of the Bm or Bf horizons decrease with depth. The sola have pH values (in water) above 5.5 and 100 percent base saturation as determined by neutral salt (NaCl). The parent material is usually calcareous. Earthworms are not found in these soils.

The Brown Wooded soils occur in the dry valleys in the Cordillera and extend from the United States into the Yukon Territory. They occur also in northern forested portion of the Great Plains Region. In the valleys of the Cordillera they appear to be the zonal soils of the dry forest areas, but in the forested Great Plains areas they are developing under climatic and biotic conditions similar to those of the Gray Wooded soils. The Brown Wooded soils appear to represent a stage of soil development between Regosolic and Podzolic soils. Their lack of distinct eluvial and illuvial horizons appear to be due to dry climate, youthfulness, high lime parent materials or a combination of all these factors.

Subgroups:

4.21 <u>Orthic Brown Wooded</u> - <u>L-H</u>, (Ah < 2"), <u>Bm</u> or <u>Bf</u>, (Cca), <u>Ck</u> or <u>C</u>

Soils with L-H organic horizons in virgin condition, overlying Bm horizons, or occasionally with Bf horizons. The Bm horizon has usually a chroma of 3 or more and the chroma difference between B and C is greater than 1. The parent materials are usually calcareous.

4.22 Degraded Brown Wooded - <u>L-H</u>, <u>Ae</u> or <u>Aej</u>, <u>Bf</u> or <u>Bfj</u> or <u>Bm</u> or <u>Btj</u>, <u>Ck</u> or <u>C</u>

Soils with light-colored eluvial (Ae) horizons less than 1 inch (2.5 cm) thick or Aej several inches thick, with Bm or Bf horizons. Btj horizons occur on loamy and finer-textured parent materials but are usually absent on coarse-textured parent materials.

4.2-/7 <u>Cryic Brown Wooded</u>

Soils with permafrost within 40 inches (100 cm) of the mineral soil surface.

4.2-/8 <u>Gleyed Brown Wooded</u>

Imperfectly drained soils with mottling and duller colors present in the lower solum and in the parent material.

4.3 <u>Acid Brown Wooded Great Group</u>

Brunisolic soils with organic surface horizons (L-H), with a Bf or Bm horizon and a moderately to strongly acid solum, but without a distinct mineral-organic (Ah) surface horizon.

Light-colored eluvial horizons up to 1 inch thick may be present. The chroma, the organic matter content and the oxalate-extractable iron and aluminum of the Bf or Bm horizons decrease with depth. The sola have pH values (in water) ranging generally from 4.5 to 6.0 and the base saturations (determined by NaCl extraction) range from about 65 to 100 percent. The parent materials are usually acidic.

Earthworms are invading some Acid Brown Wooded soils and under their action the upper mineral part of the solum is incorporated into the organic surface to form a distinct Ah horizon. Where such conditions are found these soils may be included with the Acid Brown Forest Great Group.

The Acid Brown Wooded soils occur in all provinces but their major distribution is in the western part of the Appalachian region in Quebec and in the southern parts of the Canadian Shield in Ontario and Quebec. In these areas they may be considered as zonal soils.

The Acid Brown Wooded soils appear to represent a stage of soil development between the Regosol and the Podzol.

Subgroups:

4.31 Orthic Acid Brown Wooded - (L-H), (Ah < 2"), Bf or Bfh or Bhf or Bm, C

Well drained soils without any apparent eluviated horizons and with B horizons of high chroma at or near the surface and fading in chroma with depth.

4.32 Degraded Acid Brown Wooded - (L-H), Ae or Aej, Bf or Bfh or Bhf or Bfj, C

Soils with Ae horizons less than 1 inch thick or Aej several inches thick and with Bf, or Bfh, or Bm horizons.

4.3-/7 Cryic Acid Brown Wooded

Soils with permafrost within 40 inches (100 cm) of the mineral soil surface.

4.3-/8 Gleyed Acid Brown Wooded

Imperfectly drained soils with mottling and duller colors present in the lower solum and in the parent material.

4.4 Acid Brown Forest Great Group

Brunisolic soils with distinct mineral-organic (Ah) surface horizons, with Bm or Bf horizons and moderately to strongly acid sola.

The organic matter content of the surface horizon is generally high. The base saturation (NaCl) of the solum is commonly 80 to 100 percent and the pH (in water) generally ranges from 4.5 to 5.5. The parent materials are acidic.

The main occurrence of these soils is in the west coastal area of British Columbia where winters are mild and the summers cool and dry. Where these soils are found the mean annual temperature is generally above 47°F (8.3°C) and the annual precipitation ranges from 27 to 45 inches, of which only 1.1 to 2.2 inches falls in July and August.

The present native vegetation on these soils ranges from coniferous forest to grass and fern. However, there is clear evidence that these soils were developed under grass and fern vegetation having a canopy of oak trees and that now this vegetation is being replaced by coniferous tree species and shrubs.

These soils are not common in Eastern Canada. Where found 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. Here they occur mainly under deciduous trees. The development of distinct Ah horizons is attributed to the incorporation of the L-H horizons by earthworms into the upper part of the mineral sola of Acid Brown Wooded soils and Podzols.

Subgroups:

4.41 Orthic Acid Brown Forest - (L-H), Ah, Bm or Bf or Bfh, C

Well drained soils with a distinct dark grayish brown to black Ah surface horizon over a brown to yellowish brown B horizon (Bm or Bf).

4.4-/8 Gleyed Acid Brown Forest

Imperfectly drained soils with mottling and duller colors in the lower solum and in the parent material.

4.5 Concretionary Brown Great Group

Brunisolic soils with thin organic surface (L-H) horizons underlain by a brown to reddish brown (Bfcc) horizon containing many concretions (shot) and having an acid solum.

The soils usually have some clay-coated peds in the lower part of the solum. The parent materials are generally moderately acid and of medium to fine texture.

Iron and aluminum oxides are formed in the upper B horizon but are not translocated downward. The free oxides bind the other soil constituents into hard magnetic concretions which range in size from silt to fine gravel and these oxides inactivate both organic and inorganic exchange sites. The present investigations suggest that dioctahedral aluminum chlorite forms authigenically from interstratified montmorillonite clay inherited from the parent material. The exchange cation content of the Bfcc horizons is low but, owing to the low effective cation exchange capacity (NaCl) the base saturation is moderately high.

The Concretionary Brown soils have been found in Canada only on the west coast of British Columbia where winters are mild and summers are cool and dry. Where these soils are found the mean annual temperature is generally above $47^{o}F$ ($8.3^{o}C$) and the annual precipitation ranges from 35 to 70 inches, of which only 1.5 to 3.0 inches fall in July and August. These soils are seldom affected by frost.

The natural vegetation found on these soils is Douglas fir, hemlock and red cedar with a dense understory of ferns, bracken, salal and Oregon grape.

Subgroups:

4.51 Orthic Concretionary Brown - L-H, Bfcc or Bfhcc, C

Soils with a thin ($< 2"$) mineral-organic (Ah) horizon that overlies a brown to reddish-brown horizon (Bfcc or Bfhcc) containing many spheroidal concretions or shot-like.

4.5-/8 Gleyed Concretionary Brown - L-H, Bfcc, BCg, Cg

Soils with distinct mottles in the lower part of the sola. These soils have somewhat thicker Ah horizons and brighter chroma in the Bfcc horizons than the associated Orthic Concretionary Brown soils.

4.6 Alpine Brown Great Group

Brunisolic soils with thin, organic mats (L-H) and with dark colored distinct Ah horizons usually turfy in the upper part, and brown B horizons.

The parent materials of the Alpine Brown soils are moderately acid 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 down slope movement are active.

These soils have developed in the forest-alpine transitional areas of the Cordillera. With increasing grass cover (increasing elevation) the Ah horizons become thicker and more turfy, and with increasing density of coniferous forests (decreasing elevation) Ah horizons become thinner and less turfy.

Subgroups:

4.61 Orthic Alpine Brown - (L-H), Ah, Bm, C

Well drained soils having a thin organic mat (L-H) over a distinct dark colored Ah horizon and a brownish B horizon.

4.6-/7 Cryic Alpine Brown

Soils with permafrost within 40 inches (100 cm) of the mineral soil surface.

4.6-/8 Gleyed Alpine Brown

Soils highly mottled and with higher chromas in the lower part of the sola.

REPORT ON THE CLASSIFICATION OF REGOSOLIC SOILS

L. Farstad

Chairman, Subcommittee on Regosolic Soils

5. Regosolic Order

Great Group		Subgroup
5.1 Regosol	5.11	Orthic Regosol
	5.12	Deorcic Regosol
	5.1-/5	Saline Regosol
	5.1-/7	Cryic Regosol
	5.1-/8	Gleyed Regosol
5.2 Podzo Regosol	5.21	Arenic Podzo Regosol
	5.22	Cutanic Podzo Regosol
	5.2-/7	Cryic Podzo Regosol
	5.2-/8	Gleyed Podzo Regosol

5. Regosolic Order

Well and imperfectly drained mineral soils with no horizon development except a nonchernozemic Ah horizon (see page 18) that may or may not be present,

and

Well and imperfectly drained soils that have light colored eluvial horizons (Ae) more than 1 inch thick and weak illuvial horizons (B) containing insufficient accumulations of sesquioxides, clay or organic matter to meet the requirements of the Podzolic Order.

5.1 Regosol Great Group

Well and imperfectly drained mineral soils with no horizon development except a nonchernozemic Ah that may or may not be present. Organic surface horizons (L-H) less than 12 inches (30 cm) may occur.

5.11 Orthic Regosol - (L-H),(Ah),C

Soils consisting essentially of parent material in which any Ah if present is too weak or too thin (less than 2") to produce a mixed surface soil 6 inches thick (Ap horizon) appreciably darker than the parent material. These soils lack visible evidence of soluble salts, gleying and permafrost.

Included in this subgroup are aridic soils that have or will produce an Ap horizon 6 inches thick with color values lighter than 3.5 moist and 5.5 dry.

5.12 Deorcic Regosol - (L-H), Ah, C

Soils with nonchernozemic Ah horizons of sufficient development to produce mixed surface soils 6 inches thick (Ap horizons) appreciably darker than the parent material. These soils lack visible evidence of soluble salts, gleying and permafrost.

N.B. "Appreciably darker" means that on light colored parent materials with color values of 7 and 8 (dry), the Ap horizon must have a color value of 5.5 or less (dry). On darker colored parent materials, 6 or less (dry), the Ap horizon must be darker than the parent material by more than one unit of value (dry).

5.1-/5 Saline Regosol

Soils with a saline (> 4 mmhos/cm conductivity) horizon or layer within two feet (60 cm) of the surface or salinity exceeding a conductivity of 6 mmhos/cm between 2 and 4 feet if the soil above is nonsaline.

5.1-/7 Cryic Regosol

Regosols with permanently frozen layers within 40 inches (100 cm) of the mineral soil surface. There may be gleying in the lower part of the profile.

5.1-/8 Gleyed Regosol

Regosols with the characteristics of any of the above subgroups but with mottling and dull colors in the subsurface soil due to periodic wetness.

The separation of Gleyed Regosols from Humic Gleysols and Gleysol is based on the distinctness of the gleyed horizon. Gleyed Regosols have Cgj horizons while the soils in the Gleysolic Order have Cg horizons.

5.2 Podzo Regosol Great Group

Well and imperfectly drained soils that have light colored eluvial horizons (Ae) more than 1 inch thick and weak illuvial horizons (B) containing insufficient accumulations of sesquioxides, clay or organic matter to meet the requirements of the Podzolic Order. The parent material of these soils is coarse or moderately coarse in texture. Organic surface horizons (L-H) are usually present in the virgin soils but seldom exseed a few inches in thickness. Weak or thin Ah horizons may also be present.

These soils have developed under forest or pine grass-forest vegetative cover. They were formerly classified as Gray Forested soils in the Podzolic Order. The description given in the N.S.S.C. 1963 report, however, applies chiefly to the Cutanic Podzo Regosol Subgroup.

5.21 Arenic Podzo Regosols - (L-H), (Ah), Ae, Bfj, C

Podzo Regosols with free iron and aluminum as the main accumulation products in the B horizon but less than that required for the Podzol Great Group. That is, the oxalate extractable Δ(Fe + Al) is less than 0.8 percent.

These soils strongly resemble Podzols in appearance except the B horizons are usually lower in chroma. Also they usually have less acidic sola and higher base saturation than the Podzols. These Podzo Regosols have only been found on sands having a low amount of weatherable minerals. They occur in many parts of Canada.

5.22 Cutanic Podzo Regosols - (L-H), (Ah), Ae, Btj or AB or A and B, C

Podzo Regosols with clay as the main accumulation product in the B horizon but lacking a Bt horizon diagnostic of the Gray Wooded soils. The B horizon contains small concentrations of clay in isolated peds, tongues, clay flows, or in thin horizons ($< 2"$). The matrix of the B horizon is either darker in color value or higher in chroma by one unit or more than the Ae horizon. These soils are mildly acidic and the percent base saturation is high.

The Cutanic Podzo Regosols usually have thick Ae horizons. The B horizon is sometimes replaced by a horizon consisting of separate pockets of Ae and B materials (A and B horizon) and in extreme cases the matrix of the entire solum consists dominantly of light colored eluvial materials with small peds of darker colored illuvial material occurring in the lower part.

The main occurrence of the Cutanic Podzo Regosols is in the plateau region of south central British Columbia under pine grass-forest vegetative cover. The climate here is characterized by heavy winter and low summer precipitation. However, it would appear that the nature of the parent material is the dominant factor in the formation of these soils, as on finer textured parent materials under the same biotic and climatic conditions Gray Wooded soils have developed.

5.2-/7 Cryic Podzo Regosols

Podzo Regosols with permanently frozen layers within 40 inches (100 cm) of the mineral soil surface. There may be gleying in the lower part of the profile.

5.2-/8 Gleyed Podzo Regosols

Podzo Regosols with mottling and dull colors in the subsurface soil due to periodic wetness.

REPORT ON THE CLASSIFICATION OF GLEYSOLIC SOILS

W. A. Ehrlich

Chairman, Subcommittee on Gleysolic Soils

6. Gleysolic Order

Great Group		Subgroup
6.1 Humic Gleysol	6.11	Orthic Humic Gleysol
	6.12	Rego Humic Gleysol
	6.13	Fera Humic Gleysol*
	6.1-/5	Saline Humic Gleysol
	6.1-/6	Carbonated Humic Gleysol
	6.1-/7	Cryic Humic Gleysol
6.2 Gleysol	6.21	Orthic Gleysol
	6.22	Rego Gleysol
	6.23	Fera Gleysol*
	6.2-/5	Saline Gleysol
	6.2-/6	Carbonated Gleysol
	6.2-/7	Cryic Gleysol
6.3 Eluviated Gleysol	6.31	Humic Eluviated Gleysol
	6.32	Low Humic Eluviated Gleysol

6. Gleysolic Order

The soils are saturated with water at one or more seasons, or are artificially drained. The soils are developed under hydrophytic vegetation or they may be expected to produce hydrophytic vegetation if left undisturbed.

These soils may have an organic horizon of less than 12 inches of consolidated or 18 inches of unconsolidated peat, an Ah horizon, or both, or they may be without these horizons. If the soils are cultivated the suggested criteria for classifying surface horizons is presented in the definitions of 6.1 and 6.2. The B horizons**, if present, may have one of the following combinations of colors:

(a) Dominant chromas of 1 to 2 in hues of 10YR or redder on the ped surfaces, or om the matrix if the peds are lacking, accompanied by mottles of stronger chroma, or

(b) Dominant chromas of 1 to 3 in hues of 2.5Y or yellower on the ped surfaces or on the matrix if the peds are lacking, accompanied by mottles of stronger chroma and redder hue, or

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* Two subgroups, Fera Humic Gleysol and Fera Gleysol, are additions. In the previous classification these soils were included with the orthic subgroups in the Gleysolic Order.

**The color criteria for B and C horizons are suggested as guides for classifying Gleysolic soils.

(c) Dominant chromas of 1 or less on the surfaces of the peds or on the matrix if peds are lacking and stronger chroma of mottles if present.

The C horizons have colors in one of the following:

(a) Hues as red as 10YR or redder, chromas of 2 or less if mottled, less than 1 if not mottled, or

(b) Hues between 10YR and 10Y (i.e. 2.5Y, 5Y, 7.5Y), chromas of 3 or less if mottled and 1 or less if not mottled, or

(c) Hues bluer than 10Y (i.e. GY, G, BG, B, PB), or

(d) Any color that may be due to uncoated sand grains.

6.1 Humic Gleysol Great Group

Soils with an Ah horizon more than 3 inches thick under virgin conditions and when mixed to a depth of 6 inches (or cultivated Ap) has more than 3 percent organic matter and has a rubbed color darker than 3.5 when moist or 5.0 when dry and is at least 1.5 units of value (moist) darker than the next underlying horizon either B or C.

