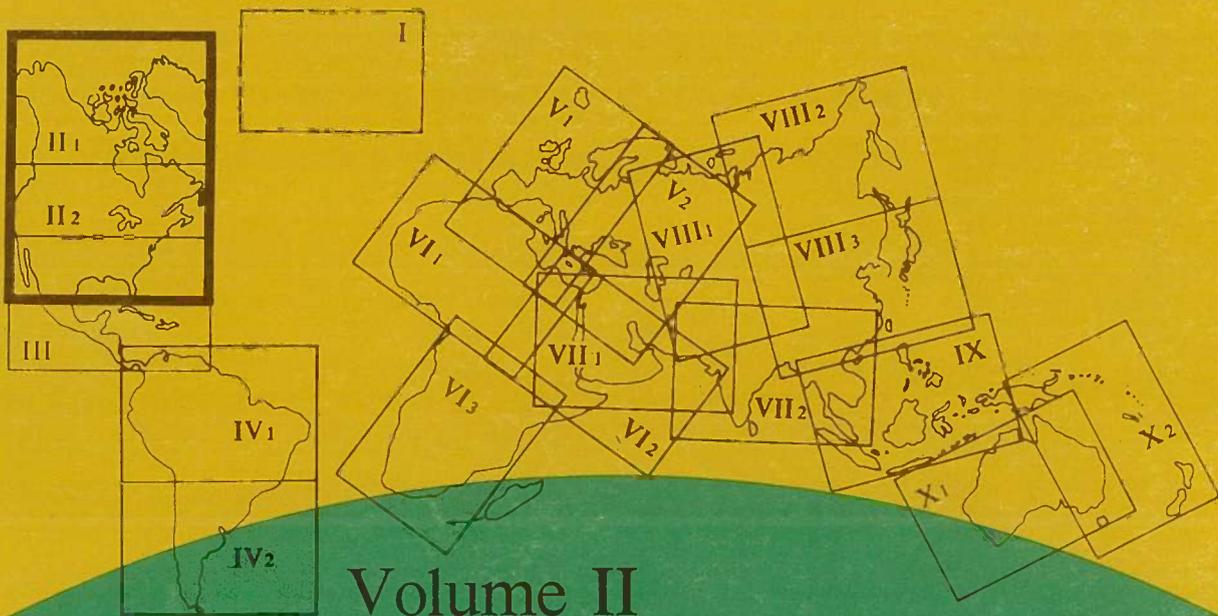


FAO - Unesco

Soil map of the world

1:5 000 000



Volume II
North America

Unesco

FAO-Unesco
Soil map of the world
1 : 5 000 000
Volume II
North America

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Soil map of the world

Volume I	Legend
Volume II	North America
Volume III	Mexico and Central America
Volume IV	South America
Volume V	Europe
Volume VI	Africa
Volume VII	South Asia
Volume VIII	North and Central Asia
Volume IX	Southeast Asia
Volume X	Australasia



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

FAO - Unesco

Soil map of the world

1 : 5 000 000

Volume II

North America

Prepared by the National Cooperative Soil Survey of the United States of America, the National Soil Survey Committee of Canada, and the Food and Agriculture Organization of the United Nations

Unesco - Paris 1975

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PREFACE

The project for a joint FAO/Unesco Soil Map of the World was undertaken following a recommendation of the International Society of Soil Science. It is the first attempt to prepare, on the basis of international cooperation, a soil map covering all the continents of the world in a uniform legend, thus enabling the correlation of soil units and comparisons on a global scale. The project, which started in 1961, fills a gap in present knowledge of soil potentialities throughout the world and provides a useful instrument in planning agricultural and economic development programmes.

The project has been carried out under the scientific authority of an international advisory panel, within the framework of FAO and Unesco programmes. The different stages of the work included comparative studies of soil maps, field and laboratory work, and the organization of international expert meetings and study tours. The secretariat of the joint project, located at FAO Headquarters, was vested

with the responsibility of compiling the technical information, correlating the studies and coordinating the drafting of the maps and text. FAO and Unesco shared the expenses involved in the realization of the project, and Unesco undertook publication of its results.

The present volume, covering the soils of North America, is the second of a set of ten which make up the complete publication of the Soil Map of the World. The first volume records introductory information and presents the definitions of the elements of the legend which is used uniformly throughout the publication. Each of the nine following volumes comprises an explanatory text and the corresponding map sheets covering the main regions of the world.

FAO and Unesco wish to express their gratitude to the government institutions, the International Society of Soil Science, and the many individual soil scientists who have contributed so much to this international project.

CONTENTS

Preface	v	H. Phaeozems in the United States.....	95
Summaries	vii	I. Lithosols in Canada	96
English	vii	I. Lithosols in the United States	97
French	ix	J. Fluvisols in Canada	97
Russian	xi	J. Fluvisols in the United States	98
Spanish	xiii	K. Kastanozems in Canada	98
1. Introduction	1	K. Kastanozems in the United States	100
2. Acknowledgements	3	L. Luvisols in Canada	101
3. The map	4	L. Luvisols in the United States	102
Topographic base	4	M. Greyzems in Canada	104
Map units	4	M. Greyzems in the United States	104
Cartographic representation	4	O. Histosols in Canada	104
Sources of information	6	O. Histosols in the United States	105
4. Environmental conditions	8	P. Podzols in Canada	106
SOIL CLIMATE	8	P. Podzols in the United States	106
Soil temperature	9	R. Regosols in Canada	107
Soil moisture	11	R. Regosols in the United States	108
VEGETATION	17	S. Solonetz in Canada	110
Vegetation regions	17	S. Solonetz in the United States	111
PHYSIOGRAPHY AND GEOLOGY	30	T. Andosols in Canada	111
5. The soils of North America	41	T. Andosols in the United States	111
Distribution of major soils	41	V. Vertisols in the United States	112
6. Description and distribution of soils, land use and soil suitability	82	W. Planosols in the United States	112
LAND USE IN NORTH AMERICA	82	X. Xerosols in the United States	113
DESCRIPTION, DISTRIBUTION AND SUITABILITY OF SOILS	84	Y. Yermosols in the United States	113
A. Acrisols in the United States	86	Z. Solonchaks in Canada	114
B. Cambisols in Canada	87	Z. Solonchaks in the United States	115
B. Cambisols in the United States	88	Conclusions	115
C. Chernozems in Canada	89	Appendix 1. Morphological, chemical and physical properties of North American soils: data from selected profiles	116
C. Chernozems in the United States	90	Appendix 2. Table of correlated legends of reference soil maps	208
D. Podzoluvisols in the United States	91	Figures	
E. Rendzinas in Canada	91	1. Sources of information	6
G. Gleysols in Canada	91	2. Soil climate regimes	13
G. Gleysols in the United States	94	3. Potential natural vegetation regions	19
		4. Physiographic regions	33
		5. Surface geology	35
		6. Major soil regions	43
		7. Land-use regions	85