Examples of cultivated soil: $\frac{\text{Ap}}{\text{B or C}} = \frac{3.5}{5.0 \text{ or higher}} = \frac{3.0}{4.5 \text{ or higher}}$

These soils may have organic horizons up to 12 inches thick.

6.11 Orthic Humic Gleysol Subgroup

Soils with a noncalcareous (< 2 percent $CaCO_3$ equivalent) Ah or Ap horizon and a gleyed B horizon underlain by strongly gleyed, dull colored soil material. May have up to 12 inches of consolidated peat on the surface.

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

This soil, except for strong gleization and degree of wetness, resembles the better drained Gleyed Orthic Black in morphological characteristics.

6.12 Rego Humic Gleysol Subgroup

Soils with a noncalcareous (< 2 percent $CaCO_3$ equivalent)* Ah or Ap horizon which grades into dull colored, gleyed soil material. May have up to 12 inches of consolidated peat on the surface.

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

This soil, except for strong gleization and degree of wetness, resembles the better drained Gleyed Rego Black in morphological characteristics.

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* Application of HCl to soils with approximately 2 percent $CaCO_3$ equivalent results in weak effervescence that can be detected only when treated sample is held near the ear.

** The horizons in brackets may or may not be present.

6.13 Fera Humic Gleysol Subgroup

Soils with a noncalcareous (< 2 percent $CaCO_3$ equivalent) Ah or Ap horizon and a high chroma strongly gleyed B horizon with an accumulation of dithionate extractable iron (one percent greater than in the C horizon) and little or no accumulation of dithionate extractable aluminum (no more than 0.5 percent higher than in the C horizon). May have up to 12 inches of consolidated peat on the surface.

Profile type: (L-H), Ah, (Ahe), (Aeg), Bgf, Cg

This soil, except for strong gleization and degree of wetness, resembles the better drained, weakly leached, Gleyed Eluviated Black in morphological characteristics.

6.1-/5 Saline Humic Gleysol

Soils with a saline (> 4 mmhos/cm conductivity) horizon or layer within two feet of the surface or salinity exceeding a conductivity of 6 mmhos/cm between 2 and 4 feet if the soil above is nonsaline (< 4 mmhos/cm). May have up to 12 inches of consolidated peat on the surface.

Profile type: Saline C horizon; A and B horizons may be saline.

This soil, except for strong gleization and degree of wetness, resembles the better drained, Gleyed Saline Black in morphological characteristics.

6.1-/6 Carbonated Humic Gleysol

Soils with a carbonated (> 2 percent $CaCO_3$ equivalent) Ah or Ap horizon which grades into calcareous nonsaline horizons or layers. May have up to 12 inches of consolidated peat on the surface.

Profile type: Carbonated horizons or layers throughout the profile.

This soil, except for strong gleization and degree of wetness, resembles the better drained, Gleyed Carbonated Black in morphological characteristics.

6.1-/7 Cryic Humic Gleysol

Any Humic Gleysol with permafrost within 40 inches of the mineral soil surface. May have up to 12 inches of consolidated peat on the surface.

Profile type: Permafrost within 40 inches of the mineral soil surface.

6.2 Gleysol Great Group

Soils that may have a dark colored surface horizon up to 3 inches thick under virgin conditions and when mixed to a depth of 6 inches (or cultivated Ap) has either less than 3 percent organic matter or it differs from the next underlying horizon (Aej, B or C) by 1.5 units or less in value when moist if the value of the underlying horizon is 4 or more, or by one unit or less if the value of the underlying horizon is 3 or less.

Examples of cultivated soil: $\frac{Ap}{Aej,\ B\ or\ C} = \frac{2.5}{4.0}$ or higher, $\frac{2.0}{3.0}$ or higher

May have up to 12 inches of consolidated peat on the surface.

6.21 Orthic Gleysol Subgroup

Soils with an A, B, C horizon sequence. The Ah, if present, is less than 3 inches thick under virgin conditions and the soil with or without this surface horizon when cultivated is identified by the description under 6.2. May have up to 12 inches of consolidated peat on the surface.

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

This soil, except for strong gleization and degree of wetness, resembles the better drained, Gleyed Podzo Regosol in morphological characteristics.

6.22 Rego Gleysol Subgroup

Soils with an Ah or Ap, Cg or Cg only horizon sequence. The Ah, if present, is less than 3 inches thick under virgin conditions and the soil with or without this surface horizon when cultivated is identified by the description under 6.2. The surface horizon or layer is noncalcareous (<2 percent $CaCO_3$ equivalent). May have up to 12 inches of consolidated peat on the surface.

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

This soil, except for strong gleization and degree of wetness, resembles the better drained Gleyed Orthic Regosol in morphological characteristics.

6.23 Fera Gleysol Subgroup

Soils with an A, B, C horizon sequence. The soil is similar to the one described under 6.13 except that the Ah horizon, if present, under virgin conditions is less than 3 inches thick. The cultivated soil is identified by the description under 6.2. May have up to 12 inches of consolidated peat on the surface.

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

This soil, except for strong gleization and degree of wetness, resembles the better drained Gleyed Podzo Regosol in morphological characteristics.

6.2-/5 Saline Gleysol

Soils with a saline (>4 mmhos/cm conductivity) horizon or layer within 2 feet of the surface or salinity exceeding a conductivity of 6 mmhos/cm between 2 and 4 feet if the soil above is nonsaline (<4 mmhos/cm). May have up to 12 inches of consolidated peat on the surface.

Profile type: Saline C horizon; A and B horizons may be saline.

This soil, except for strong gleization and degree of wetness, resembles the better drained, Gleyed Saline Regosol in morphological characteristics.

6.2-/6 Carbonated Gleysol

Soils with a carbonated (> 2 percent $CaCO_3$ equivalent) surface horizon of layer which grades into calcareous nonsaline horizons or layers. May have up to 12 inches consolidated peat on the surface.

Profile type: Carbonated horizons or layers throughout the profile.

6.2-/7 Cryic Gleysol

Any Gleysol soil with permafrost within 40 inches of the mineral surface. May have up to 12 inches of consolidated peat on the surface.

Profile type: Permafrost within 40 inches of the mineral surface.

This soil, except for strong gleization and degree of wetness, resembles the better drained, Cryic Gleyed Regosol in morphological characteristics.

6.3 Eluviated Gleysol Great Group

Soils with or without an Ah horizon under virgin conditions and with Aeg and Btg horizons. If cultivated the surface horizon is differentiated on the basis of the descriptions under 6.1 and 6.2. May have up to 12 inches of consolidated peat on the surface.

6.31 Humic Eluviated Gleysol Subgroup

Soils with an Ah horizon greater than 3 inches thick under virgin conditions or an Ap as described under 6.1 and with Aeg, Btg and Cg horizons. May have up to 12 inches of consolidated peat on the surface.

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

This soil, except for strong gleization and degree of wetness, resembles the better drained, Gleyed Eluviated Black in morphological characteristics.

6.32 Low Humic Eluviated Gleysol Subgroup

Soils may have an Ah horizon up to 3 inches thick under virgin conditions or an Ap as described under 6.2 and with Aeg, Bfg and Cg horizons. May have up to 12 inches of consolidated peat on the surface.

Profile type: (L-H), (Ah), (Ahe), Aeg, Btg, Cg, (Ckg), (Ccag)

This soil, except for strong gleization and degree of wetness, resembles the better drained, Gleyed Dark Gray Wooded or Gleyed Gray Wooded in morphological characteristics.

FAMILY CLASSIFICATION OF SOILS

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Introduction

The subcommittee members had to consider the various viewpoints expressed concerning the basis to be adopted in respect to family grouping in the Canadian Soil Classification Scheme.(1) In brief, the viewpoints expressed fall mainly in two groups: 1. - those favoring a taxonomic classification; and 2. - those favoring interpretative land classification.

Taxonomic classification

The taxonomic classification "per se" is one which is based on the characteristics developed in the soil profiles during its formation. In this objective, the family, as a categorical level, in the Canadian Scheme, is in line with the procedure used in establishing the higher categories: the order, great group, subgroup or the lower ones: series and type. The family lying between the subgroup and the series should be necessarily a grouping of soil series within each respective subgroup. The criteria to be used will not necessarily be the same within the classes of all various kinds of soils.

Interpretative classification

An interpretative land classification, that is for immediately applied objectives, was proposed by several colleagues for a family grouping that would use criteria significant in the use and management of soils and plants. As an example, a grouping of series derived from various land capability classes and subclasses data compiled under the ARDA Land Inventory. This suggestion was not, at this time, retained by the subcommittee members even if it seems to meet some of the requirements of the soil family definition given in 1963.(1) Mention should be made that the usefulness of soils is subject to change with the changing arts and skills in agriculture. For this reason it would be desirable, at this moment, to consider these interpretative groupings outside the regular NSSC Scheme.

Definition of soil family

A soil family was defined by the NSSC in 1963 as being: "A group of soil series within a subgroup that are relatively homogeneous with respect to soil-air, soil-water and plant-root relationships. Hence families are differentiated primarily on the basis of properties important to the growth of plants. This category as yet has not been widely used in Canada."(1)

This definition above meets several objectives in a general way but, for those who want a more specific taxonomic point of view, the definition of the family would be: A soil family is a grouping of soil series, within a subgroup, that are relatively homogeneous in genetic horizons but at a broader degree than that used in the soil series.

Criteria selected

For a practical application of the foregoing statements, it was agreed by the subcommittee that a certain set of soil properties or criteria should be listed and proposed for trial in the various provinces. Some provinces have used most of these criteria in the establishment of soil families; it is hoped that all provinces will give a fair trial of these proposals.

The criteria selected are listed as follows:

1. - Texture*

The number of broad textural classes to be used could vary for certain kinds of soils. At this time, broad textural classes (6) are proposed, namely:

a) Coarse-textured soils: sands and loamy sands.
b) Modertately coarse-textured soils: sandy loam and fine sandy loam.
c) Medium-textured soils: very fine sandy loam, loam, silt loam and silt.
d) Moderately fine-textured soils: clay loam, sandy clay loam, silty clay loam.
e) Fine-textured soils: sandy clay, silty clay and clay.
f) Very fine-textured soils: heavy clay, that is with more than 60% clay.

Modifiers to textural classes

The term fragmental would apply to any of the textural classes if more than 20%, by volume, of the materials was larger than 2 mm.

2. - Composition (chemical and partly mineralogical)

Due to lack of mineralogical data the subcommittee suggests a consideration of the composition of the soil materials, namely, the presence or contents of soluble salts and/or of free carbonates, as used in naming soil horizons. These criteria, added to that of texture, have a strong connotation on mineralogical composition of the soil materials.

3. - Depth to a lithic contact

Although the relative importance of depths of soils could vary in various provinces, it is thought that soils having a lithic contact at less than 12 inches and more than 12 inches but less than 36 inches should be separated. By lithic contact, it is meant a layer of hard rock (hardness of 3 or more on the Mohs scale).

*Texture classes, as defined, are applied to the soil profile that lies between the base of the Ap or 6 inches, whichever is deeper, and 36 inches or to a lithic contact or a non-conforming layer.

4. - Non-conforming layers

The presence within 36 inches of a non-conforming layer, that is, one which has more than two textural classes differences.

5. - Special horizons

The presence of 1) fragipan and 2) compacted layers below the solum.

6. - Peaty families

Soils having a peaty surface, that is from 8 to 12 inches, were formerly considered peaty subgroups. They are now considered peaty families.

7. - Depth of solum

The depth of solum and that of diagnostic horizons when present could be considered at the family level.

8. - Temperature

Some consideration was given to the use of temperature limits in establishing soil families. No definite recommendation can be made at this time. Soil temperature, being a soil property, is to be envisaged as an important criteria in the future.

Family on a national basis

The subcommittee cannot, at this time, make definite recommendations for the establishment of family at a national basis. This approach would be, in the opinion of our NSSC Chairman, Dr. A. Leahey, a very valuable one from a standpoint of soil correlation between provinces.

Reference:

(1) National Soil Survey Committee of Canada. Mimeographed, p. 5. Fifth Meeting, Winnipeg, March 4-8, 1963.

REPORT ON THE CLASSIFICATION OF ORGANIC SOILS

W. A. Ehrlich

Chairman, Subcommittee on Organic Soils

The classification of organic soils presented here was accepted and recommended for trial by the National Soil Survey Committee at its meeting at Laval University in October, 1965.

The classification proposed here is a modification of the one adopted by the Soil Conservation Service, United States Department of Agriculture, at the National Technical Work Planning Conference of the Cooperative Soil Survey held in Chicago, Illinois, in January 1965.

To facilitate understanding of this scheme, it is arranged in the order of definitions and criteria followed by the classification of organic soils and notes on classification procedure. A section on properties of some organic soils is attached.

Definitions and Criteria of Organic Soils

A. Control Section[1]

Thickness of control section in organic soils is 40 inches from the surface if the organic material is consolidated or 60 inches if it is unconsolidated. Consolidation of peat is the result of subsidence through drainage, cultivation, pasturing, etc. The control section may extend into the underlying mineral soil or bedrock substratum.

B. Kinds of tiers and layers[2]

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

1. Surface tier is the top 12 inches of consolidated or 18 inches of unconsolidated organic material. (This thickness of peat is permissible with mineral soils.) This tier, except the loose surface litter, is included with the classification of Terric and Lithic types having less than 24 inches of consolidated or 36 inches of unconsolidated organic material. Where these thin peats occur they are classified on the dominant type of peat modified by other types if present in significant proportions.

2. Subsurface tier is immediately below and is equal in thickness to the surface tier. This tier establishes the great group classification if

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[1]Assumed to include the zone of maximum microbiological activity.

[2]Tiers and layers are described to permit easier discussion of parts of the control section.

no mineral substratum is present. If a mineral substratum occurs in this tier, the peat in this tier is included and classified with the surface tier on the basis of the dominant kind of peat.

3. Bottom tier is that portion extending from the subsurface tier to the bottom of the control section. This portion may range from totally organic to totally mineral. The organic material in this tier, if in significant proportions, establishes or assists in establishing the subgroup classification.

In summary, tiers in the control section are as follows:

	Consolidated	Unconsolidated
Surface tier	0-12"	0-18"
Subsurface tier	13-24"	19-36"
Bottom tier	25-40"	37-60"

4. Diagnostic layers

Fibric - least decomposed stage.
It must have more than 2/3 fibers (140 mesh >.1 mm) in the total mass. More than 50 percent of the fibers must be well preserved as to not change chroma when rubbed wet or will resist disintegration or becoming greasy.

Mesic - intermediately decomposed stage.
It has a fiber content between 1/3 and 2/3 in the total mass, or if the fiber content exceeds 2/3 of the total mass over 50 percent of the fibers will decrease at least one unit in chroma when rubbed wet, or if the fiber content exceeds 2/3 of the total mass and does not change color upon rubbing then over 50 percent of the fibers are easily broken down or become greasy when rubbed wet.

Humic - most decomposed stage.
It must have less than 1/3 fiber in the total mass. It must not change color when rubbed wet, and the sodium pyrophosphate extract on white filter paper is lower in value and higher in chroma than 10YR 7/3.

5. Other layers

Unic - consisting of one diagnostic mesic or humic layer throughout the organic section in the subsurface and bottom tiers or in shallow peats throughout the organic section of the surface and subsurface tiers.

Fennic[1] - dominantly fibric fen peat in the subsurface tier or dominantly fibric fen peat in the surface and subsurface tiers if a mineral substratum occurs in the subsurface tier.

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[1] Fenno-Mucinic or Mucinic-Fennic may be used where the first name indicates a subordinate quantity that exceeds one-sixth of the volume in the organic profile (also see footnote on page 3).

Mucinic - dominantly fibric moss peat in the subsurface tier or dominantly fibric moss peat in the surface and subsurface tiers if a mineral substratum occurs in the subsurface tier.

Stratic - two or more kinds of diagnostic peat layers in significant proportions[1] in the subsurface and bottom tiers or in the surface and subsurface tiers if the mineral substratum occurs in the subsurface tier. Twelve kinds of Stratic types may occur: Stratic Mesic Fibrisol; Stratic Humic Fibrisol; Stratic Meso-Humic Fibrisol; Stratic Humo-Mesic Fibrisol; Stratic Fibric Mesisol, etc. Where all diagnostic layers occur in significant proportions[1] they are arranged in the order of increasing amounts. The first named of three has a suffix "o" in place of "ic" to reduce discordance of names. The "ic" remains when only one modifier is used.

Luvic - an illuvial layer in the subsurface tier or in the upper bottom tier with more colloidal material than the underlying peat. This layer has fine materials with a greasy, glossy appearance in fractures and in root channels.

Clasto - a layer(s) of significant proportions with 30 to 70 percent mineral material in the organic part of the control section.