This volume describes the North American section of the 1 : 5 000 000 Soil Map of the World. The compilation of the Soil Map of North America was jointly carried out in 1970-71 by the Soil Research Institute of the Canada Department of Agriculture and the Soil Conservation Service of the United States Department of Agriculture.

The maps

The two map sheets which make up the Soil Map of North America are drawn on topographic base maps of the 1 : 5 000 000 series of the American Geographical Society. The map units are associations of soil units divided into texture and slope classes. They are marked on the maps by symbols. The dominant soils are shown by colours and phases are shown by overprints.

A small inset map shows the reliability of soil information from which the map was compiled.

Detailed definitions of the soil units and full descriptions of all the terms used may be found in Volume I.

The text

The first chapter describes the development of the project in North America and gives some possible uses of the map. The second acknowledges the co-operation of participating agencies and the large number of people who contributed to the maps and text, and the third gives a brief explanation of the soil legend, which is described in detail in Volume I, and the principal sources of information utilized in the compilation of the map.

The main chapters of this volume deal with environmental conditions, soil distribution, land use and suitability.

ENVIRONMENTAL CONDITIONS

Chapter 4 contains brief accounts, with maps, of the four factors of the environment that have close

relationships with the pattern of soils: soil climate, vegetation, physiography and surface geology.

Classification of *soil climate* is based on soil temperature and soil moisture regimes as defined in the U.S. Department of Agriculture Soil Taxonomy. Since the criteria used in delimiting soil climatic units are those important to plant growth, the soil climate map is complementary to the soil map in the transfer of crop information from one part of the world to another. The main soil climatic regions are outlined on a small-scale map (Figure 2).

Vegetation is discussed on the basis of 24 potential natural vegetation regions distinguished on the basis of the association of plant communities and their relationships to environmental conditions. These regions are outlined on a small-scale map (Figure 3). The text gives some brief notes on each region.

The discussion of *physiographic regions* includes brief statements on the geology and geomorphology of broad areas of the subcontinent. Twelve regions are delineated on a small-scale map (Figure 4).

Surface geology is shown only by a map (Figure 5); there is no explanatory text. Fourteen map units show dominant rock types grouped according to geologic era.

SOILS AND LAND USE

Chapters 5 and 6, describing the soils of the continent, contain an extensive table of soil associations, an account of the distribution of the main soils, and a discussion of land use and soil suitabilities for agriculture.

The table of *soil associations* lists all the map units in alphabetical order of symbols. Other columns show:

- Associated soils
- Inclusions
- Phases
- Areas of units in 1 000 hectares
- Climate
- Regions of occurrence
- Vegetation
- Lithology or parent materials

The *distribution of major soils* is discussed on the basis of 18 major soil regions which are outlined on a small-scale map (Figure 6). The main soils of each region are discussed in relation to factors of the environment, and a brief account of their extent and location is given.

Description and distribution of soils, land use and soil suitability are discussed in Chapter 6. In a short introductory note to the chapter, distribution of the principal kinds of land use in North America is outlined and is further illustrated in Figure 7.

The main soil units are then considered separately in alphabetical order. Their general distribution, soil temperature and moisture regimes, parent material, topography, land use, productivity and management problems are discussed for each unit. The specific characteristics, suitability and use of the soil subunits are also outlined.

Conclusions

Most of the soils in the northern part of North America have temperature regimes too cold, moisture regimes too wet, or slopes too steep for them to be used for production of food, feed, or fibres; some are a source of timber and others serve as wild-life habitat. Those in the southern part of the

continent are in an environment generally better suited for farming, although in the southwestern part they are subject to limitations imposed by a deficiency of moisture and in the western and eastern parts by steep slopes of mountains and highlands. In only 5 percent of Canada are the soils used for farm enterprises. An additional 2 percent of the land area of the country has potential for development, although some of it has limitations imposed by climate and physical features. In the United States, about 20 percent of the land area is used as cropland. Potentially, an additional 11 percent of the country could be similarly used although some of it is marginal for the production of cultivated crops. This increase in the area of cropland could be made only by increasing the intensity of use of land at present under forest and pasture.

The appendixes

Site and profile data, including profile descriptions and analyses, are given in Appendix 1 for some of the main soil units. A correlation between the units of the FAO/Unesco Soil Map of the World, the Soil Map of the United States (scale 1 : 7 500 000) and the Soil Map of Canada (scale 1 : 5 000 000) is presented in Appendix 2.

Le présent volume de la Carte mondiale des sols au 1/5 000 000 est consacré à l'Amérique du Nord. La documentation nécessaire à l'établissement de la Carte des sols de l'Amérique du Nord a été réunie en 1970-71 par l'Institut de recherche pédologique du Département de l'agriculture du Canada et par le Service de conservation des sols du Département de l'agriculture des Etats-Unis.