Limno - a significant layer(s) (> 2 inches) of marl, diatomaceous earth, sedimentary peat, bog iron, possibly others.

Cumulo - alternate layers of organic and mineral materials.

Cryic - permanently frozen within the control section.

Terric - unconsolidated mineral substratum with less than 30 percent organic matter occurring in the subsurface or bottom tiers.

Lithic - consolidated mineral substratum (bedrock) occurring in the subsurface or bottom tiers.

- -

[1]Significant proportions in peats extending into the bottom tier, is more than one-sixth of the total mass for each diagnostic type in the subsurface and bottom tiers, and of similar amounts for those peats extending only into the subsurface tier. The dominant type should be greater than one-third of the total mass in the subsurface tier or in the surface and subsurface tiers if a mineral substratum occurs in the subsurface tier.

Classification

Order	Great Group	Subgroup
7.0 Organic	7.1 Fibrisol	7.11 Fennic Fibrisol 7.12 Mucinic Fibrisol 7.1/3 Stratic[1] 7.1/4 Clasto- 7.1/5 Limno- 7.1/6 Cumulo- 7.1/7 Cryic 7.1/8 Terric 7.1/9 Lithic
	7.2 Mesisol	7.21 Unic Mesisol 7.22 Luvic Mesisol 7.2/3 Stratic 7.2/4 Clasto- 7.2/5 Limno- 7.2/6 Cumulo- 7.2/7 Cryic 7.2/8 Terric 7.2/9 Lithic
	7.3 Humisol	7.31 Unic Humisol 7.32 Luvic Humisol 7.3/3 Stratic 7.3/4 Clasto- 7.3/5 Limno- 7.3/6 Cumulo- 7.3/7 Cryic 7.3/8 Terric 7.3/9 Lithic

7.0 Organic Order

Soils with 30 percent or more of organic matter and with more than 12 inches of consolidated or 18 inches of unconsolidated organic material.

7.1 Fibrisol Great Group

Organic soils in the least decomposed stage as defined under <u>Fibric</u> in types of diagnostic layers.

7.11 Fennic Fibrisol - soils dominantly fen peat in the subsurface tier or in the subsurface and surface tiers if a mineral substratum occurs in the subsurface tier.

- -

[1]The subgroups to which the virgule is applied may be used together where better definition of the soil is required, e.g. Terric Clasto-Fennic Fibrisol; Lithic Cumulo-Mucinic Fibrisol; etc.

7.12 Mucinic Fibrisol - soils dominantly peat mosses in the subsurface tier or in the subsurface and surface tiers if a mineral substratum occurs in the subsurface tier.

7.1/3 Stratic - two or more kinds of diagnostic peat layers, dominantly fibric, in significant proportions in the subsurface and bottom tiers or in the surface and subsurface tiers if a mineral substratum occurs in the subsurface tier. Four kinds of Stratic Fibrisol soils may occur: Stratic Mesic Fibrisol; Stratic Humic Fibrisol; Stratic Meso-Humic Fibrisol; and Stratic Humo-Mesic Fibrisol. (See definition of Stratic.)

7.1/4 Clasto - dominantly fibric peat with 30 to 70 percent mineral matter throughout most of the control section.

7.1/5 Limno - dominantly fibric peat with significant amounts of one or more of marl, diatomaceous earth, sedimentary peat, bog iron, possibly others.

7.1/6 Cumulo - dominantly fibric peat with alternate layers of peat and mineral materials.

7.1/7 Cryic - dominantly fibric peat with a permanent frost layer in the control section.

7.1/8 Terric - dominantly fibric peat with an unconsolidated mineral substratum within the subsurface or bottom tier.

7.1/9 Lithic - dominantly fibric peat with a consolidated mineral substratum (bedrock) within the subsurface or bottom tier.

7.2 Mesisol Great Group

Organic soils in an intermediately decomposed stage as defined under <u>Mesic</u> in types of diagnostic layers.

7.21 Unic Mesisol - soils consisting of intermediately decomposed peat throughout the subsurface and bottom tiers or in shallow peats throughout the organic section of the surface and subsurface tiers.

7.22 Luvic Mesisol - soils dominantly intermediately decomposed peat with an illuvial layer in the subsurface or upper bottom tiers having more colloidal material than the underlying layer.

7.2/3 Stratic - two or more kinds of diagnostic peat layers, dominantly mesic, in significant proportions in the subsurface and bottom tiers or in the surface and subsurface tiers if a mineral substratum occurs in the subsurface tier. Four kinds of Stratic Mesisol soils may occur: Stratic Fibric Mesisol; Stratic Humic Mesisol; Stratic Fibro-Humic Mesisol; Stratic Humo-Fibric Mesisol. (See definition of Stratic.)

7.2/4 Clasto - dominantly mesic peat with 30 to 70 percent mineral matter throughout most of the organic part of the control section.

7.2/5 Limno - dominantly mesic peat with significant amounts of one or more of marl, diatomaceous earth, sedimentary peat, bog iron, possibly others.

7.2/6 Cumulo - dominantly mesic peat with alternate layers of peat and mineral materials.

7.2/7 Cryic - dominantly mesic peat with a permanent frost layer in the control section.

7.2/8 Terric - dominantly mesic peat with an unconsolidated mineral substratum within the subsurface or bottom tiers.

7.2/9 Lithic - dominantly mesic peat with a consolidated mineral substratum (bedrock) within the subsurface or bottom tiers.

7.3 Humisol Great Group

Organic soils in a decomposed stage as defined under Humic in types of diagnostic layers.

7.31 Unic Humisol - soils consisting of decomposed peat throughout the subsurface and bottom tiers or in shallow peats throughout the organic section of the surface and subsurface tiers.

7.32 Luvic Humisol - soils dominantly decomposed peat with an illuvial layer in the subsurface or upper bottom tier having more colloidal material than the underlying layer.

7.3/3 Stratic - two or more kinds of diagnostic layers, dominantly humic, in significant proportions in the subsurface and bottom tiers or in the surface and subsurface tiers if a mineral substratum is in the subsurface tier. Four kinds of Stratic Humisols may occur: Stratic Fibric Humisol; Stratic Mesic Humisol; Stratic Fibro-Mesic Humisol; Stratic Meso-Fibric Humisol. (See definition of Stratic.)

7.3/4 Clasto - dominantly humic peat with 30 to 70 percent mineral matter throughout most of the organic portion of the control section.

7.3/5 Limno - dominantly humic peat with significant amounts of one or more of marl, diatomaceous earth, sedimentary peat, bog iron, possibly others.

7.3/6 Cumulo - dominantly humic peat with alternate layers of peat and mineral materials.

7.3/7 Cryic - dominantly humic peat with a permanent frost layer in the control section.

7.3/8 Terric - dominantly humic peat with an unconsolidated mineral substratum within the subsurface or bottom tier.

7.3/9 Lithic - dominantly humic peat with a consolidated mineral substratum (bedrock) within the subsurface or bottom tier.

Series Criteria

Based mainly on criteria presented below and possibly others occurring in the subsurface and bottom tiers.

1. Sphagnic - more than 50 percent.
2. Hypnic - more than 50 percent.
3. Woody - more than 10 percent by volume.
4. Dystrophic - $<$ pH 5.3 in .01 M $CaCl_2$ or pH 5.8 in H_2O (sat. paste).
5. Eutrophic - $>$ pH 5.3 in .01 M $CaCl_2$ or pH 5.8 in H_2O (sat. paste).
6. Calcareous - weakly, moderately, strongly, very strongly, extremely.
7. Sulphureous - $>$ one percent.
8. Ferruginous - $>$ one percent.
9. Toxic elements - al, zn, etc.
10. Texture of mineral substratum in shallow peats on the basis of textural groups of coarse, moderately coarse, medium, moderately fine, fine and very fine.
11. Development of mineral soil.

Phase Criteria

Based mainly on the surface tier on criteria used for series separations and any other significant characteristic such as anthropic (burned, mined, scalped).

Notes on Classification Procedure

1. Mineral substratum within the surface tier

A soil with less than 12 inches of consolidated or less than 18 inches of unconsolidated peat (surface tier) is not a member of the Organic Order.

2. Mineral substratum within the subsurface tier

A soil, including mineral layer(s) and organo-mineral inclusions, exceeding the surface but not the subsurface in thickness is a shallow peat. This organic soil is classified on the types of peat in the surface (excluding fresh, loose litter) and subsurface tiers. The dominant type of peat establishes the great group of either Fibrisol, Mesisol or Humisol and the subordinate type or types of peat as well as other modifiers establish the subgroup. Exceptions to the last statement on modifiers are "Unic", meaning one, in the Mesisol and Humisol great groups, and Fennic or Mucinic in the Fibrisol Great Group. Fennic or Mucinic peats may be uniform in composition, however they are not classified on uniformity but on dominance of one or the other in the diagnostic section. All shallow peats are prefixed with Terric or Lithic, depending on the kind of mineral substratum.

3. Mineral substratum below the subsurface tier

An organic soil with a thickness exceeding the subsurface tier is classified at the great group level on the basis of the dominant peat (i.e. fibric, mesic or humic) in the subsurface tier and at the subgroup level the peat is classified on the subordinate type or types of peat and modifiers in the subsurface and bottom tiers. Examples of classification for this type of peat are: one with 7 inches of consolidated Fennic fibric peat in the subsurface and the remainder in this and bottom tiers as mesic peat would be a Stratic Mesic Fennic Fibrisol. If both mesic and humic peats were the remainder of the above example, the soil would be a Stratic type of either a Meso-Humic or Humo-Mesic Fibrisol depending on the dominance of the subordinate group. Additional modifiers may be necessary to add to the above such as Terric or Lithic if the mineral substratum is in the bottom tier, or Clasto if high in mineral content, or Cryic if permanently frozen, etc.

4. Mineral substratum below the control section

   For organic soils with peats extending beyond the bottom tier or control section, the classification is based on the same concepts as outlined in 3 except that Terric and Lithic are not applicable.

5. Where Terric or Lithic are used, they should be used as prefixes, e.g. Terric Clasto-Fennic Fibrisol rather than Clasto Terric Fennic Fibrisol. Where Cryic is used with Terric or Lithic it should follow either term but it should precede the others listed. The placement of these terms is to indicate the respective relevancy of the modifiers to the great group.

6. As presently defined the horizon "L" (litter) is the fibric layer, "F" (fermentation) is the mesic layer and "H" (humus) the humic layer. Where the layers repeat they are to be indicated with Arabic numerals used as suffixes, e.g. L1, F1, L2, F2, H1, F3, etc. When no repetition of the layer occurs, the suffix need not be used.

7. If applicable, the lower case suffixes as defined in the 1965 N.S.S.C. proceedings may be used with the layers L, F and H.

Properties of Organic Soils

In this section are certain data which presently appear to be the most useful for organic soil classification. These are fiber characteristics (size and amount), bulk density, water holding capacity, pH, ash content and degree of decomposition. Below are some data on physical and chemical analyses compiled by R. S. Farnham and H. R. Finney in Advances of Agronomy, Vol. 17, page 137, 1965.

Layer type	Range in fiber content (>0.1% dry wt. basis)	Range in ash content (% dry wt. basis)	Range in water-holding capacity (% dry wt. basis)	Range in bulk density[1] g/cc	Range in pH (H_2O)	Range in nitrogen content (% dry wt. basis)	Range in sodium pyrophosphate solubility (%)
Fibric	76-91	2.5- 9.2	850-1920	0.06-0.17	2.9-7.5	0.4-3.0	0.1-0.75
Mesic	48-51	11.4-21.2	625-660	0.21-0.23	4.5-7.5	1.5-3.0	0.5-1.5
Sapric (Humic)	12-20	26.2-59.4	187-418	0.31-0.45	4.5-8.0	1.0-3.0	0.75-3.5

The data in the table indicate ash content and bulk density as most meaningful. These figures suggest a range in ash content of fibric to be less than 10.0 percent, mesic from about 10.0 to 25.0 percent, humic to be greater than 25.0 percent; and in bulk density (on a wet volume basis), the fibric to be less than 0.2 grams per cubic centimeter, mesic from about 0.2 to 0.3 and humic to be greater than 0.3 grams per cubic centimeter.

The figures on water holding capacity show a definite pattern of decreasing in capacity with increasing decomposition. Further to these data on water, Farnham and Finney pointed out that: at all suctions (0-15 bars) the water contents of fibric layers, expressed on an oven dry basis, are greater than those of mesic which in turn are greater than those of humic. Using the same water controls expressed on a volume basis (the amount of water lost expressed as the volume of water per unit volume of soil in bulk) water contents of humic are highest at all suctions other than at or near saturation. Water contents of mesic are intermediate and that of fibric are least.

The sodium pyrophosphate extract test for degree of decomposition, according to some local trials, is reasonably good for distinguishing humic layers. For the extracts of these layers the value should be lower and the chroma higher than 10YR 7/3. For the mesic layers the test is variable and therefore indecisive. For the fibric layers the extract values are generally higher and the chromas lower than 10YR 7/3; however, exceptions occur. The determination of fibric is usually no problem since the material is generally coarse enough to obtain a reasonably accurate classification by visual means.

Another probable criterion for distinguishing relative degrees of decomposition in organic soils is exchange capacity. This capacity, considerably greater in organic than in mineral soils, is affected by degree of decomposition and possibly by the kind of plant remains. However, the meagre data available do not show enough to draw firm conclusions.

Information on nitrogen and pH is useful for fertility evaluation and in separations for series and phases. For an adequate fertility assessment, however, it is necessary also to determine the presence or absence of a wide range of plant nutrients.

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[1] Wet volume basis

One of the problems in the classification of organic soils is determining whether the material is consolidated or unconsolidated and therefore the control section to use. The simplest way to do this is to appraise the drainage. If the area is drained, that is, if the water table is more than 40 inches from the surface, the peat will have had initial subsidence and it will be very firm; if the peat is undrained, that is, if the water table is within 40 inches from the surface, it will be soft and spongy. The 40 inch depth for drained peat and the 60 inch depth for undrained peat as control sections are somewhat arbitrary although a relationship exists between the two depths. Peat on drainage subsides initially about 30 percent, thus a 60 inch thickness of peat through drainage is reduced to 40 inches, the recommended control section for drained peat. Under good drainage peat will continue to subside almost indefinitely; however, these probable changes in the future, like those expected in mineral soils, have to be ignored.

In addition to 40 and 60 inch control sections, intermediate depths arrived at by a formula[1] could be used for peat soils with water tables ranging from the surface to depths exceeding 40 inches. This range of control sections, through application of the formula, was tried but the differences in control sections from one site to another made comparisons difficult and somewhat confusing. Applications of the formula on a few examples of deep peat soils follow:

	Calculated control section	Recommended control section
1.	Dwt = 40 inches S = 40 + 1.5 (40-40) = 40 inches	40 inches (drained)
2.	Dwt = 20 inches S = 20 + 1.5 (40-20) = 50 inches	60 inches (undrained)
3.	Dwt = surface S = 0 + 1.5 (40-0) = 60 inches	60 inches (undrained)

Assessing drainage in organic soils with a mineral substratum within 40 inches of the surface poses a different problem. A general rule to follow is to establish whether the water table is in the peat or in the mineral substratum. If it occurs in the peat it is likely undrained and if in the mineral substratum it is likely drained (soil 2).

To illustrate the classification of organic soils, two profiles are described.

Soil 1

Location
Surface vegetation - stunted black spruce and tamarack, labrador tea, sphagnum moss.
Description - Unconsolidated (water table at 30", 60" control section).

L1 0-4 inches, brown (10YR 5/3 dry) coarse-fibered, spongy, strongly acid, sphagnum moss.

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[1] $S = Dwt + 1.5 (40-Dwt)$, where S is the control section, Dwt is the depth to the water table, 1.5 is the subsidence factor and 40 is a constant for depth of drained peat.

L2 4-36 inches, brown to dark brown (10YR 5/3 to 3/3 dry) coarse to medium fibered, loose, strongly acid, sphagnum peat with some sedge remains. Sodium pyrophosphate test 10YR 8/2.

L3 36-54 inches, dark brown (10YR 3/3 dry) partly disintegrated, medium fibered, matted to felt-like, medium acid, sedge and sphagnum remains. Sodium pyrophosphate test 10YR 8/3.

F 54-60 inches, dark brown to very dark brown (10YR 3/3 to 2/2 dry) moderately decomposed, medium to fine fibered, compacted, medium acid, sedge remains. Fibers become greasy when rubbed wet. Sodium pyrophosphate test 10YR 8/3.

Key to classification

Control section = 60 inches (unconsolidated or undrained).
0-18" surface tier - fibrous, sphagnic, no decomposition, acidic.
19-36" subsurface tier - fibrous, sphagnic, slight decomposition, acidic.
37-54" bottom tier - fibrous, fennic and sphagnic, slight to moderate decomposition, neutral.
55-60" bottom tier - matted fine fennic fibers about 50 percent decomposed, neutral.

This soil has more than 36 inches of undrained peat, therefore the great group classification is based entirely on the subsurface tier. (If a mineral substratum occurred in the subsurface tier the classification would be based on the dominant kind in the surface and subsurface tiers). Since the diagnostic layer has more than 66.6 percent fibers it is a fibric type of some kind. Sphagnum predominates with fennic material exceeding one-sixth of the mass below the surface tier to the 54 inch depth thus classifying this as a fen and moss type of Fibrisol. The 6 inch layer of mesic peat at the bottom of the control section being less than one-sixth of the subsurface and bottom tiers is not used in the classification.

Taxonomic classification

Order - Organic
Great Group - Fibrisol
Subgroup - Fenno-Mucinic Fibrisol

Soil 2

Location
Surface vegetation - black spruce, sphagnum, feather mosses, sedges.
Description - Consolidated (water table 50", 40" control section).

L 0-4 inches, grayish brown to light grayish brown (10YR 5/2 to 6/2 dry) coarse fibered, loose, slight decomposition with more than 66.6% fibers, slightly acid, sphagnum and feather mosses. Sodium pyrophosphate test 10YR 8/3.

F 5-20 inches, very dark grayish brown (10YR 3/2 dry) fine fibered, some woody remains, moderately decomposed with about 50 percent fibers remaining, neutral, mainly sedges and reeds with some sphagnum. Fibers greasy when rubbed wet. Sodium pyrophosphate test 10YR 7/2.

Ahg 20-23 inches, very dark gray (10YR 3/1 dry) fine sandy loam, weak fine granular, slightly sticky when wet, slightly hard when dry, iron stained, mildly alkaline.

Cg 23-40 inches, light gray (2.5Y 7/2 dry) fine sandy loam, structureless, moderately alkaline.

Key to classification

Control section = 40 inches (consolidated or drained).
0-12" surface tier - 4 inches fibric peat, 8 inches mesic peat.
12-24" subsurface tier - 8 inches mesic peat, 4 inches mineral material.
24-40" bottom tier - mineral material.

Mineral soil occurs in subsurface tier, therefore the classification is based on the dominant kind of peat in the surface and subsurface tiers (excluding the loose surface). With moderate decomposition the peat is classified as Mesic. Being uniform throughout the peat section (excluding the loose surface) it is Unic and since a mineral substratum occurs within the control section it is also Terric.

Taxonomic classification

Order - Organic
Great Group - Mesisol
Subgroup - Terric Unic Mesisol

REPORT OF THE SUBCOMMITTEE ON CHEMICAL AND PHYSICAL ANALYSES

A. F. MacKenzie, Chairman

Terms of Reference:

The subcommittee on Chemical and Physical Analyses was instructed to review the findings of the 1963 report dealing with methods of soil analysis to be used in soil survey work. In particular the subcommittee was to attempt to clarify the term "diagnostic horizon".

The subcommittee decided the following points should be enumerated:

(1) "diagnostic horizons" as indicated in the 1963 report of the N.S.S.C. were those horizons that could be analyzed to place a soil profile into its particular great group. It was not intended that only one horizon be analyzed for any one profile, or for any one determination. There are times when analysis of horizons above and below a "diagnostic horizon" is required. Such "diagnostic horizons" as a textural B or an iron B can only be defined in relation to the horizons above or below.

(2) The subcommittee felt there were a number of analytical procedures that should be examined and evaluated by soil survey personnel. It is recommended that new procedures be carried out along with current standard procedures for a trial period, allowing the methods to be evaluated and compared.

Chemical Analysis

(a) pH of soils should be obtained by suspending the soils in 0.01 molar calcium chloride, preferably in a one to two soil solution ratio. (Schofield and Taylor, 1955. Soil Sci. Amer. Proc. 19: 164.)

(b) Free oxides - The subcommittee recommended ammonium oxalate-extractable iron and aluminum as used by McKeague and Day (McKeague, J. A., and J. H. Day, 1966. Can. Jour. Soil Sci. 46: 13), in addition to dithionate extractable iron, Mehra and Jackson method. (Mehra, P. O., and M. L. Jackson, 1960, 7th Natl. Conf. Clays and Clay Minerals: 317-327.)

(c) Carbonates - Total carbonates were suggested by the Schollenberger method. (Schollenberger, C. J., 1958, Soil Sci. 85: 10-13). Calcite and dolomite could be determined by the Skinner, Halstead and Brydon method of differential decomposition rates in acid. (Skinner, S.I.M., R. L. Halstead and J. E. Brydon, 1959. Can. J. Soil Sci. 39: 197-204.)

(d) Organic matter - The Walkley-Black method was suggested as a suitable technique. (Walkley, A. 1946. Soil Sci. 63: 251-263. Greweling, T., and M. Peech, 1960. Chemical Soil Tests, Cornell Univ. Agr. Exp. Sta. Bull. 960). In addition the dry combustion method for organic carbon was suggested. (Allison, L. E., 1965, Chpt. 90, Methods of Soil Anal. Amer. Soc. Agron.

Madison, Wisconsin). Loss on ignition for organic soils was suggested. Solubility of organic material in sodium pyrophosphate was suggested as a method of determining the degree of decomposition in organic soils. (Farnham, R. S., and H. R. Finney, 1965. Adv. in Agron. 17. 115-161.)

(e) Salt concentration - Salt concentration by saturation extract was suggested. (U.S.D.A. Handbook 60, 1954. Gov't. Printing Office, Washington, D.C.)

(f) Exchangeable cations - The method of J. S. Clark was suggested in which exchangeable cations are extracted in neutral 2 N sodium chloride. (Clark, J. S. 1965. Can. J. Soil Sci. 45: 311-322.)

(g) Cation exchange capacity - The ammonium acetate extract method is suitable for soils of neutral pH with little sesquioxide content. For calcareous soils a possible method is that of using lithium fluoride extractions. (Yaalon, D. H., J. Van Schuylenborgh, and S. Slager, 1962. Neth. J. Agric. Sci. 10: 217-222.) For soils with high sesquioxide contents and a high 1:1 clay mineral content, neutral salt extraction and saturation followed by replacement with another neutral salt is preferable to acetate extractions. An example of this method is that of Schofield in which NH_4Cl is used to saturate the soil, and KNO_3 is used to displace both the ammonium and chloride ions. Both displaced ions are then determined. (Schofield, R. K. 1949. J. Soil Sci. 1: 1-8.)

(h) For the determination of nitrogen in soils - The methods of Bremner were suggested for the analysis of soils. (Bremner, J. M. 1965, Chp. 83, 84, Methods of Soil Anal., Amer. Soc. Agron. Madison, Wisconsin.)

Physical Analysis

(a) Particle size distribution - The pipette analysis with pre-treatment to remove soluble salts and organic matter was maintained as the standard analysis. The procedure of Toogood and Peters was suggested as a suitable technique. (Toogood, J. A., and T. W. Peters, 1953, Can. J. Agric. Res. 33: 159-177.) Carbonates should be removed if they restrict dispersion. Removal of free oxides may be necessary for some studies. The subcommittee felt that the hydrometer technique could be used for some purposes. (Day, P. R. 1956. Soil Sci. Soc. Amer. Proc. 20: 167-169.)

(b) Moisture characteristics - The subcommittee felt that moisture characteristics are best determined by a soil water vs. suction analysis. Two or three points on the curve would be a minimum. Lower suction values should be obtained on undisturbed cores.

Data compilation - The subcommittee recommended that a uniform system of reporting of analyses should be established. This should include analysis on the basis of volume as well as weight. The subcommittee also suggested that regional correlators could collect analytical results and prepare a list of soils that had been analyzed. This list could be circulated so that anyone interested in information could write to the regional correlator.

Reference soils - The subcommittee felt some thought should be given to collecting the available data on significant soil profiles in one publication. An example was the Caribou.

Expression of results - Analyses should be expressed on the basis of oxides for silicate analyses, and on the elemental basis for other analyses.
Physical analysis - It was suggested that water should be calculated in per cent by volume as well as by weight.

Sampling - The problem of representative sampling was discussed by the subcommittee. Problems of what soils to sample and how often to sample them were again raised, but no change in current practices was suggested.

Selective analysis - The subcommittee again felt that the analyses to be carried out on soil profiles should be those which would yield the most information for the least effort. The concept of "routine analysis" was again rejected in favor of a concept of selected analyses for specific purposes.

REPORT OF THE SUBCOMMITTEE ON SOIL SURVEY REPORTS

D. B. Cann, Chairman

Soil survey reports are the principal means of presenting soil information to the public. The increasing use of soil survey reports both in agriculture and in many other disciplines makes it essential that the reports provide reliable and accurate information. The way in which this information is presented will determine in a large measure the extent to which our reports are used.

Terms of Reference. The subcommittee on soil survey reports was asked to review the recommendations of the 1955 report and to suggest such revisions as seemed desirable in view of our experience since that time. It was also asked to consider the advantages and disadvantages of three general styles of Canadian reports (Ontario, Edmonton, Alberta and C.D.A. reports). In addition, the subcommittee examined reports from the United States and Ireland.

Many of the recommendations of the 1955 report have been implemented. Better quality paper is used in the reports and photographs have improved in quality. More colored photographs are being used. The use of a summary in the front of the report has not been generally followed nor has the placing of detailed descriptions in a separate section of the report. However, the soil descriptive material has been expanded as has also the section on utilization of the soil.

The subcommittee dealt at some length with the subject of publishing interim or preliminary maps. It was felt generally that this practice should be avoided if possible and an effort should be made to have the map and report come out together to avoid extra expense. It was agreed that there are some situations where a preliminary map is useful for special purposes.

It is recommended that publication of such maps be left to the discretion of local authorities and that distribution be limited to specialists. A limited amount of labor and expense should be involved.

It is recommended also that extra copies of the final map sheet should be ordered for distribution on request, especially in the case of maps being completed before the report. The final map and report should be released together as soon as possible.

The subcommittee studied the recommendation of the 1955 report to publish a scientific monograph on the soils of major sections of each province. It was decided that the present state of our knowledge does not permit the publication of scientific monographs of very large areas. Instead, it is recommended that each province undertake the preparation of a guide or summary report similar to the recently published "A Guide to Understanding Saskatchewan Soils". The content of this report would depend on the area covered and on the state of knowledge of the soils in that area. Eventually, these guides could be expanded into scientific monographs of physiographic regions.

The subcommittee examined several reports having different styles of format. It was felt that some guidelines as to format and content of Canadian soil survey reports should be suggested in order to maintain some degree of national uniformity in our publications. It was agreed that reports should be technical rather than general extension publications, since the reports are now used by technical people in many fields other than agriculture. The general format presented here is the one most favored by the subcommittee and is recommended for use in future soil survey publications. It is intended to promote uniformity in presentation of material, but is in no sense intended to be restrictive as to content within the guidelines. Under the main headings, the subcommittee suggests topics which they feel should be treated in the report. In some instances a specific arrangement is suggested. In some reports not all of these will be necessary or even desirable.

Recommended General Format of Soil Survey Reports

1. Table of Contents (index)[1]

2. Preface or Foreword. This may or may not be used.

3. Acknowledgments. Use in all reports.

4. Summary. Recommended in all reports.

5. Introduction. Recommended in all reports. It should be a description of the purpose and content of the report. Some authors combine the Summary and Introduction. A report should have either a Preface or an Introduction.

6. General Description of the Area
   This section should include discussion of the following: Location and Extent, Climate, Physiography, Geology, Vegetation, Population, Towns, Industries, Transportation, History of Development and Economic Aspects. Those underlined are considered essential, but do not necessarily have to be discussed in this order. The treatment of the other subjects should be brief.

7. Soil Development and Classification
   (a) It is recommended that the factors of soil formation be treated first (climate and vegetation, geology and parent materials, topography and drainage). This section is an interpretation of the major sections presented under "General Description of the Area" as related to soil development.
   (b) Soil development - kinds of soils, etc.
   (c) Soil classification - soil key.

1/ See under Descriptions of Soils

Note: In Saskatchewan, sections (b) and (c) may not be discussed in the report, if the "Guide" is issued with the report.

8. Descriptions of the Soils

The soils may be described either in alphabetical or in taxonomic order. However, the subcommittee recommends that in those reports in which the soils are not treated alphabetically, an index to the soils, listed alphabetically, should be presented as part of the Table of Contents. Soils may be listed alphabetically in the Table of Contents if desired. It is felt that as much information as possible about the soil should appear in one place. Soil analyses may appear with the detailed soil description or in the latter part of the report or in both places. Only pertinent information should appear with the soil description. Both a generalized and detailed profile description should be used. The following format is suggested for writing descriptions of the soils:

(a) Location and extent, parent materials, topography, drainage, vegetation, great soil group.
(b) Generalized profile description.
(c) Detailed profile description (tabular form) (give depth or thickness of horizons in inches followed by centimeters in brackets).
(d) Range in characteristics.
(e) Associated soils (difference between related or similar types).
(f) Use - a statement, no matter how brief, is recommended, where soils have a very limited use.

9. Land Use

(a) Agriculture - history, present agriculture, soil problems, soil management, soil capability, soil ratings.
(b) Forestry)
(c) Wildlife)
(d) Recreation)

Treatment of these subjects depends on the information available. They can be treated in the same manner as the section on agriculture.

10. Engineering Applications

The development of this section will depend on the information available.

11. Discussion of Analytical Data

The subcommittee agreed that a discussion of the chemical and physical composition of the soils was desirable.

(a) Methods of Analysis - should be outlined in this section.
(b) Tables of Physical and Chemical Analyses - are presented in this section if they are not presented with the description of the soils.

12. Appendix

This section includes tables of data not used elsewhere in the report, e.g. acreages of soils.
References - can be placed here or as footnotes throughout the text.
Glossary.

13. Classification of Soils According to the American Comprehensive System of Classification

This section may or may not appear in the report depending on the preference of the author(s).

Other Topics Considered by the Subcommittee

The subcommittee recommends that the style of binding used in Nova Scotia Soil Survey Report No. 14 be considered for general use. The title on the spline should be readable when the report is lying face up.

The most economical size for reports is 6 x 9 or $8\frac{1}{2}$ x 11 inches. The smaller size is preferred. It is recommended that whichever size is used, there should be uniformity within each province.

The subcommittee recommends that a transition to the metric system be instituted when possible.

Appearance of report - The appearance of some reports could be improved by dressing up the cover, using color or some other means. The authors' names could be omitted and placed on the title page, giving more room on the cover. Colored photographs should be used where they are of good quality and contribute to the understanding of the text.

The subcommittee was favorable toward the publication of photomosaic maps for detailed soil surveys.

PUBLISHED SOIL MAPS ON A PHOTOMOSAIC BASE

by

J. G. Beaudoin

The presentation of soil information on photomosaic bases, rather than on line maps, is a subject which has been under discussion and consideration for many years. This interest has been unanimous in Canada although the strongest support has come from Manitoba and Ontario. This can probably be attributed to the fact that resurveys have already begun or are under serious consideration in these two provinces. Resurveys provide an opportunity to undertake detailed surveys where it is deemed necessary which, in turn, lend themselves admirably to photomosaic mapping.

The reasons why this system of presentation was not implemented earlier are probably different in the various provinces, however, some apply to all provinces.

(a) The value of presentation of soil information on photomosaic bases increases only if detailed surveys are undertaken instead of the reconnaissance and broad reconnaissance surveys which have dominated the survey pattern in the past. This is understandable since the provincial Soil Survey Units were reluctant to undertake detailed surveys while there were still large tracts of agricultural lands in Canada for which there was no soil information available. This pattern is now close to reversing itself and I am confident that, in the next few years, more and more detailed surveys will be undertaken.

(b) The presentation of soil information on photomosaic background introduces problems of both economic and technical nature which necessitate a research program of production methods before the scheme can be fully evaluated and adopted. Until now very little experimentation has been carried out in Canada on this subject.

The initial aim of the Soil Survey organization is to make an inventory of the various soils and portray their distribution in their relative position to other existing features. To arrive at this purpose it has been the habit in Canada to use an existing map on a scale more or less suitable to portray this information. Therefore, we now find that very little standardization as to size and scale has been adopted and soil maps are published, depending on need, on numerous scales and sizes varying from less than one mile to one inch to four miles to one inch and even smaller. These have been identified as reconnaissance and broad reconnaissance surveys. Detailed surveys have been relegated to special areas such as irrigation projects and individual farms and were not made available for distribution as a general rule.

Now that most agricultural areas have been surveyed and that resurveys based on new classification schemes are being considered it is imperative that detailed surveys be given serious consideration in areas that warrant it.

Before discussing the economic and technical aspects of this program let us consider the advantages and disadvantages which will be encountered once this system is implemented.

The greatest advantage to be gained from an aerial photomosaic background map is that the base on which the soil information is plotted is relatively recent and illustrates the present land use pattern. This feature is most important in this age of rapid urban and rural development.