Les cartes

Les deux feuilles qui constituent la Carte des sols de l'Amérique du Nord ont été établies d'après les cartes topographiques de base au 1/5 000 000 de l'American Geographical Society. Les unités cartographiques sont constituées d'associations de sols divisées en classes de texture et de pente. Elles sont indiquées sur les cartes par des signes conventionnels. Les sols dominants sont représentés par des couleurs et les phases apparaissent en surcharge.

Une petite carte, insérée en cartouche, indique le degré de fiabilité des données pédologiques utilisées pour l'établissement de la carte.

On trouvera dans le volume I de la série les définitions détaillées des unités pédologiques et les descriptions complètes des termes employés.

Le texte

Le chapitre 1 retrace la genèse du projet en Amérique du Nord et indique les possibilités d'utilisation de la carte. Dans le chapitre 2, les auteurs remercient les organismes participants et les très nombreuses personnes qui ont contribué à l'établissement des cartes et à la rédaction du texte. Le chapitre 3 explique brièvement la légende des sols, décrite en détail dans le volume I, et indique les sources de renseignements utilisés pour l'établissement de la carte.

Les chapitres principaux (4, 5 et 6) du présent volume traitent du milieu, de la répartition des sols, et de leur vocation et utilisation agricoles.

LE MILIEU

Le chapitre 4 contient de brefs exposés, accompagnés de cartes, sur les quatre facteurs du milieu

étroitement liés avec les divers types de sols: climat pédologique, végétation, physiographie et géologie de surface.

La classification des *climats pédologiques* est basée sur les régimes thermiques et hydriques des sols, tels qu'ils sont définis dans la « Soil Taxonomy » du Département de l'agriculture des Etats-Unis. Etant donné que les critères utilisés pour délimiter les unités pédo-climatiques sont ceux qui présentent de l'importance pour la croissance des plantes, la carte des climats pédologiques constitue un complément à la carte des sols pour le transfert des renseignements relatifs aux cultures, d'une région du monde à une autre. Les principales régions pédo-climatiques sont délimitées sur une carte à petite échelle (figure 2).

La *végétation* est répartie en 24 régions de végétation naturelle, qui se distinguent les unes des autres par les associations de communautés de plantes qu'on y rencontre, et par leurs relations avec le milieu. Ces régions sont délimitées sur une carte à petite échelle (figure 3). On trouvera dans le texte quelques brèves indications sur chacune de ces régions.

L'étude des *régions physiographiques* comprend de brefs exposés sur la géologie et la géomorphologie de vastes zones du sous-continent. Douze régions sont délimitées sur une carte à petite échelle (figure 4).

La *géologie de surface* n'est indiquée que par une carte (figure 5), sans texte explicatif. Quatorze unités cartographiques montrent les types de roches dominants groupés selon l'ère géologique.

LES SOLS ET LEURS UTILISATIONS

Les chapitres 5 et 6, où sont décrits les sols du continent nord-américain, contiennent un tableau détaillé des associations de sols, un exposé sur la répartition des principaux sols, et une étude de la vocation et de l'utilisation agricoles de ceux-ci.

Le tableau des *associations de sols* énumère toutes les unités cartographiques, dans l'ordre alphabétique des signes conventionnels (première colonne, « symboles »). Les autres colonnes indiquent:

les sols associés,
les inclusions,

les phases,
les superficies des unités, en milliers d'hectares,
le climat,
la localisation de ces unités,
la végétation,
la lithologie ou les matériaux.

La répartition des principaux sols est étudiée sur la base de 18 grandes régions pédologiques, qui sont délimitées sur une carte à petite échelle (figure 6). Les principaux sols de chaque région sont traités en fonction des divers facteurs du milieu, avec un bref rappel de leur étendue et de leur localisation.

Le chapitre 6 s'intitule *Description et répartition des sols, leur vocation et leur utilisation agricoles*. Dans une note d'introduction, la répartition des principaux types d'utilisation des terres en Amérique du Nord est brièvement indiquée; elle est en outre illustrée à la figure 7.

Les principales unités pédologiques sont ensuite examinées séparément par ordre alphabétique. On étudie pour chaque unité la répartition générale des sols, les régimes thermiques et hydriques, les matériaux parentaux, la topographie, les problèmes d'utilisation, de productivité et de mise en valeur des terres. Les caractéristiques spécifiques, la vocation et l'utilisation des sous-unités pédologiques sont aussi esquissées.

Conclusions

La plupart des sols de la partie septentrionale de l'Amérique du Nord ont des régimes thermiques trop froids, des régimes hydriques trop humides, une

déclivité trop forte pour être exploités, qu'il s'agisse de cultures vivrières, fourragères ou de plantes à fibres; certains sols conviennent à la production de bois et d'autres sont le domaine de la faune sauvage. Les sols de la partie méridionale du continent bénéficient d'un environnement dans l'ensemble plus propice à l'agriculture, encore que dans la partie sud-ouest, leurs possibilités soient limitées par l'insuffisance d'humidité et, dans les parties occidentale et orientale, par les fortes pentes des montagnes. Au Canada, 5 pour cent seulement des terres sont consacrées à l'agriculture; 2 pour cent de plus pourraient être mis en valeur, mais une partie subit les limitations imposées par le climat et les caractéristiques physiques. Aux Etats-Unis, environ 20 pour cent des terres sont cultivées; 11 pour cent de plus pourraient l'être, mais une partie est marginale pour la production de cultures. Cet accroissement de la superficie cultivée ne pourrait être obtenu que par une utilisation plus intensive des terres qui portent actuellement des forêts et des pâturages.

Annexes

On trouvera dans l'annexe 1 des données concernant les sites et les profils, y compris des descriptions et analyses de profils, pour quelques-unes des principales unités pédologiques, et dans l'annexe 2 une corrélation entre les unités de la Carte mondiale des sols FAO/Unesco, de la carte des sols des Etats-Unis au 1/7 500 000 et de la carte des sols du Canada au 1/5 000 000.

Настоящий том посвящен североамериканской части Почвенной карты мира, составленной в масштабе 1 : 5 000 000. Составление Почвенной карты Северной Америки было совместно осуществлено в 1970-1971 гг. Почвенным институтом Министерства сельского хозяйства Канады и Службой сохранения почв Министерства сельского хозяйства США.

Карты

Два листа карт, составляющих почвенную карту Северной Америки, составлены на основе топографических карт Американского географического общества (серия карт масштаба 1 : 5 000 000). Картографические единицы представляют собой ассоциации почвенных единиц, разделенные на классы по механическому составу и наклону. Они отмечены на картах условными обозначениями. Преобладающие почвы даны в красках, в то время как фазовые различия показаны с помощью надпечаток.

Небольшая карта-вкладка показывает степень надежности информации о почвах, на основе которой составлялась карта.

Подробные определения почвенных единиц и полное описание всех используемых терминов можно найти в томе I настоящего издания.

Текст

В первой главе описывается развитие проекта в Северной Америке и приводятся некоторые замечания по использованию карты. Во второй главе выражается благодарность за сотрудничество учреждениям и большому числу лиц, которые приняли участие в составлении карт и текста, в третьей главе дается краткое пояснение почвенной легенды, подробно описанной в томе I, и указаны основные источники информации, использованной при составлении карты.

Основные главы данного тома посвящены условиям окружающей среды, распределению почв, использованию и пригодности земли.

УСЛОВИЯ ОКРУЖАЮЩЕЙ СРЕДЫ

В главе 4 содержится краткое описание, с картами, тех четырех факторов окружающей среды, которые тесно связаны с распространением почв: климат, растительность, физическая география и геология поверхности.

Классификация почвенного климата основана на температурном и водном режиме почвы в соответствии с определениями почвенной таксономии Министерства сельского хозяйства США. Поскольку критерии, использованные при определении единиц почвенного климата, являются теми критериями, которые представляют важность для роста растений, то климатическая карта служит дополнением к почвенной карте в смысле передачи информации об урожае из одной части мира в другую. Основные почвенно-климатические районы показаны на мелкомасштабной карте (рис. 2).

Растительность рассматривается на основе 24 потенциальных районов естественной растительности, различимых на основе фитоценоза и его связи с условиями окружающей среды. Эти районы указаны на мелкомасштабной карте (рис. 3). В тексте даны краткие замечания по каждому району.

Рассмотрение физико-географических районов включает краткое описание геологии и геоморфологии широких зон субконтинента. На мелкомасштабной карте нанесено 12 районов (рис. 4).

Геология поверхности показана только на карте (рис. 5); пояснительного текста нет. Четырнадцать картографических единиц показывают преобладающие типы пород, сгруппированные в соответствии с геологическими периодами.

ПОЧВЫ И ИСПОЛЬЗОВАНИЕ ЗЕМЛИ

В главах 5 и 6, описывающих почвы континента, содержится обширная таблица ассоциаций почв, говорится о распространении основных почв, а также об использовании земли и пригодности почвы для сельского хозяйства.

В таблице ассоциаций почв перечисляются все картографические единицы в алфавитном порядке условных обозначений. Другие колонки показывают:

Сочетающиеся почвы
Включения
Фазы
Площади единиц в 1 000 га
Климат
Районы распространения
Растительность
Литология или материнские породы

Распространение основных почв рассматривается на базе восемнадцати крупных почвенных районов, которые показаны на мелкомасштабной карте (рис. 6). Основные почвы каждого района рассматриваются в связи с факторами окружающей среды, а также приводятся краткие сведения по их распространению и местонахождению.

Описание и распределение почв, землепользование и пригодность почв рассматриваются в главе 6. В кратком вступительном примечании к главе в общих чертах описываются основные виды землепользования в Северной Америке, иллюстрацией чего служит рис. 7.

Далее рассматриваются по отдельности в алфавитном порядке основные почвенные единицы. По каждой единице рассматривается их общее распределение, температурный и водный режимы почвы, материнские породы, топография, землепользование, продуктивность и проблемы управления. Кратко даются также специфические характеристики, пригодность и использование подразделений почвенных единиц.

ВЫВОДЫ

Большинство почв в северной части Северной

Америки обладает слишком холодными температурными режимами, слишком влажными водными режимами или слишком крутыми склонами для производства продуктов питания, фуража или волокна; на некоторых растут леса, другие служат хабитатом некультивируемой растительности и диких животных. Почвы южной части континента в общем находятся в более подходящей для сельского хозяйства среде, хотя в юго-западной части они подвержены ограничениям, обусловленным недостатком влаги, а в западных и восточных частях - крутыми склонами гор и возвышенностей. Только на 5 проц. территории Канады почвы используются для сельского хозяйства. Кроме того, 2 проц. площади суши страны представляют собой потенциально пригодные земли, хотя некоторые из них подвержены ограничениям, обусловленным климатом и физическими характеристиками. В Соединенных Штатах около 20 проц. площади суши используется как пашня. Потенциально еще 11 проц. площади страны может быть использовано аналогичным образом, хотя часть ее представляет незначительный интерес для производства возделываемых культур. Такое увеличение площади пахоты может быть достигнуто только за счет увеличения интенсивности использования земли, занимаемой в настоящее время лесами и пастбищами.

Приложения

В Приложении 1 приводятся данные по участкам и профилям, включая описания и анализы профилей для некоторых из основных почвенных единиц. Соотношение между единицами почвенной карты мира ФАО/ЮНЕСКО, почвенной карты Соединенных Штатов (масштаб 1 : 7 500 000) и почвенной карты Канады (масштаб 1 : 5 000 000) представлено в Приложении 2.