The preparation of topographical maps for a country the size of Canada is a long tedious process and the periodical revision of each sheet is also a major undertaking. At the present time only 5,000 map sheets out of a potential total of 13,000 at the scale of 1:50,000 are available for the area south of the 60th parallel. It is very difficult to estimate when this area will be completely covered and a cyclical system of revision established.

In the past we have often published soil maps on bases that were over twenty years old and on which the only revision and updating had been what was obvious to the watchful eye of the soil surveyor such as new towns, highways, dams, major reclamation or irrigation projects.

On the other hand photomosaics are relatively simple and fast to prepare once the specifications are adopted and the method is approved. The fact that any photomosaic has no legal value in Canada should not be a deterrent factor in the case of soil surveys. I feel that an up to date uncontrolled mosaic of no legal value is of greater importance than a completely outdated base map. On the other hand I am sure that in the near future fully controlled mosaics will become quite common and will receive the same recognition as maps produced by photogrammetric plotters and at that time the necessary legislation will be passed to legalize their use. In the case of Soil Survey uncontrolled mosaics are adequate; what is needed is a base for the plotting of the soil lines in their relative position in respect to up to date physical and man made features. To the soil surveyor one of the greatest advantages of the mosaic is that he can establish his scale of publication according to the amount of detail he wishes to portray without consideration being given to the availability of base maps. In the matter of detailed soil survey the scale of 1:20,000 used in the United States seems to be acceptable to most soil surveyors. It would be impossible to consider the acceptance of this scale for soil survey in Canada without the use of mosaics because the only mapping produced in this country at a near scale is at 1:25,000 and covers only urban and suburban areas which are of little interest to the soil surveyor.

If I may touch on the financial aspect of the photography at this time we must admit that the cost of air photos compared to the overall cost of a detailed survey is a negligible item; as a matter of fact this accounts for only a few cents of each dollar invested in any soil survey project. Furthermore, the cost of publishing the results obtained is also only a minor factor when compared to the total cost.

The illustration of soil information on a photomosaic background may necessitate two sets of aerial photos. The first, to be used for interpretation and plotting, should be of large scale up to date photographs taken at medium to low level altitudes. Should these photos be taken with a desirable type of aircraft and camera according to rigid photomosaic specifications they would be very adequate for the final photomosaic publication. However, in most cases, the soil mapping will be made on existing photos which were taken for topographic mapping and therefore do not meet the necessary specifications for mosaics.

Topographical mapping does not require the rigid specifications demanded of photomosaics; variance in aircraft elevation, tilt and crab can all be compensated on the various photogrammetric plotters.

On the other hand, in the case of photography for mosaics, every photo must be taken at a constant altitude without tilt or crab of the aircraft, otherwise the function of preparing the mosaic becomes practically impossible.

During the past summer two attempts were made to prepare a mosaic of Waterloo County, Ontario, from existing photos and each one failed because the original photography had not been taken according to specifications written for this purpose. This is not a criticism of the photographs themselves which were ideally suited for interpretation or photogrammetric plotting but could not be fitted into a suitable mosaic. In trying to mosaic the photographs it was noted that the aircraft had varied by as much as 900 ft. of altitude and this of course made the fitting of the photographs into a mosaic an impossibility. As an experiment, it was decided at this time to reduce or enlarge, as required, all the photos to a common scale. This procedure did not solve our problem either. At this stage it had been agreed that the enlargement and reduction of some of the photos would match the largest number of photos of identical scale. The original photos had been printed on a controlled continuous tone log Etronic printer which had given us prints of common density. The enlarged and reduced prints which were processed on standard enlargers without the benefit of a new negative could not be tone controlled and would necessitate hand retouching which would become a formidable task.

Retouching would also have been necessary to adjust the joins of the photos which were slightly out of line as a result of the tilt and crab of the aircraft. This retouching is a tedious task which requires the technician to make adjustments wherever necessary on each join of the photos using as many as twelve shades of the gray scale ranging from white to black before the mosaic is rephotographed with a half tone screen for final reproduction. Another meeting was held at this stage and it was agreed that it would be cheaper to rephotograph the area than to make another attempt at preparing the mosaic which could very well have developed into another futile effort.

This is where the second series of photographs justifies itself. At the beginning it had been agreed that the publication of the mosaics would be at the scale of 1:20,000. In order to eliminate some of the technical problems encountered in the preparation of the mosaic it was decided to request high altitude photography which would eventually be enlarged to the required size. This photography would be taken from a very stable aircraft flown at an altitude of 30,000 ft. This had been agreed upon in principle, but after checking with the Air Transport Control we discovered that to fly at that altitude permission had to be obtained 14 days in advance because of the danger of interfering with commercial air lanes. Since it is impossible to forecast good photographing weather this far in advance this plan was abandoned. This is also probably one of the reasons why high level photography is 2 to 3 years behind schedule in Canada. However, photography could be made from an altitude of 20,000 feet without major difficulties and while realizing that this alternative was not as suitable as the higher altitude it was agreed to proceed with the plan. Requests were placed for photography with the Interdepartmental Committee on Air Surveys to be flown during 1966 and using new specifications which they approved. There are four separate areas to be photographed; Waterloo and Brant counties in Ontario and the Winkler-Morden and Portage la Prairie areas in Manitoba.

I would like to point out, at this time, that although our request for aerial photos was restricted to the areas mentioned, the Interdepartmental Committee on Air Surveys would automatically enlarge the areas requested to cover the balance of any 1:50,000 National Topographic map sheets which might be partly covered by our request.

The requested scale of photography will eliminate most of the problems of preparing an aerial photo background for our maps if the contractor adheres to the new rigid specifications approved for these projects. The preparation of each sheet which is based on 6' of longitude by 3' of latitude in the east and 3 sections by 3 sections in the west will only necessitate an enlargement of a single photo or the fitting of a few into the desired mosaic.

This layout was agreed upon in order that all publications would be of a standard size of 9" x 11" with each mosaic having only one tip in.

It is not anticipated that a great amount of detail will be lost in the final reproduction by using high altitude photos since the interpretation and plotting of soil lines will be made on low to medium level photographs and transferred at a later stage to the high level photography.

The scale distortion will be identical to that of a map since the scale of a photo is fixed by the ratio of the focal length of the camera lens to the height above the ground. The effect of height will be that each imaginary contour will be on a different scale. Consequently no form of photographic representation can be at a definite and uniform scale unless the ground is quite flat. We can therefore accept that in Canada the areas of a worthwhile size where a uniform scale can be achieved on an aerial photo are limited. Of course, the same is true of a line map, but here an advantage can be obtained by the overprinting of contour lines which give the illusion of slope. In aerial photography, this can only be obtained by stereoscopic pairs and therefore impossible to obtain in the case of mosaics. However, this physical limitation of our visual acuity is partly overcome by the use of a stereoscope in the field by the soil surveyor.

The economic involvement of a photomosaic program is a very intricate one and at this time it is almost impossible to draw any conclusions except that it will mean a more extensive financial expenditure. It is also felt that this will remain this way until at least the third or fourth report is published on this basis. The first is expected to be essentially experimental, in the second we will endeavour to eliminate the errors and resolve the problems which we will encounter in the first. However, we anticipate the third and following to be well coordinated productions.

We are well aware that the production of a mosaic background soil survey report will be more expensive than our present type of report and for the following reasons:

1. We feel that it is desirable to produce and incorporate in the report a fully colored and contoured soil association map which will give the reader an overall picture of the soil pattern. This map will be only slightly cheaper to produce than the present soil map which accompanies each soil survey report.

2. For each map sheet presently produced at a scale of one mile to one inch approximately 30 to 40 sheets with photomosaic background at a scale of 1:20,000 will be required to supplement the soil association map. This will necessarily involve a longer production time; it will require considerably more typesetting because of the surround of a greater number of sheets and the necessity of duplicating names of features which may be common to several sheets.

3. The system will necessitate a more comprehensive system of adjusting the data along the four edges of each mosaic sheet and in turn require a more thorough and intricate method of editing.

4. It will be necessary that political boundaries, roads and railroads, drainage and shorelines, cities, towns, villages and buildings be identified before they can be scribed and labelled on each mosaic. This will necessitate various degrees of air photo interpretation on the part of the cartographer. This interpretation could well develop into one of the most time consuming aspects of the production of a mosaic.

5. For each mosaic sheet published it will be necessary to prepare a negative of the background information, a scribecoat of the planimetry, a name overlay and a scribecoat of the soil boundaries and symbols.

6. We will have to transfer and adjust the soil lines from the field photographs to the mosaics by means of a projector because in practically all cases these will be at different scales.

7. To identify and locate each mosaic sheet it will also be necessary to produce a key map indicating the area covered and having sufficient background information in order that any location within one sheet can be easily established.

8. In the reproduction stages negatives for the halftone, the black and the red plate will be prepared, watercote proofs will be required for the editing aspect, and lithographic plates will be required for the printing of each sheet. Press time will be increased; trimming, collating and folding will have to be provided.

In consideration of the above statement it is obvious that it would be presumptuous on our part to try and estimate the cost of such an endeavour before we face the problems which will develop and make some attempt at evaluating them.

From these comments it can be assumed that while detailed soil survey projects published with an aerial photo background are desirable it would be preferable if these were published on enlargements of high altitude photos rather than on mosaics of low altitude photos which are difficult and expensive to produce. To achieve this aim it is essential that more extensive planning be made at the provincial meetings in order that arrangements can be made for the photography well in advance of the completion of the field work.

In these days of high costs, efforts should be made to take advantage of all information at our disposal and one way to reduce these high costs would be to base the area of each soil survey project on N.T.S. map sheets rather than on a county basis as has been the pattern in Eastern Canada in the past. As previously stated the I.C.A.S. in allocating contracts to commercial firms for aerial photography base their requests on N.T.S. map sheets and if we were to make full use of the photos taken under one contract it would eliminate the duplication of future photography. Our experience has proven that it is impossible to match photos taken under different conditions.

And now that I have climbed out on the proverbial limb I feel that I can crawl out a little further to test if it will support more of my views.

To my mind, serious consideration should be given to using the N.T.S. map sheet system for all resurveyed areas whether on line maps or mosaics. The system has already been successfully introduced in Saskatchewan and Alberta to the delight of the Department of Mines and Technical Surveys which print our maps, and I can assure you also that of your Cartographic Office which appreciates any effort at standardization. I am hoping that this system is given serious thought in Manitoba where a resurvey is in progress for the South West Sheet which is part of the N.T.S. map sheet 62F. which overlaps into Saskatchewan. Under this scheme the map would now be known as either the Manitoba portion of sheet 62F Virden or a cooperative project could be effected to cover the full area of the map sheet. Where a provincial boundary bisects a map sheet I realize that problems would occur in the publication of the report and map. However, I doubt that these cannot be overcome with the necessary correlation and collaboration of both parties.

The system does present problems; nevertheless it should not be abandoned before being given serious consideration. Of course, the greatest advantage is that the implementation would hasten the release of the soil survey information to the users soon after the completion of each project and this should be our aim. It would eliminate the long delays which have occurred in the past where immense areas were surveyed as part of a single soil survey project. These took years of field, laboratory and office work which had to be continuously revised in the light of new classification systems and were reluctantly published 5 or 10 years after the project was originated.

In these days of rapid developments it is essential that the information gathered by the soil surveyors be made available as soon as possible to other Government Departments, Universities and the vast number of users which request the information.

Another argument in favor of this system is that very soon resurveys will occur in all provinces and if based on N.T.S. map sheet names and numbers the danger of confusion between a soil survey report "old series" and "new series" would be eliminated.

From a Cartographic point of view it would simplify and speed up publication since most base maps could be obtained from the Department of Mines and Technical Surveys and converted by overlays and with a minimum of adjustments and revisions into a soil map.

CANADA LAND INVENTORY

Opening Remarks
by
L. E. Pratt

Two and one-half years ago, at the last meeting of the National Soil Survey Committee, members of the ARDA administration asked for and received the cooperation of this committee in developing and implementing a national system of classification of soil capability for agriculture. This interpretative classification of lands for agricultural capability was required as a part of a nation-wide inventory of land capability for major alternative uses - subsequently called the Canada Land Inventory.

At this time I wish to express the admiration of myself and other members of the ARDA administration toward the effective manner in which the member organizations of this committee have responded to this challenge.

Since the last N.S.S.C. meeting we have been fortunate in receiving equally fine cooperation from other federal and provincial government agencies responsible for research and administration in the other major uses of land - forestry, wildlife and recreation. As a result of this cooperation we are now at various stages in the development, trial use and implementation of land capability classification systems in these other fields.

We appreciate this opportunity to discuss with you our progress in the development of these other classification systems and particularly, our growing awareness of the need for interdisciplinary cooperation if this very ambitious undertaking is to be successful.

Before calling on the Coordinators of the forestry, wildlife and recreation sectors of the Land Inventory to address you on their activities, I would like to take a few minutes to emphasize the importance of this undertaking. I will not do this by expressing my own opinion as that may be suspect to a certain degree of partiality. Rather I will quote from two recent speeches by a provincial Cabinet Minister and a federal Deputy Minister.

Addressing a dinner meeting at the provincial agriculture ministers' conference held in Winnipeg last summer, the Honourable Sterling Lyon, Minister of Mines and Natural Resources for Manitoba, is reported to have said that the Canada Land Inventory is one of the great national objectives which Canada can strive for. He said, "In my mind, if it is developed properly, it ranks in importance with the building of the C.P.R. or the St. Lawrence Seaway as a great national undertaking whose results will benefit generations to come".

In a similar vein, Dr. L. Z. Rousseau, Deputy Minister of Forestry for Canada, addressing a meeting of the Northern Alberta Development Council, said "That the Canada Land Inventory should, henceforth, be regarded as an indispensable instrument for the establishment, improvement and development of sound forest management practices in this country, is beyond doubt in my mind. Its potentialities, though different, are as important for forestry as they are for agriculture; but in either case, they hold the key to a rational husbandry of the two resources."

At recent meetings across the country, Mr. Davidson, Assistant Deputy Minister of Rural Development, has stressed that the two major tasks of Canada in the rural development sphere are those of working toward optimum land use and optimum opportunities for the employment of our labor resources. He regards the Canada Land Inventory as the major source of information upon which to base recommendations to the federal and provincial governments of Canada for future programs in these fields.

As for myself I have been fortunate to be in a position to fully appreciate the potential usefulness of this program. With the type of political and administrative publicity I have referred to we have to be constantly on guard to see that credit, and consequently financial support, is given to the proper agencies that have made this Inventory possible. I hope you will agree that so far we have been successful in this regard.

I have not read the presentations that you will hear this morning, because I feel strongly that the most appropriate cooperative arrangements between yourselves and the scientists of the other disciplines represented here must grow out of a mutual understanding of the needs and possibilities. I hope I can contribute toward providing opportunities for this growth in understanding and toward expediting administrative arrangements so that the people of Canada will benefit from the resulting cooperation between all the various groups of scientists that are interested in improving land use.

I hope that the presentations this morning and the discussions that result will further this aim. Many of you will be attending the forthcoming meetings in Vancouver and Wolfville where we hope to obtain agreement on the classification systems in wildlife and recreation. We have asked the senior federal and provincial soil surveyors to attend these regional meetings because we believe you can contribute substantially to the development of these classification systems, and the exchange of views will help toward developing cooperative arrangements for the field work in each province.

Beyond this series of technical meetings and our continual administrative discussions with the provinces and other federal departments we can do very little toward fostering the day to day cooperation that is essential to the success of this Inventory. It is up to you and the foresters, wildlife biologists and recreationists in your provinces to determine mutually satisfactory work relationships. I think the effort is worth it. I hope you agree.

THE FOREST LAND CAPABILITY PROGRAM

by

R. J. McCormack

In the brief time at my disposal I would like to deal with three aspects of the forest land capability program which, I believe, will be of interest to this group. These will be: a very brief progress report, a comparison of the forestry and agriculture capability systems and an explanation of the National Committee on Forest Land which has recently been announced.

As most of you know the classification system of land capability for forestry was adopted at a national meeting in January of this year. We do not, as yet, have a complete progress report for this year but expect to complete 50,000 to 75,000 square miles. From west to east the areas in which the program is being carried out are as follows:

British Columbia - Prince George-Quesnel
Alberta - Grand Prairie
Saskatchewan - Prince Albert North
Manitoba - Interlake and Sandilands
Ontario - Eastern, Central and Northern Ontario
Quebec - Gaspé, Lower St. Lawrence, Quebec-Saguenay R., Western Quebec
New Brunswick - Sussex-Chipman
Nova Scotia - Pictou, Colchester, Antigonish Guysborough Counties
Prince Edward Island - To be completed next year
Newfoundland - Gambo-Gander

Since most, if not all of you, are familiar with the forest land classification, there would seem to be little point in dwelling on it. However, a comparison of the essential differences with that of agriculture would, I think, be useful as it would, to some extent at least, indicate the differences in approach to classification for the two purposes.