En este volumen se describe la sección de América del Norte del Mapa Mundial de Suelos a escala 1 : 5 000 000. La compilación del Mapa de los Suelos de América del Norte fue efectuada conjuntamente en 1970-71 por el Instituto de Investigaciones Edafológicas del Departamento de Agricultura del Canadá y por el Servicio de Conservación de Suelos de la Secretaría de Agricultura de los Estados Unidos.

Los mapas

Las dos hojas con mapas que comprenden el Mapa de Suelos de América del Norte se han trazado sobre la base de los mapas topográficos de la serie a escala 1 : 5 000 000 de la American Geographical Society. Las unidades del mapa son asociaciones de unidades de suelos divididas en clases texturales y de inclinación. Se indican en el mapa por medio de símbolos. Los suelos dominantes se muestran por colores, mientras que las diferentes fases se indican con sobreimpresiones.

Un pequeño mapa intercalado en un recuadro indica la fiabilidad de la información sobre suelos que sirvió de base para la compilación del mapa.

En el Volumen I de la serie pueden encontrarse definiciones detalladas de las unidades de suelos y descripciones completas de todos los términos utilizados.

El texto

En el primer capítulo se describe el desarrollo del proyecto en América del Norte y se dan algunas notas sobre los usos posibles del mapa. En el segundo se da cuenta de la cooperación de organismos participantes y del gran número de personas que han colaborado en los mapas y en el texto, y en el tercero se da una breve explicación de la leyenda de suelos, descrita en detalle en el Volumen I, así como las principales fuentes de información utilizadas en la compilación del mapa.

Los principales capítulos de este volumen tratan de las condiciones ambientales, distribución de suelos y utilización y aptitud de las tierras.

CONDICIONES DEL MEDIO

El Capítulo 4 contiene breves reseñas, con mapas de los cuatro factores del medio que guardan una estrecha relación con la estructura de los suelos: clima del suelo, vegetación, fisiografía y geología superficial.

La clasificación del *clima del suelo* se basa en los regímenes de temperatura y humedad del mismo, tal como se definen en la taxonomía de los suelos agrícolas de la Secretaría de Agricultura de los Estados Unidos. Dado que los criterios adoptados para delimitar las unidades climáticas de suelos son aquellas que interesan al crecimiento de las plantas, el mapa de climas del suelo sirve así de complemento del mapa de suelos para la transferencia de información sobre cultivos de una parte del mundo a otra. Las principales regiones climáticas del suelo se bosquejan en un mapa a pequeña escala (Figura 2).

La *vegetación* se estudia sobre la base de 24 regiones naturales de vegetación potenciales, diferenciadas sobre la base de la asociación de las comunidades de plantas y de su relación con las condiciones ambientales. Estas regiones se bosquejan en un mapa a pequeña escala (Figura 3). El texto contiene algunas breves notas sobre cada región.

El examen de las *regiones fisiográficas* comprende breves exposiciones sobre la geología y geomorfología de amplias zonas del subcontinente. Se delimitan 12 regiones en un mapa a pequeña escala (Figura 4).

La *geología superficial* se muestra únicamente mediante un mapa (Figura 5), sin texto explicativo alguno. Catorce unidades cartográficas muestran tipos de rocas dominantes agrupados según la era geológica.

LOS SUELOS Y EL USO DE LA TIERRA

Los Capítulos 5 y 6, en que se describen los suelos del continente, contienen un extenso cuadro de las asociaciones de suelos, una reseña de la distribución de los suelos principales y un estudio sobre

el uso de la tierra y de la aptitud de los suelos para la agricultura.

En el cuadro de *asociaciones de suelos* se enumeran todas las unidades del mapa por orden alfabético de los símbolos. En las otras columnas se presentan:

Suelos asociados
Inclusiones
Fases
Superficie de las unidades en miles de ha
Clima
Regiones en que se presentan
Vegetación
Litología o materiales de partida

La *distribución de los suelos principales* se examina sobre la base de 18 grandes regiones de suelos, que se delimitan en un mapa a pequeña escala (Figura 6). Los suelos principales de cada región se estudian en relación con los factores del ambiente y se da una breve indicación de su extensión y emplazamiento.

La *descripción y distribución de los suelos, utilización de las tierras y aptitud de los suelos* se estudian en el Capítulo 6. En una breve nota preliminar al capítulo se esboza la distribución de las principales clases de utilización de las tierras en América del Norte, completando esta exposición con la ilustración de la Figura 7.

Seguidamente se estudian las principales unidades del suelo por separado y en orden alfabético. Para cada unidad se examina su distribución general, los regímenes de temperatura y humedad del suelo, el material de partida, la topografía, la utilización de la tierra, la productividad y los problemas de ordenación. También se exponen brevemente características específicas y aptitud y utilización de las subunidades de suelos.

Conclusiones

La mayoría de los suelos en la parte septentrional de América del Norte tienen regímenes de temperatura demasiado fríos, o regímenes de humedad demasiado húmedos, o pendientes demasiado escarpadas para que puedan utilizarse en la producción de alimentos, forrajes o fibras; algunos constituyen una fuente de madera y otros sirven como hábitat para la vida silvestre. Los de la parte meridional del continente se hallan en un medio ambiente generalmente más apto para la agricultura, si bien en la parte sudoriental sufren limitaciones impuestas por una falta de humedad y en las partes occidental y oriental por laderas demasiado escarpadas de montañas y colinas. En Canadá, sólo en un 5 por ciento de su extensión territorial los suelos se utilizan para la explotación agrícola. Otro 2 por ciento de la superficie del país ofrece un potencial para el desarrollo, si bien parte de ellos tienen limitaciones impuestas por el clima y por caracteres físicos. En los Estados Unidos, alrededor del 20 por ciento de la superficie del país se utiliza como tierras labrantías. Potencialmente podría utilizarse otro 11 por ciento de las tierras en modo semejante, si bien algunas de ellas son marginales para la producción de cultivos. Este aumento en la superficie de las tierras agrícolas podría lograrse únicamente redoblando la intensidad con que hoy se utilizan las tierras ocupadas por bosques y pastos.

Apéndices

En el Apéndice 1 se dan datos sobre emplazamientos y perfiles, e incluso descripciones y análisis de perfiles, para algunas de las principales unidades de suelos. En el Apéndice 2 se presenta una correlación entre las unidades del Mapa Mundial de Suelos FAO/Unesco, el Mapa de Suelos de los Estados Unidos (escala 1 : 7 500 000) y el Mapa de Suelos del Canadá (escala 1 : 5 000 000).

1. INTRODUCTION

History of the project¹

Recognizing the need for an integrated knowledge of the soils of the world, the Seventh Congress of the International Society of Soil Science, held at Madison, Wisconsin, United States in 1960, recommended that ways and means be found for the publication of soil maps of the great regions of the world. As a follow-up to this recommendation, FAO and Unesco agreed in 1961 to prepare jointly a Soil Map of the World based on the compilation of available soil survey material and on additional field correlation. The secretariat of the joint project was located at the headquarters of FAO in Rome. It was responsible for collecting and compiling the technical information, undertook correlation studies, and drafted the maps and text.

In June 1961 an advisory panel composed of prominent soil scientists representing various parts of the world was convened by FAO and Unesco to study the methodological, scientific and various other problems related to the preparation of a Soil Map of the World.²

A meeting on Soil Correlation for North America was held in Mexico in February 1965. This meeting and related study tour, from Mexico City to the Pacific coast, was the first consultation on soil correlation problems and on the preparation of a general soil map of the North American continent. Its purpose was to compare the soil units used for the general maps prepared in Canada, Mexico and the United States, and to discuss the possibility of preparing a continental soil map with a unified legend at a scale of 1 : 5 000 000.

¹This section refers mainly to the preparation of the Soil Map of North America. The history of the project as a whole is dealt with more completely in Volume I.

²The participants at this meeting were:

Consultants: G. Aubert (France), M. Camargo (Brazil), J. D'Hoore (Belgium), E. Lobova (U.S.S.R.), S.P. Raychaudhuri (India), G.D. Smith (United States), C.G. Stephens (Australia), R. Tavernier (Belgium), N.H. Taylor (New Zealand), I.V. Tiurin (U.S.S.R.), F.A. Van Baren (Netherlands).

Unesco Secretariat: V. Kovda and M. Batisse.

FAO Secretariat: D. Luis Bramão, R. Dudal and F. George.

The FAO Secretariat was entrusted with the drafting of a set of definitions of soil units which would fit the soils of the North American continent on the basis of the definitions used in the respective countries.

These definitions were discussed at the International Congress of Soil Science in Bucharest, and the comments made were incorporated in a second draft which was presented at a second meeting on soil correlation for North America, held in Vancouver, Canada, in August 1966. The meeting was preceded by a study tour initiated at Winnipeg, which offered the opportunity of correlating the national soil units between North American countries and testing the second draft of the soil definitions for the Soil Map of the World.

This second draft was later discussed by the Advisory Panel of the Soil Map of the World held in Moscow in August 1966.

A third soil correlation meeting for North America was held at El Paso, Texas, in October 1967, in combination with a field correlation in the southeastern United States. It was agreed that the Soil Conservation Service of the U.S. Department of Agriculture would assume the responsibility for the coordination of work to be carried out for the compilation of the Soil Map of North America. A first draft of the map was completed in 1968 and presented at the Ninth Congress of the International Society of Soil Science in Australia.

The main sources of information used in the preparation of the Soil Map of North America are described in Chapter 3.

Objectives

Transfer of knowledge and experience from one area of the earth to another can only be successful when allowance is made for similarities and differences in the geographical, soil and climatic conditions of the regions or countries involved. Furthermore, the economic feasibility of different management techniques under prevailing socioeconomic condi-

tions needs to be assessed before they can be recommended for adoption. Reliable information on the nature and distribution of the major soils of the world is thus of fundamental importance. However, the preparation of regional and continental soil maps requires a uniform legend and nomenclature and the correlation of existing soil classification systems. One of the principal objectives of the FAO/Unesco Soil Map of the World project was to promote agreement among soil scientists all over the world on an international soil correlation system.

The Soil Map of North America and the explanatory text provide background information allowing safe transfer of agricultural techniques developed in Canada and the United States to other areas of the world having similar environmental conditions.

Value and limitations of the map

The Soil Map of the World is meant to be a source of factual data, providing a basis and framework for further regional and national soil surveys at a more detailed scale. It may assist in selecting methods for reclamation, crop production, fertilizer application and general use of soils. Until now all attempts to make overall plans or forecasts for agriculture have been hampered by lack of uniformity in the terminology, nomenclature and classification of soils, and by lack of a comprehensive picture of the world's soil resources.

Through a systematic interpretation of the Soil Map of the World, it will be possible to make an appraisal of the distribution and the production potential of the major soils on a continental basis and to delineate broad areas having priority for further study. This inventory of soil resources will bring to light the limitations and potentialities of the various regions of the world for increased food production.

In addition, a global soil map can be a valuable teaching aid for the training of geographers, soil scientists, agronomists and all those who are involved with the study of the environment.