The fundamental differences may be discussed under 3 categories. These are:

1. We are concerned only with the effect of the physical and chemical properties of the soil on the growth of commercial tree species.

Thus we are not concerned with slope or topography which, of course, is one of the main criteria of classification for agriculture. Similarly only in extreme, if at all, are we likely to recognize stoniness. Erosion was considered to be primarily a management condition and not an inherent soil property.

On the other hand, since a tree crop is exposed to all the possible variations of climate for a minimum of 40 and usually close to 100 years, we have had to pay more attention to the climatic factor. We have decided that limiting factors are necessary to express extremes of heat and cold, aridity or drought, and exposures to winds, ice storms, salt spray or a combination. We also use C where a combination of climatic factors are limiting. There are a few other minor differences but they are mostly for mapping convenience. It is worth mentioning that, where we use the same limiting factor symbol as you do we have tried to use it in the same sense.

2. Productivity:

It was decided from the beginning that a productivity rating along with a rating of the physical and chemical properties of the soil would be desirable for a variety of reasons. These are:

a) The system would have greater economic application.
b) It would be more objective.
c) It would be more useful for forest managers.
d) It would allow the participation of persons whose background was primarily forestry.
e) It would make use of a vast amount of forest inventory information.
f) It would permit of a comparison between the productivity as expressed by capability and average production which is available from inventory statistics. This, of course, is a major departure from the agricultural approach. A number of measures of productivity are possible but after considerable discussion we have adopted gross mean annual increment in cubic feet per acre per year to rotation age, exclusive of thinnings, bark and branch wood. It would be somewhat comparable if you were to use the volume production of the stem of wheat, not the seed, as a measure of your capability rating. In the light of our short experience I feel the inclusion of a productivity rating has been a wise move. While we realize that you must subdivide land initially on a physical basis, nevertheless the productivity rating has kept the classifiers honest and has resulted in a much more objective approach. Because of the ability of species over long periods of time to adapt themselves to peculiar soil conditions we must insist that the productivity rating will be for the best species or group of species adapted to the site and these are stated, where possible, in the symbol.

3. Moisture:

The third difference, and in my opinion one of the major difficulties that foresters encounter in interpreting soils maps, is the importance of soil moisture to tree growth. Those of you who have been on field trips with some of us this past summer will agree, I think, that our preoccupation with soil moisture is justified. In the beginning we have found a need to consider the quality as well as quantity of available moisture. Thus telluric or moving soil moisture is almost always beneficial. Furthermore except in very high rainfall areas, which in Canada only occur in the Coast region of British Columbia, our best sites seem to be occurring on somewhat imperfectly drained areas rather than the well drained as traditionally assumed. The point which can tentatively be made, at this time, is that we will probably need more moisture or drainage classes than have heretofore been provided. I do not believe it is clear yet how many classes may be required nationally, but there is no question that your maps will be much more valuable to us if greater attention is given to moisture and drainage separations.

Finally I would like to outline briefly the purpose in the formation of the National Committee on Forest Land which was recently announced by Mr. Sauvé and, by so doing, perhaps dispel some of the doubts and blunt some of the criticism of your group.

The aims of the committee are to advise the Deputy Minister, Canada Department of Forestry, on the technical aspects of the forest land capability program of the Canada Land Inventory of ARDA, recommending such revisions as from time to time appear necessary. It will also advise on the development of a national system of forest land and soils inventory, and on the research that seems necessary to support an inventory of the forest land resource.

The terms of reference are:

1. To examine, review and offer recommendations on systems of land classification developed for use at national or regional levels, with particular attention to the correlation of inter-provincial programs.

2. To investigate and make recommendations on a system of forest land inventory which would serve as a basis for sound forest management and rational use of wildlands.

3. To review research pertaining to the management of forest land and soil, recommending investigations on problems pertaining to classification and interpretation for use.

4. To serve as a review board and clearing house for recommendations and proposals on forest land classification and research which are submitted to the committee by other national or regional organizations.

5. To promote teaching of land-and-soil inventory techniques in forestry schools and universities.

6. To express a Canadian viewpoint on forest land survey and classification methods, utilizing the joint experience of participants in those evolving fields of work.

Membership will consist of one representative from each province, from each faculty of forestry of Canadian universities, and each regional office of Canada Department of Forestry. There will be representation from the National Soil Survey Committee, Canadian Wildlife Service, National Parks Service and the Canada Land Inventory of ARDA.

This is the formal organizational detail but my purpose today is to give you some of the background behind the formation. In the first place we have no national approach to forest land classification in Canada; in fact there are almost as many systems as we have classifiers. Thus it is not possible for anyone to speak with any degree of unanimity; it is only possible to express a personal opinion. One of the primary purposes of this committee is to stimulate a national approach or, put in another way, to find out what system we wish to adopt.

Secondly I do not believe many of the provinces have decided whether all or even any of their forest land should be classified. There is no doubt that a decision in this regard is necessary before any meaningful discussion can take place on methods.

Thirdly, there must be a large increase in the number of trained forest land classifiers before any sizeable program can be undertaken. The logical source of these trained men is from the forestry faculties of our universities but to do this there will have to be a considerable effort on the part of the universities to provide the necessary educational training.

The committee is intended to stimulate decisions in all of these matters. I am aware that you are concerned as to your responsibility in the event a forest land classification program is undertaken. I can assure you that we will be anxious to enlist your help in such a program and to cooperate fully. However, it should be obvious to you that we have to get our own house in order before any effective cooperation can be achieved. All that is required now is that we maintain a certain flexibility in our approach and there will be no difficulty, even if the system we adopt may be somewhat different from that to which you are accustomed. The committee has been formed primarily to achieve a national approach and make meaningful cooperation possible.

SOILS AND WILDLIFE

by

W. Arthur Benson

The Wildlife Land Capability Classification is really two classifications (one for ungulates and one for waterfowl) which will both appear on the same map. Both classifications use productivity as their yardstick and this is related to environmental factors of several kinds. I personally would prefer to lean more heavily on soils than the present classifications superficially appear to do. An attempt has been made to be general enough so that anyone with good soils knowledge could apply that knowledge and so that people without a large soils background will not be too appalled.

It is a fact that wildlife biologists generally have a poor knowledge of soil science. Many have none. Some have taken several courses in plant ecology, agronomy, forestry or agriculture but almost always these courses have related to soils in a general way or as part of a micro-environment for some specific plant. On the other hand many wildlifers can describe broad forest belts, biotic areas, plant communities and ecological zones with a fairly high degree of competence. It is difficult to get them used to the idea that these delineations are directly related to soils and are most easily described with reference to soils.

I do not wish to give the impression that I am an exception. I am sure that my ignorance, about soils, will become apparent as we progress further in these meetings. I have been lucky in that I have at several times, in several places, worked on problems which concerned plant reactions to particular soil factors. Unfortunately, until recently, I had never really bothered much about soil classification itself and what it could mean to me. Other wildlife biologists across the country are in varying stages of realizing the same thing.

Believe it or not it is possible to write treatises on soil moisture as it affects the oak-hickory and linden-maple associations; capillary water and its effect on corn growth; plasticity of the subsoil as it affects occurrence of red-osier dogwood, etc., without knowing anything about soil classification. I have done some of these things but I am appalled now by how much work I put in on it that was not required. The information was already available if I had only spent the time to learn to use it.

In what way are soils data important to wildlife? Ours is a dawning respect for soils data and at the moment the full realization of their importance escapes us. At best I can give you some examples. Research is needed for full realization but with luck soil scientists will volunteer information on some plant - soil reactions which will be of tremendous help.

These examples will not confine themselves to the Canada Land Inventory but are mostly directly applicable. There are first of all some rather obvious situations. You cannot have groundhogs or gophers where there is no soil for burrows. You cannot have any wildlife on vast expanses of sheer rock. You cannot produce waterfowl on a lake with a salt crust.

Dr. J. Tener of the Canadian Wildlife Service has finished a monograph on the muskox and it will be printed this year. In his work he compares the supply of nitrogen on soils of a muskox winter range with that found in the Milk River brown soils studied by Wyatt, Newton, Bowser and Odynsky (1941). He finds that the comparisons are close. He also compares the base exchange properties, potassium levels, and other factors and comes to the conclusion that muskoxen range in the Arctic compares favorably with the best cattle range of Alberta for the properties studied. The actual plant species involved are quite different as are their adaptations. The major reason for the difference is that the annual thaw of the surface layer in the Arctic (over permafrost) varies with the texture of the soil and its water content. Under the Arctic conditions only those plant species whose below soil surface parts are adaptable to soil movement or deposition can successfully colonize and persist.

In forested regions, soil moisture directly or indirectly, is the most critical factor in germination, early survival and growth of useful wildlife shrub and tree species and/or in the competition they receive in the early stages from tree species.

Seed germination and early survival in forested areas involve mainly the surface soil, hence surface conditions and colonizing vegetation are extremely important. Later penetration to the lower soil layers and their relative fertility is important.

Again in forested soils of the west, wildlifers are particularly interested in texture and other factors as they relate to erosion. In fisheries and in game we have come to expect logging methods (i.e., the roads and dragging systems) to cause more gullying and runoff, more destruction of soil and contamination of water, than any other factor or land-use. It is helpful to be able to predict how bad it is going to be because of the effect on game and fish production.

Flowering dogwood and red-osier dogwood (Cornus sp.) densities are related to texture and depth of the surface soil and the plasticity of the subsoil. Fine textured soils are better than medium or coarse soils. With wolf willow (Eleagnus sp.) and with buffalo berry (Sheperdia sp.) the situation is reversed. All species are important wildlife shrubs and the dogwoods are the ice cream cones of the wild hoofed mammals.

The understory vegetation is greatly affected by fertility and for most species of vegetation useful to big game the shade tolerance increases with increasing fertility.

Topography is important to big game mainly when it affects light penetration to the understory or because a slope faces south. On the other hand, topographic phase is extremely important to waterfowl in that it so greatly affects presence of water.

Wild rice requires a peculiar combination of circumstances. It withstands only a slight amount of alkalinity. It prefers neutral waters which are fairly clear and requires a high carbonate availability to its rooting system. Obviously soils information gives the best key to its distribution.

Depth to bedrock or some other impervious layer is often important in judging marsh values. Some rock-bound marshes go through a cycle of plant establishment, optimum growth on deposited soil, wind displacement, floating masses of vegetation which die, decomposition, recolonization and establishment and so on again. In the long run the plants and stable soil win out but the time is too great for normal management plans.

Turbidity is an important factor to the growth of submerged aquatics because of the light reduction it causes. Therefore, if surrounding soils are prone to erosion it is often important to know the amount of colloidal clay present in those soils. Similarly particle size is important in determining how long turbidity will remain after rapid runoff periods.

In the western short and mid-grass prairie, the wildlife species depend greatly on a few species of plants whose presence, absence or abundance are entirely dependent on factors which are soil factors or which are reflected by soils. As an example, the Stipa-Bouteloua or Bouteloua-Stipa communities are directly related to soil moisture as is the Agropyron community. In this same western region the presence of Symphoricarpus is often an important factor to the presence and abundance of deer, porcupine, hare, sharptailed grouse and nesting ducks. Symphoricarpus is only found where soil moisture is high. Where soil moisture penetrates to a considerable depth, a shrub community of particular importance to game animals occurs. Plants in this community are the previously mentioned Symphoricarpus occidentalis plus Artemisia cana, Rosa Macounie, Salix interior and numerous forbs. The interspersion of these variations of soil moisture determine the interspersion of cover and hence the wildlife species present and to a very large degree, their abundance. For a particular area this information can often come from examining the topographic phase but it is most difficult for the wildlifer to determine the degree to which soil moisture is affected by topographic phase for a particular soil type within a particular soil series. For this the wildlife biologist needs the help of a pedologist.

The examples I gave earlier where closely related work was done without reference to soil scientists have their parallel in other fields I am sure. Certainly we in the other fields are at fault, but perhaps the soil scientist has been partially at fault because he has often failed to provide other fields with simple keys to his work and because in many cases he was not really available to anyone outside agriculture. This latter situation continues but to a lesser degree than in the past. The change has largely occurred because of ARDA and because of individual and very personal ad hoc relationships between a particular soil scientist and a particular scientist from another field.

In the past, the close association of soil scientists with agriculture was natural and efficient. It suited the times and the economic goals of the country. At present, many of us from other fields feel that the time has come for soil scientists to become more and more soil scientists instead of agricultural soil scientists. The demands from other fields are ever increasing and while we do not expect that needs from the wildlife field will ever be a large part of soil activities in Canada, this will be offset by the much greater needs of forestry and engineering and of the many groups like wildlife which, together, will involve a large volume of work. I am not saying that soil taxonomy is agriculturally biased, only that the services and availabilities of soil scientists are biased in this way. Because of this, we in the minor fields are in fear that the too few pedologists that Canada now has will be split to forestry and agriculture and thus become even more unavailable to us in the future.

RECREATION CAPABILITY AND SOILS

by

C. S. Brown

1. Introduction - The Growing Importance of Recreation as a Use of Land

"Nine-tenths of the American population participated more than four billion times in one or another of seventeen forms of outdoor recreation in the summer of 1962. Very likely the participation will be three times greater than that before the year 2000 when three-quarters of all Americans will be living in cities and may have more leisure and more money for recreation".

So started a section of the United States Year Book of Agriculture for 1963, which you will recall is devoted to "A Place to Live".

We in Canada may well take note, for the same trends are in evidence here. A few short decades ago in the United States and only years ago in Canada there appeared to be ample unspoiled public land available and well suited to meet all likely future needs for outdoor recreation. But rapid increases in urbanization, in leisure time, in mobility, in prosperity and in overall population have enabled unprecedented masses of people to enjoy outdoor recreation more and more frequently. And they are taking full advantage of nearly every opportunity as quickly as it is offered, with obvious preference for the non-urban forms. The resultant need for more land is making demand predictions of even ten years ago look naive.

The actual land supply problem is now gaining attention in Canada. At the federal level, the Canada Land Inventory program is financing the mapping of lands according to their natural capability for recreation. Federal ARDA funds are supplementing provincial funds in accelerating recreation land acquisition programs in several provinces.

Development of recreation land resources and the construction of user facilities have also mushroomed in Canada during the past ten years, with major capital inputs at all levels of government and from the private sector. Land is being firmly committed to recreation uses, but frequently without proper consideration given to all factors influencing its suitability.

My purpose in describing these well-known trends is to impress upon soil scientists, as Canada's real land scientists, the growing significance of recreation as a use of land and the need for much closer attention to soil-recreation relationships.

I will first tell you something of the objectives of the recreation sector of the Canada Land Inventory, the techniques being used and the progress to date. I will introduce for discussion the subject of soil relationships in the inventory, and conclude with some observations about soils in recreation resource use planning.

2. Recreation

Various systems have been devised and put to use to select and classify recreation areas and sites for particular recreation uses, but there had been no attempt before last year to parallel agricultural capability rating systems in the recreation capability field.

A tentative classification system was developed last winter by a committee of federal and provincial parks people working with ARDA representatives. The approach devised represented an attempt to meet in one classification system the needs of federal ARDA and of provincial land administrators as well as possible. Thus, the system was designed to do more than rate land capabilities for broad planning purposes as ARDA initially intended. Furthermore, it would provide a framework for the gathering of detailed data about the physical character of high capability areas--data which could be most useful to provincial or local agencies at the programming and operational decision-making levels.

The system developed reflects such influences as time and cost limitations, the scarcity of professionally competent people, the site, rather than area orientation of most outdoor recreation, and the extremely wide variety in the character of recreation resources. The variety factor challenges the validity of a classification system which would encompass all resources, and necessitates the definition of a common basis of evaluation.

In consideration of ARDA's interests in rural economic development, the factor selected was the measure of intensity or quantity of use which the land (or the attraction) would engender and sustain given good management and ignoring access and location criteria. This measure might be expressed in numbers of persons per unit area at peak load, or in maximum number of use units such as visitor-days per year. Present knowledge of recreation habits and preferences of people, applied to the known wearing quality of site types, was considered sufficient to enable meaningful guidelines to be defined to make this a measurable and useful criterion.

The number and variety of recreation activities to which a unit of land is suited was recognized as a second important factor.

Types of recreation activity were grouped according to their resource requirements. The desirability of conformity with the structure of the forestry and agriculture classification systems was considered.

The intensive use capability of beaches, and the high and increasing popularity of shore-based activities place shorelands generally in a high rating relative to uplands. Within the shoreland group, bathing beaches rate high, with typical summer cottage sites following. Outstanding phenomena suited to special uses also warrant a high rating. Shorelands lacking capability for swimming or boating drop to the level of uplands suited only to extensive types of use. In these, the variety of activities possible and the quality of the landscape in terms of scenery, topography, surface water, natural history phenomena and other attractions determine the rating.