Although the publication of the Soil Map of the World marks a significant step forward, it is necessary to point out its inherent limitations. The accuracy and detail of the information which can be shown are obviously limited by the small scale of the map and by the fact that soil data for some areas are scarce because of lack of direct observations. These limitations also apply to the interpretative data, since they can only be as accurate as the soils information on which they are based. Despite these shortcomings, this soil map is the

most recent and detailed inventory of soil resources based on international cooperation. Its limitations emphasize the necessity for intensified soil correlation and for obtaining better knowledge of the nature and distribution of soils in those parts of the world where information is lacking.

Use of the map and explanatory text

Against the background of the topographic base, the soil map shows the broad pattern of dominant soils, marked by different colours. Clusters of closely related colours have been used for soils which have similar characteristics so that major soil regions can be recognized.

More detailed information about each mapping unit can be derived from the soil association symbols. The composition of the soil associations is given in Chapter 5; in Table 6 they are listed alphabetically and numerically, together with areas, location, dominant vegetation, soil climate and lithology. A table showing the composition of the soil associations is also given on the back of the maps.

The meaning of the classes for texture and topography which accompany the symbols of the mapping units is also explained on the soil map, as is the explanation of the overprints which indicate phases. These are further described in Chapter 3. The definitions of the soil units involved can be found in Volume I. The profile descriptions and analytical data in Appendix 1 illustrate and further clarify the soil definitions. Appendix 2 is a correlation table of the FAO soil units with the units of the reference soil maps of Canada and the United States.

The geographical distribution of the soils is indicated in Chapter 5. For this purpose the continent has been subdivided into major soil regions.

Chapter 6 gives information on the occurrence, land use, limitations, suitabilities and potentialities of the soil units in Canada and the United States. The specific management problems of the soil units are discussed in this chapter.

Those who are interested not only in the nature, distribution and suitabilities of the soils, but also in the natural environment, will find additional reading in Chapter 4. This chapter deals with soil climate, with potential natural vegetation (which in great parts of Canada can still be observed), with physiography (supplementing information in the chapter on the distribution of soils) and with lithology.

Some general conclusions of the study may be found at the end of Chapter 6.

2. ACKNOWLEDGEMENTS

The preparation of the Soil Map of North America could be accomplished only with the cooperation of the Governments of Canada and the United States, and of private institutions and soil scientists, who provided basic material and took an active part in the meetings, study tours and discussions which led to the various drafts of the map and text.

It would not be possible to name all those on whose work the Soil Map of North America is based. A total acknowledgement is therefore made of the contributions of the National Cooperative Soil Survey of the United States of America and the National Soil Survey Committee of Canada. For the preparation of the 1 : 5 000 000 map and the accompanying explanatory text primary responsibility rested with the deputy administrator for Soil Survey of the U.S. Department of Agriculture Soil Conservation Service, successively Ch. E. Kellogg and W.M. Johnson, the director and staff for Soil Survey Investigations, G.D. Smith and J.F. Douglass, and the head of the Soil Geography Unit,

K.T. Ackerson. In Canada, the responsibility rested with W.A. Ehrlich, research coordinator, Research Branch of the Canada Department of Agriculture, with the staff of the Soil Research Institute, J.S. Clayton, D.B. Cann, J.H. Day, and I.B. Marshall; and the Agrometeorology Section of the Plant Research Institute for its aid in developing criteria for the soil climates of Canada. The correlation with the Soil Map of Mexico was made with the assistance of G. Flores Mata, Director, Dirección de Agrología, Secretaría de Recursos Hidráulicos.

In FAO, the editorial work on the explanatory text and the map was carried out by A. Pérot. The responsibility for the intercontinental correlation and preparation of the international legend was entrusted to R. Dudal.

Grateful acknowledgement is made of the permission given by the American Geographical Society of New York to use its 1 : 5 000 000 World Map as a basis for the preparation of the Soil Map of the World.

3. THE MAP

Topographic base

The Soil Map of North America was compiled on the 1 : 5 000 000 topographic map series of the American Geographical Society of New York. For North America, this map is in two sheets divided between latitudes 48° and 56°N. A bipolar oblique conic conformal projection was used.

Areas of land surface measured directly on the map with a planimeter are subject to errors of less than 8 percent; distances are subject to errors of less than 4 percent. Accuracy can be greatly improved by use of the key map on the American Geographical Society map, which gives lines of equal scale departure and conversion tables based on mean scale departure ratio.

Map units

The map unit consists of a soil unit or of an association of soil units. The textural class is indicated for the dominant soil unit and a slope class reflects the topography in which the soil association occurs. Furthermore, the associations may be phased according to the presence of indurated layers or hard rock at shallow depth, stoniness, salinity and alkalinity. The soil units, classes and phases are defined in Volume I.

Each soil association is composed of dominant and subdominant soil units, the latter estimated to cover at least 20 percent of the delimited area. Important soil units which cover less than 20 percent of the area are added as inclusions.

The symbols of the mapping units show the soil unit, textural class and slope class as follows:

Soil units. The symbols used for identification of the soil units are those shown in the list of soil units on the back of the map. They are listed also in Table 1.

Textural classes. The textural classes, coarse, medium and fine, are shown by the symbols 1, 2 and 3 respectively.

Slope classes. The slope classes, level to gently undulating, rolling to hilly, and strongly dissected to mountainous, are indicated by the letters a, b and c respectively.

Cartographic representation

SYMBOLS

The soil associations have been identified on the map by the symbol representing the dominant soil unit, followed by a figure which refers to the descriptive legend on the back of the map in which the full composition of the association is outlined.

Example: Ao38 Orthic Acrisols and Ferric Acrisols with inclusions of Dystric Planosols

Ao39 Orthic Acrisols and Humic Cambisols

Associations in which Lithosols are dominant are identified by the Lithosol symbol I combined with the symbol for one or two associated soil units.

Example: I-Be Lithosols and Eutric Cambisols

I-La-Bd Lithosols, Albic Luvisols and Dystric Cambisols

Where there are no associated soils or where the associated soils are not known, the symbol I is used alone.