The system is evolving as follows: Good beaches associated with useful backshore, and outstanding special use phenomenon will rate classes 1 and 2, depending on quality and size criteria. Typical cottage frontage will rate Class 3, while poorer shorelands as well as good and fair quality uplands suited to extensive types of activity will rate classes 4 and 5. Class 6 lands have very limited capability for only extensive uses, and Class 7 lands have almost none in the popular sense.

The system provides also for an indication in the mapping symbols of types of attractions and limitations to use.

The recreation capability maps will thus identify all significant attractions in most categories; will give a reliable indication of shorelands with public beach potential, and with private, commercial or group use potential; and will indicate areas of superior scenery in the popular sense, and the location and type of most special use features. Upon complexing, patterns of high capability areas will emerge to assist in the definition of recreation regions, to serve tourist promotion, watershed management and highway programming purposes.

Even at the 1:50,000 scale of mapping, the inventory is too generalized to be of assistance in park or recreation area planning at the design stage.

At the national level, the inventory will give a reliable indication of the natural capability for recreation use of all land covered and of the national distribution of recreational resources. It will allow comparison of capability for recreation with capability for other uses and with present use.

In spite of various problems and of continued evolution of the system through the trial year, progress has been relatively good, and over 400 1:50,000 map sheets or 8% of the present inventory area in eight provinces will have been completed by the end of the fiscal year.

Problems encountered this year will be ironed out at federal-provincial meetings this fall and winter, and changes agreed upon in the classification system will then be incorporated into this year's maps. The program should proceed next spring in most provinces at a rate designed to complete the inventory area now defined not later than 1969.

3. The Soil Scientist in Recreation Land Inventory

The soil scientist may question the usefulness of soil survey data in the mapping of capability for recreation in such a system as this. True, recreation capability is not closely related to soils, and rarely is soil the critical factor. The exception is the presence of sand at water's edge. An excellent natural beach can often be predicted accurately from a soil map.

In various other instances soil factors exert a more or less strong influence on recreation capability. Limiting examples include: severe boulder conditions in the surface soil, stony till on shore lands, impermeable hard pan layers or other natural drainage restrictions, shallow soil over bed rock, surface erosion hazards and susceptibility to flooding, the likelihood of the presence of potable subsurface water is often known to the soils man, and the recreation quality of streams and small lakes can be predicted from surrounding soils.

Much more valuable than the information the recreation man can interpret from the soils type map is the familiarity of the soil scientist with much of the landscape the former is mapping. Traditionally, soils people have taken note of all natural and cultural aspects of the landscape, and this familiarity can save the recreation capability assessor many miles of travel and hours of enquiry and interpretation. Every soil scientist is something of a geomorphologist, and there is a close relationship between land form and recreation capability. There is strong advocacy for the recreation capability survey to map land forms as the first stage of capability mapping in areas where such mapping has not been done.

Needless to say, the soil type map which shows contours is much more useful than that which does not.

One of the first objectives of the recreation mapping crew is to block out areas of low potential. They are inclined to do this by scanning small scale air photos if these are available. They then use large scale photos for study of positive areas, and check all uncertain features and unit boundaries in the field. In many instances, this preliminary step could be expedited considerably by consultation with a soils man familiar with the area, or by access to soil survey photo mosaics.

Three federal regional coordinator positions have now been established in the recreation sector, and recruitment is now under way. One of the responsibilities of the incumbents of these positions will be to establish liaison with soils people in each province in their region, and to encourage the recreation inventory staffs to take full advantage of any services or assistance available from those sources.

4. The Soil Scientist in Recreation Resource Development

The opportunities for application of soil science in recreation resource use planning outside the Canada Land Inventory are much greater than within it. The detailed zoning, for various intensive and extensive uses, of land allocated to recreation, can be much more intelligently done after soil survey. The detailed locating of structures and facilities for core area development must take soils into account. Reliable advance planning of the recreational use of new reservoirs is impossible without thorough study of the soils above, within and below the range of anticipated reservoir operating levels.

The basic physical properties of soils which influence park planning are the same as those which determine agricultural practices. Only the groupings and interpretations are different. Stoniness, shallow soils, hardpan, shrink-swell properties, permeability, all affect the locating of roads, buildings, camp grounds, playgrounds and parking lots. Soil texture, soil reaction and organic content, along with slope, permeability and surface drainage are important criteria in the planning of improved landscapes for play fields, picnic grounds and golf courses. Sources of construction materials--clays, sands and gravels--are significant. Susceptibility to slumping or to wave or runoff erosion on shorelands is of extreme importance in planning waterfront development.

In the Canadian prairies and in the Missouri basin in their United States counterpart, where there is a severe shortage of surface water for recreation, major reservoirs of this and the last decade brighten the prospects of the population of the entire region for close-to-home water-oriented recreation. Overenthusiasm in this respect, failure to either wait and see the effect of raised water tables and wave action, or to consult competent soil scientists, resulted in frequent disappointment and the loss of significant capital investments. On a Missouri system reservoir I was shown the abandoned remains of a public park development with tree plantations, public rest rooms, picnic, camp and play grounds, and an elaborate concrete boat launching ramp, developed on a site which the engineers expected to offer the best natural beach conditions on the reservoir. Five years after the reservoir filled, a twelve-foot wave cut bank had retreated through one-third the depth of the park. The original sand deposit had been transported by wave and current action to form a good beach a half mile away, the boat ramp was in scattered fragments, the toilet building was toppling on the lip of the bank.

In another instance, the occupants of a carefully planned and attractively developed summer cottage subdivision were putting large capital investments into rip-rapping and other devices to protect from wave action the frontage rapidly encroaching on their properties. In still another instance, surface cracks were appearing up to eight hundred feet inland from the water's edge as unstable subsurface materials responded to saturation. In the Qu'Appelle valley in the Regina area a choice park site on an old stream delta, bought and developed for public park purposes at high expense, was disappearing rapidly into the lake from wave erosion as a result of a two-foot lifting of lake level.

Proper consideration of soils information or consultation with soil scientists could have avoided all of these losses and disappointments. In contrast, a camp ground near Halifax developed privately on farmland demonstrated the value of soil knowledge. Arriving there late one summer evening with a travel trailer, with heavy rains forecast and no internal roadways surfaced, we were reluctant to risk camping overnight on ground allocated. The owner reassured us, insisting he had considered soils carefully in selecting a camp ground within his one thousand acre holding and that the soils in the camping area would stand any amount of summer rain without softening or surface puddling. The night's rain and morning observations proved him to be right.

The present unprecedented rate of recreation area development across Canada offers soil scientists an excellent opportunity to make an extremely useful contribution. The adaptation of soils data to park planning needs is scarcely under way. Park agencies are now depending on engineers and foresters for park design and none that I know of in Canada employs a soil scientist. But as soil scientists offer their services to agriculture, and to forestry though they are not foresters, they might well, to mutual advantage, offer them also to park agencies. Their contribution can be significant. Their failure to do so could result in the growth of another group--associating itself with park planners and park engineers--with loss of much of the advantage of the long experience and tradition of soil science, and much time in the process--but of necessity stepping into the soils-recreation research vacuum which now exists.

For those who would like to explore further, a brief bibliography is appended.

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CLASSIFICATION OF CALCAREOUS GRADES, TEXTURAL GROUPINGS AND REACTION CLASSES

The N.S.S.C. accepted for immediate use in soil survey the following nomenclature and limits.

1. Calcareous grades

(a) Weakly calcareous	2-5%	$CaCO_3$ equivalent
(b) Moderately calcareous	6-15%	" "
(c) Strongly calcareous	16-25%	" "
(d) Very strongly calcareous	26-40%	" "
(e) Extremely calcareous	> 40%	" "

2. Textural groupings

(a) Coarse textured - sands, loamy sands

(b) Moderately coarse textured - sandy loam, fine sandy loam

(c) Medium textured - very fine sandy loam, loam, silt loam, silt

(d) Moderately fine textured - sandy clay loam, clay loam, silty clay loam

(e) Fine textured - sandy clay, silty clay, clay (40-60%)

(f) Very fine textured - > 60% clay

3. Reaction

	pH		pH
Extremely acid	< 4.5	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	> 9.0

PROPOSAL FOR STUDY OF REARRANGEMENT OF GLEYSOLIC SOILS

Dr. Ehrlich recommended that the soil survey personnel in Canada study the feasibility of a subgroup for strongly gleyed soils in each of the great groups with soils of similar profile characteristics, except gleization, to those in the Gleysolic Order.

This arrangement, eliminating the Order of Gleysolic soils, would permit the use of a modifier, such as Aquic, Hydric or Wet, for all subgroups within each great group in the same manner as the use of Carbonated and Saline in the Chernozemic Order. The modifier would be applicable in all orders except in Organic. This scheme permits a greater number of soils in the strongly gleyed class than presently exist in the Gleysolic Order. Also it would permit a gleyed equivalent, except for the gleyed or imperfectly drained classes which in themselves are intergrades between poor and well-drained, for all subgroups with similar profile characteristics. The imperfectly drained classes would remain as presently defined and would not have use of the modifier.

Comparisons between Gleysolic soils and better drained equivalents are made below:

Gleysolic	Similar soils with better drainage
Rego Humic Gleysol	Rego Black
Orthic Humic Gleysol	Orthic Black
Fera Humic Gleysol	weakly Eluviated Black
Saline Humic Gleysol	Saline Black
Carbonated Humic Gleysol	Carbonated Black
Cryic Humic Gleysol	?
Rego Gleysol	Orthic Regosol
Orthic Gleysol	Podzo Regosol
Fera Gleysol	Podzo Regosol
Saline Gleysol	Saline Regosol
Carbonated Gleysol	Carbonated Regosol
Cryic Gleysol	Cryic Regosol
Humic Eluviated Gleysol	Eluviated Black
Low Humic Eluviated Gleysol	Dark Gray Wooded or Gray Wooded

Examples of the application of Aquic to the above soils are:

Aquic Rego Black, Aquic Orthic Black, Aquic Arenic Podzo Regosol, etc.

RESOLUTIONS

N.S.S.C. Meeting 1965

1. Whereas the present title of the soil drainage classes, outlined in the 1963 report, is misleading.

   Therefore, be it resolved that the present title be changed from "Soil Moisture Classes" to "Soil Drainage Classes".

   Moved by B. C. Matthews
   Seconded by P. Lajoie
   Carried

2. Be it resolved that the N.S.S.C. Committee recommend that the Chairman of the N.S.S.C. prepare an introduction to the next report in which the philosophy behind the evolution and development of the Canadian system of taxonomic classification is explained.

   Moved by B. C. Matthews
   Seconded by W. E. Bowser
   Carried

3. Whereas it is of utmost importance that the definition and description of each class in each category be such that they cannot be misunderstood.

   Therefore, be it resolved that in the reports of this present meeting, the various classes in each category will be defined in terms of differentiating characteristics and some other characteristics that are not differentiating for the particular class may be included in the description but should be clearly indicated as non-differentiating characteristics.

   Moved by B. C. Matthews
   Seconded by A. Mailloux
   Carried

4. Whereas 1) the N.S.S.C. at its meeting in Winnipeg, March 4-6, 1963, recognized the need for additional interpretation of soil survey information as part of the Canadian Land Inventory program of ARDA and agreed to develop a soil capability classification system and establish an inventory of agricultural soil capability for the settled areas of Canada,

   Whereas 2) the need is now apparent for the establishment of land capability classification systems for forestry, wildlife and recreation land uses, Whereas 3) ARDA has established additional staff to implement these capability systems and has requested the members of the organization of N.S.S.C. to assist their staff in the use of soil survey information in their land inventory program,

Therefore, be it resolved that the N.S.S.C. endorse the principle of cooperation by its member organizations a) in making available the soil survey data that they have assembled and b) in advising on the interpretation of soil survey data by scientists in the forestry, wildlife, and recreation capability inventory programs.

Moved by D. W. Hoffman
Seconded by R. Baril
Carried

5. Be it resolved that the N.S.S.C. express the sincere appreciation of its members to the Quebec Department of Agriculture and Colonization for the warm welcome and social hour provided on Wednesday evening.

Moved by H.W.R. Chancey
Seconded by J. Hilchey
Carried

6. Be it resolved that the N.S.S.C. express the sincere appreciation of its members to Laval University and its Faculty of Agriculture for providing excellent facilities for the plenary and subcommittee meetings and for arranging the interesting tour of the Agriculture Service Building and for the pleasant reception on Monday afternoon.

Moved by A. Dubé
Seconded by D. W. Hoffman
Carried

7. Be it resolved that the N.S.S.C. express the gratitude of its members to Dr. L. Daviault, Director of the Canada Forest Research Laboratory, for providing facilities for subcommittee meetings.

Moved by B. Rochefort
Seconded by L. Farstad
Carried

MEMBERS OF SUBCOMMITTEES

Organic Soil Classification:	Ehrlich (Chairman), Chancey, Dubé, Odynsky, Rochefort, Smith, Wicklund.
Capability Maps for New Soil Survey Reports:	Hortie (Chairman), Hilchey, Hoffman, Mailloux, McCormack, Peters.
Soil Families:	Baril (Chairman), Ellis, Langmaid, Matthews, Sprout, Raymond, Reeder.
Chemical Analyses:	MacKenzie (Chairman), Clark, Godbout, Hedlin, Heringa, Rowles, St. Arnaud.
Soil Survey Reports:	Cann (Chairman), Acton, Day, Laplante, Manery, Mills, Toogood.
American System of Soil Classification:	Clayton (Chairman), Arnold, MacDougall, McKeague, Millette, Pawluk, Tabi.

ATTENDANCE AT PLENARY SESSIONS

British Columbia

L. Farstad	Research Branch, C.D.A.	Vancouver
C. Rowles	University of British Columbia	Vancouver
N. Sprout	B.C. Soil Survey Branch	Kelowna

Alberta

E. Bowser	Research Branch, C.D.A.	Edmonton
W. Odynsky	Soil Survey, A.R.C.	Edmonton
T. Peters	Research Branch, C.D.A.	Edmonton
S. Reeder	Soil Survey, A.R.C.	Edmonton
J. Toogood	University of Alberta	Edmonton

Saskatchewan

D. Acton	Research Branch, C.D.A.	Saskatoon
J. Clayton	Research Branch, C.D.A.	Saskatoon
J. Ellis	University of Saskatchewan	Saskatoon
R. St. Arnaud	University of Saskatchewan	Saskatoon
J. Shields	Research Branch, C.D.A.	Saskatoon

Manitoba

R. Hedlin	University of Manitoba	Winnipeg
H. Hortie	Research Branch, C.D.A.	Winnipeg
R. Smith	Research Branch, C.D.A.	Winnipeg
M. Zwarich	University of Manitoba	Winnipeg

Ontario

D. Arnold	University of Guelph	Guelph
L. Chapman	Ontario Research Foundation	Toronto
J. Gillespie	Research Branch, C.D.A.	Guelph
D. Hoffman	University of Guelph	Guelph
B. Matthews	University of Guelph	Guelph
R. Protz	Research Branch, C.D.A.	Guelph
R. Wicklund	Research Branch, C.D.A.	Guelph

Quebec

R. Baril	Laval University	Quebec
B. Bernier	Laval University	Quebec
D. Carrier	Quebec Soil Survey	La Pocatiere
A. Dubé	Quebec Soil Survey	La Pocatiere
B. Forest	Laval University	Quebec
G. Godbout	Quebec Soil Survey	La Pocatiere
M. Jurdant	Research Branch, C.D.F.	Quebec
E. Kohen	Research Branch, C.D.A.	La Pocatiere
L. LaPlante	Quebec Soil Survey	La Pocatiere
A. MacKenzie	Department of Soils	Macdonald College
A. Mailloux	Quebec Soil Survey	La Pocatiere
R. Marcoux	Quebec Soil Survey	La Pocatiere
G. Millette	Department of Soils	Macdonald College
E. Pageau	Quebec Soil Survey	La Pocatiere
R. Raymond	Quebec Soil Survey	La Pocatiere
B. Rochefort	Research Branch, C.D.A.	La Pocatiere
M. Tabi	Quebec Soil Survey	La Pocatiere
L. Tardif	Quebec Soil Survey	La Pocatiere

New Brunswick

W. Holland	ARDA, C.D.F.	Fredericton
K. Langmaid	Research Branch, C.D.A.	Fredericton
G. Losier	N.B. Department of Agriculture	Fredericton
J. MacMillan	Research Branch, C.D.A.	Fredericton

Nova Scotia

J. Hilchey	Agricultural College	Truro
J. MacDougall	Research Branch, C.D.A.	Truro

Newfoundland

R. Chancey	Research Branch, C.D.A.	St. John's
P. Heringa	Research Branch, C.D.A.	St. John's

Washington, D. C.

R. Simonson	Soil Conservation Service, U.S.D.A.	Washington, D.C.

Ottawa

G. Beaudoin	Research Branch, C.D.A.
A. Benson	ARDA, C.D.F.
C. Brown	ARDA, C.D.F.
B. Cann	Research Branch, C.D.A.
J. Clark	Research Branch, C.D.A.
J. Day	Research Branch, C.D.A.
W. Ehrlich	Research Branch, C.D.A.
A. Leahey	Research Branch, C.D.A.
P. Lajoie	Research Branch, C.D.A.
R. Manery	Information Division, C.D.A.
R. McCormack	ARDA, C.D.F.
A. McKeague	Research Branch, C.D.A.
L. Pratt	ARDA, C.D.F.
E. Rouisse	Information Division, C.D.A.
S. Rowe	Research Branch, C.D.F.
P. Stobbe	Research Branch, C.D.A.

Appendix I

REPORT ON LANDSCAPE FEATURES

D. B. Cann
Chairman, Subcommittee on Landscape Features

The 1948 and 1955 reports on landscape features contain a large amount of valuable background material concerning the methods of dealing with landscape features in the various provinces. They contain also, proposed classifications of topography, landforms, erosion, stoniness, land use, and vegetative cover, some of which were suggested for trial and others were adopted for use.

The present subcommittee was asked to make a careful and critical review of this material and to endeavor to find acceptable solutions to some of the controversial matters arising out of these reports. The report of the subcommittee, which follows, is presented in three sections -- (1) Land Forms and Topographic Classes, (2) Erosion and Stoniness, and (3) Land Use and Vegetative Cover.

1. Land Forms and Topographic Classes

Land Forms: The subcommittee felt strongly that some means of indicating land form on the map in relation to soil type was important. It would be desirable to have a method of indicating land form in the mapping symbol, but there are many difficulties involved and no satisfactory scheme was proposed.

The subcommittee proposed that a list of land forms be compiled describing those secondary landforms that are encountered by the surveyor and which are not adequately described in standard texts. It was recommended that soil survey organizations in each province be asked to supply a list and description of the landforms recognized in their area and, if possible, to supply aerial photographs illustrating these landforms. Such photos would be used to compile a national collection of landform illustrations.

During the discussion by the plenary session, it was pointed out that several agencies were investigating landforms or had photos of landforms available.

It was moved that action be delayed until we have further information on the subject. Carried.

Topographic Classes: The topographic classes suggested for use in 1955 were given critical examination. It was felt that, in general, the classes should be retained, but the symbols could be simplified. It was felt also that additions to the slope classes over 30 per cent were necessary to cover slopes found in mountainous terrain. Considerable discussion centered around the 0 per cent slope class. It was thought that this could be included with the 0 - 0.5 per cent class without altering the effectiveness of the classes. The question of symbols received much discussion and decisions were reversed several times. There was a unanimous desire for a less cumbersome symbol to show slope class.

The following topographic classes and symbols were proposed by the subcommittee to the plenary session and were adopted for use.

Simple Topography Single slopes (regular surface)	Complex Topography Multiple slopes (irregular surface)	Slope %
A depressional to level	a	0 - 0.5
B very gently sloping	b	0.5 - 2
C gently sloping	c	2 - 5
D moderately sloping	d	6 - 9
E strongly sloping	e	10 - 15
F steeply sloping	f	16 - 30
G very steeply sloping	g	30 - 60
H extremely sloping	h	over 60

When descriptive terms such as undulating, rolling, etc., are used, they should be defined, either in a glossary or in connection with descriptions of the soil type.

2. Land Use and Vegetative Cover

The subcommittee is in general agreement with the views expressed on pages 66 and 67 of the 1955 report. With the exception of some special maps, land use and vegetative cover are not shown on soil maps. Most survey organizations record some of these features on field sheets, aerial photographs or in notebooks and they are used as additional information in describing the soils in the soil survey report.

It was felt that it would not be feasible to set up a uniform system of classifying and recording data for all of Canada, but this might be done on a regional basis. The broad groupings into cultivated and non-cultivated land suggested in the 1955 report are applicable everywhere, but subdivisions of these groups will depend on the object of the survey.

The subcommittee recommended that soil survey organizations continue to record land use and vegetative cover.

3. Erosion and Stoniness

Water erosion -- The water erosion classes as defined in the U.S.D.A. Soil Survey Manual were adopted. The four classes would be designated on the map as W1, W2, W3 and W4. The classes of water erosion are defined as follows:

W1 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 per cent 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 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 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 the original A horizon and others in which it consists wholly of underlying horizons. Shallow gullies may be present. Approximately 25 to 75 per cent of the original A horizon or surface soil may have been lost from most of the area.

W3 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 about 75 per cent 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 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.

Wind erosion -- The wind erosion classes as defined in the U.S.D.A. Soil Survey Manual were adopted. The classes would be designated on the map as D1, D2, and D3. The classes of wind erosion are defined as follows:

D1 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, while in others the original A horizon is removed. Generally, about 25 to 75 per cent of the original A horizon (or surface soil in soils with thin A horizons) may have been removed.

D2 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 blow-out 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 material. Areas between blowouts are deeply buried by soil material from the blowouts.

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

 Blow-pit removal. Number indicates depth in feet.

 Recent dune or dune-like accumulations. Number indicates height in feet.

 Hummocky area of mixed removal and accumulation.

Gully erosion -- The following classes of gully erosion were adopted for use.

E1 Shallow occasional gullies -- may be crossed by farm implements and occur over 100 feet apart.

E2 Shallow frequent gullies -- may be crossed by farm implements but occur less than 100 feet apart.

E3 Deep occasional gullies -- cannot be crossed by farm implements. Change of land use indicated.

E4 Deep frequent gullies -- cannot be crossed by farm implements. Change of land use indicated.

Accumulation of eroded materials

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

1+2+ etc. Thickness of accumulations in feet.

Stoniness -- The classes of stoniness, rockiness and coarse fragments expressed in the 1955 report were adopted for use. 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 0 - Non-stony land.

Stones 1 - Slightly stony land -- some stones which offer only slight to no hindrance to cultivation.

Stones 2 - Moderately stony land -- enough stones to cause some interference with cultivation.

Stones 3 - Very stony land -- sufficient stones to constitute a serious handicap to cultivation, some clearing required.

Stones 4 - Exceedingly stony land -- sufficient stones to prevent cultivation until considerable clearing is done.

Stones 5 - Excessively stony land -- too stony to permit any cultivation (boulder or stone pavement).

Rockiness -- The classes of rockiness are defined as follows.

Rocky 0 - No bedrock exposures or too few to interfere with tillage. Less than 2 per cent bedrock exposed.

Rocky 1 - 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 about 2 to 10 per cent of the surface.

Rocky 2 - 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 about 10 to 25 per cent of the surface, depending upon the pattern.

Rocky 3 - Sufficient rock outcrop to make all use of machinery impracticable, except for light machinery where other soil characteristics are especially favorable for improved pasture. 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 per cent of the surface depending upon the pattern.

Rocky 4 - Sufficient rock outcrop (or of 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 apart or less and cover some 50 to 90 per cent of the area.

Rocky 5 - Land for which over 90 per cent of the surface is exposed bedrock (rock outcrop).

Coarse fragments -- 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 diameter	3-10 inches diameter	10 + inches 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	6-15 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".

Appendix 2

REPORT ON SOIL DRAINAGE CLASSES

B. C. Matthews
Chairman, Subcommittee on Soil Drainage

The 1955 report of the Subcommittee on Soil Drainage Terminology attempted to describe drainage classes on the basis of soil morphological features that were presumed to indicate the moisture status of the soil. On application of these criteria it became apparent that soils of similar morphological features did not necessarily have similar moisture regimes.

Accordingly, the present Subcommittee on Soil Drainage has defined the soil drainage classes in terms of (1) actual moisture content in excess of field moisture capacity, and (2) the extent of the period during which such excess water is present in the plant-root zone.

It is recognized that permeability, level of ground-water 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, e.g. mottling, normally but not always reflects soil moisture status. Hence, it is recommended that 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 we consider 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 due to the nature and distribution of minerals within them. Soil drainage classes, thus, cannot be based solely upon 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 underlined. 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. Note: the word "significant" as used in the definitions is to be considered in relation to plant growth.

1. Rapidly drained - Soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.

   Soils are free of any evidence of gleying throughout the profile. Rapidly drained soils are commonly soils of coarse texture or soils on steep slopes.

2. Well drained - 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 of mottling in the upper three feet but may be mottled below depths of three feet. B horizons, if present, are reddish, brownish, or yellowish.

3. Moderately well-drained - 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 two feet. The Ae horizon, if present, may be faintly mottled in fine-textured soils or 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 - 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 or may not be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

5. Poorly drained - Soil moisture in excess of field capacity remains in all horizons for a large part of the year.

   Soils show evidence of strong gleying. Except in high chroma parent materials the B, if present, and upper C horizons 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.

   Soils show evidence of very strong gleying. Subsurface horizons 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 ground-water level, low permeability, seepage, or telluric water. If so, appropriate notation can be made following the drainage class designation.

Appendix 3

REPORT ON SOIL STRUCTURE AND CONSISTENCE

Wm. Odynsky
Chairman, Subcommittee on Structure and Consistence

Introduction

The Subcommittee was instructed to review the reports of 1948 and 1955 which were presented by Dr. W. A. Ehrlich and to determine the need of any modifications in the classification of soil structure and soil consistence.

From the comments received in reply to a questionnaire forwarded to the membership and the added information supplied by Dr. R. W. Simonson concerning recent proposals submitted by the U.S.D.A. Subcommittee, the following suggestions were submitted for consideration by the National Soil Survey Committee:

1. That "structureless" be deleted from Grade and be included as a type of structure.

2. That the Miscellaneous Structures referred to in the 1960 report consisting of "crumb", "fragmental", and "shotty" be deleted from the classification of structure.

3. That with respect to structure classification the term "species" be substituted by the term "class".

4. That the classification of soil consistence be modified by the deletion of "very friable", "extremely firm", "slightly hard", and "extremely hard" to permit some degree of duplication in this classification.

5. That cementation may be classified as "weakly", "moderately", and "strongly" cemented through the deletion of "indurated".

6. That whereas the dry - moist standard of soil moisture is used in the evaluation of soil structure, consideration be given to the use of a similar soil moisture standard in the evaluation of consistence or durability with respect to the natural peds. Such usage will permit the inclusion of the designation of durability in the terms describing soil structure. Furthermore, it was suggested that such terms as "soft", "friable", "hard" may be adequate when used alone since by definition they denote small, recognizable differences in durability.

7. That the recognition of related features such as porosity, void spaces, clay films, silica flour and other relevant morphological features should receive further attention to provide for terminology and conventions in describing these features.

The changes agreed upon are incorporated in the following:

SOIL 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 which 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 (1) a clod, formed as a result of some disturbance, such as plowing or digging, that moulds the soil to a transient mass that changes with alternating wetting and drying, (2) a fragment, formed by a rupture of a soil mass across natural surfaces of weakness, or (3) a concretion, formed by local concentrations of compounds that irreversibly cement the soil grains together.

The classification of structure involves consideration of (1) the shape and arrangement, (2) the size, and (3) 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 which 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 of consideration under the class of soil structure, whereas the degree of distinctness is expressed in the grades.

The accompanying table indicates four principal types of structure. (1) Structureless in which there is no observable aggregation or no definite orderly arrangement of natural lines of weakness; (2) Block-like in which the soil particles are arranged around a point and bounded by flat or rounded surfaces; (3) Plate-like in which the soil particles are arranged around a horizontal plane and generally bounded by relatively flat horizontal surfaces; and (4) Prism-like 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 sub types. Thus, under structureless, the single grain kind consists of an incoherent mass of individual particles whereas massive consists of a coherent mass showing no evidence of any distinct arrangement along natural lines of weakness. The block-like 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 plane surfaces, with vertices mostly 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 respect to the shape and arrangement. In this respect, the oblique dimension is inferred for the block-like type, the vertical dimension for the plate-like, and the horizontal dimension for the prism-like 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 between 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:

1. Weak - That grade of structure characterized by weakly formed peds that are barely observable in place.

2. Moderate - That 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.

3. Strong - That 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 (1) Grade (distinctness), (2) Class (size), (3) 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.

SOIL 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 consistence irrespective of whether the mass be large or small, in a natural condition or greatly disturbed, aggregated or structureless, 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 such 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 specifies friable when moist; likewise, 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 unnecessary to describe consistence at all three standard moisture conditions. The consistence when moist is commonly the most significant, and a soil description with this omitted can hardly be regarded as complete; the consistence when dry is generally useful but may be irrelevant in descriptions of soil materials that are never dry; and the consistence when wet is unessential in the description of many soils but extremely important in some.

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 description. Then, too, 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:

I. Consistence When Wet

Consistence when wet is determined at moisture levels at or slightly above field capacity.

A. Stickiness - Stickiness is the quality of adhesion to other objects. For field evaluation of stickiness, soil material is pressed between thumb and finger and its adherence is noted. Degrees of stickiness are described as follows:

0. Non-sticky: After release of pressure, practically no soil material adheres to thumb and finger.

1. Slightly sticky: After pressure, soil material adheres to both thumb and finger but comes off one or the other rather cleanly. It is not appreciably stretched when the digits are separated.

2. Sticky: After pressure, soil material adheres to both thumb and finger and tends to stretch somewhat and pull apart rather than pulling free from either digit.

3. Very sticky: After pressure, soil material adheres strongly to both thumb and forefinger and is decidedly stretched when they are separated.

B. Plasticity - 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 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, as plastic when slightly moist or wetter, plastic when moderately moist or wetter, and plastic only when wet, or as plastic with a wide, medium, or narrow range of moisture content. Express degree of resistance to deformation at or slightly above field capacity as follows:

0. Non-plastic: No wire is formable.

1. Slightly plastic: Wire formable but soil mass easily deformable.

2. Plastic: Wire formable and moderate pressure required for deformation of the soil mass.

3. Very plastic: Wire formable and much pressure required for the deformation of the soil mass.

II. 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 (a) tendency to break into smaller masses rather than into powder, (b) some deformation prior to rupture, (c) absence of brittleness, and (d) 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: Soil material crushed under very gentle pressure but coheres when pressed together.

2. Friable: Soil material crushes easily under gentle to moderate pressure between thumb and forefinger, and coheres when pressed together.

3. Firm: Soil material crushes under moderate pressure between thumb and forefinger but resistance is distinctly noticeable.

4. Very firm: Soil material crushes under strong pressure, barely crushable between 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".)

III. 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 in the hand.

0. Loose: Noncoherent.

1. Soft: Soil mass is weakly coherent and fragile; breaks to powder or individual grains under very slight pressure.

2. Slightly hard: Weakly resistant to pressure; easily broken between the thumb and forefinger.

3. Hard: Moderately resistant to pressure; can be broken in the hands without difficulty but rarely breakable between thumb and forefinger.

4. Very hard: Very resistant to pressure; can be broken in the hands only with difficulty; not breakable between thumb and forefinger.

5. Extremely hard: Extremely resistant to pressure; cannot be broken in the hands.

IV. 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, or 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. Semi-reversible 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.

1. Weakly cemented: Cemented mass is brittle and hard but can be broken in the hands.

2. Strongly cemented: Cemented mass is brittle and harder than can be broken in the hands but is easily broken with a hammer.

3. Indurated: Very strongly cemented, brittle, does not soften under prolonged wetting and is so extremely hard that for breakage, a sharp blow with a hammer is required; hammer generally rings as a result of the blow.

PARENT MATERIALS

In the parent material of soils, the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Reference to geological terms in the description of parent materials should apply to accepted terminology. Many of the terms used in stratigraphy have differing 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.

Stratum* - A layer characterized by certain unifying characteristics, properties, or attributes distinguishing it from adjacent layers. However, bedding and lamination connote a thickness of the strata, thus:

Bed* - A unit layer in a stratified sequence which is visually or physically more or less distinctly separable from other layers above and below and is one or more centimeter in thickness. A similar layer whose thickness is less than one centimeter is called a lamina.

When thickness is implied, reference to cross-stratification will involve consideration of cross-bedding or cross-lamination.

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*International Subcommission on Stratigraphic Terminology - International Geological Congress Proceedings, XXV, 1960.

Types and Classes of Soil Structure

Type	Kind	Class	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. Amorphorus (massive) structure - a coherent mass showing no evidence of any distinct arrangement of soil particles.		
2. Block-like - 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 - characterized by rounded vertices.	Fine granular	<2
		Medium granular	2-5
		Coarse granular	5-10
3. Plate-like - 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
		Medium platy	2-5
		Coarse platy	5
4. Prism-like - soil particles are arranged around a vertical axis and bounded by relatively flat vertical surfaces.	A. Prismatic structure - vertical faces well defined, and edges are 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