If information on the texture of the surface layers (upper 30 cm) of the dominant soil is available the textural class figure follows the association figure, separated from it by a dash.

Example: Ao38-2 Orthic Acrisols, medium textured, and Ferric Acrisols, with inclusions of Dystric Planosols

Ao39-2 Orthic Acrisols, medium textured, and Humic Cambisols

Where two groups of textures occur that cannot be delimited on the map two figures may be used.

Example: Bd12-2/3 Dystric Cambisols, medium to fine textured, and Albic Luvisols

TABLE 1. - SOIL UNITS FOR NORTH AMERICA

J FLUVISOLS	V VERTISOLS	C CHERNOZEMS	D PODZOLUVISOLS
Je Eutric Fluvisols	Vp Pellic Vertisols	Ch Haplic Chernozems	De Eutric Podzoluvisols
Jc Calcaric Fluvisols	Vc Chromic Vertisols	Ck Calcic Chernozems	Dg Gleyic Podzoluvisols
Jd Dystric Fluvisols		Cl Luvic Chernozems	
Jt Thionic Fluvisols	Z SOLONCHAKS		P PODZOLS
	Zo Orthic Solonchaks	H PHAEZEMS	Po Orthic Podzols
G GLEYSOLS	Zg Gleyic Solonchaks	Hh Haplic Phaeozems	Pl Leptic Podzols
Ge Eutric Gleysols		HI Luvic Phaeozems	Pg Gleyic Podzols
Gc Calcaric Gleysols	S SOLONETZ	Hg Gleyic Phaeozems	
Gd Dystric Gleysols	So Orthic Solonetz		W PLANOSOLS
Gm Mollic Gleysols	Sm Mollic Solonetz	M GREYZEMS	We Eutric Planosols
Gh Humic Gleysols	Sg Gleyic Solonetz	Mo Orthic Greyzems	Wd Dystric Planosols
Gx Gelic Gleysols			Wm Mollic Planosols
	Y YERMOSOLS		
R REGOSOLS	Yh Haplic Yermosols	B CAMBISOLS	A ACRISOLS
Re Eutric Regosols	Yk Calcic Yermosols	Be Eutric Cambisols	Ao Orthic Acrisols
Rc Calcaric Regosols	Yy Gypsic Yermosols	Bd Dystric Cambisols	Af Ferric Acrisols
Rd Dystric Regosols	Yl Luvic Yermosols	Bh Humic Cambisols	Ah Humic Acrisols
Rx Gelic Regosols		Bx Gelic Cambisols	Ap Plinthic Acrisols
	X XEROSOLS	Bc Calcic Cambisols	Ag Gleyic Acrisols
	Xh Haplic Xerosols	Bk Chromic Cambisols	
I LITHOSOLS	Xk Calcic Xerosols	Bg Gleyic Cambisols	N NITOSOLS
	Xl Luvic Xerosols		Ne Eutric Nitosols
E RENDZINAS		L LUVISOLS	Nd Dystric Nitosols
	K KASTANOZEMS	Lo Orthic Luvisols	
T ANDOSOLS	Kh Haplic Kastanozems	Lc Chromic Luvisols	O HISTOSOLS
Tv Vitric Andosols	Kk Calcic Kastanozems	Lk Calcic Luvisols	Oe Eutric Histosols
	Kl Luvic Kastanozems	La Albic Luvisols	Od Dystric Histosols
		Lg Gleyic Luvisols	Ox Gelic Histosols

Where information on relief is available the slope classes are indicated by a small letter, a, b or c, immediately following the textural notation.

Example: Ao38-2a Orthic Acrisols, medium textured, and Ferric Acrisols, with inclusions of Dystric Planosols; level to gently undulating

In complex areas where two types of topography occur that cannot be delimited on the map two letters may be used.

Example: Ao37-2bc Orthic Acrisols, medium textured, and Haplic Phaeozems with inclusions of Humic Cambisols, rolling to steep

If information on texture is not available, then the small letter indicating the slope class will immediately follow the association symbol.

Example: I-Be-c Lithosols and Eutric Cambisols, steep

MAP COLOURS

The soil associations have been coloured according to the dominant soil unit. Each of the soil

units used for the Soil Map of the World has been assigned a specific colour. The distinction between map units is shown by a symbol on the map.

The colour selection is made by clusters so that "soil regions" of genetically related soils will show up clearly.

If insufficient information is available to specify the dominant soil unit, the group of units as a whole is marked by the colour of the first unit mentioned in the list (for example, the colour of the Eutric Histosols to show Histosols in general).

Associations dominated by Lithosols are shown by a striped pattern and by the colour of the associated soils. If no associated soils are recognized (because they occupy less than 20 percent of the area or because specific information is lacking) the colour of the Lithosol unit is applied uniformly over the hatched pattern.

PHASES

Phases are indicated on the Soil Map of the World by overprints.

The *fragic* and *duric* phases show the presence of an indurated horizon such as a fragipan or a duripan occurring within 100 cm of the surface.

The *lithic* phase indicates the occurrence of hard rock between 10 and 50 cm from the surface.

The *petrocalcic* phase shows the occurrence of a petrocalcic horizon within 100 cm of the surface.

The *stony* phase marks areas where the presence of gravels, stones, boulders or rock outcrops makes the use of mechanized agricultural equipment impracticable.

The *saline* phase shows that certain soils of the association (not necessarily the dominant ones) are affected by salt to the extent that they have a conductivity greater than 4 mmhos/cm in some part of the soil within 125 cm of the surface for some part of the year. The phase is intended to mark present or potential salinization. It should be noted that saline phases are not shown as these soils are saline by definition. It follows that to identify all areas with saline soils one should include saline phases plus Solonchaks.

Where more than one of these phases applies, only the one causing the strongest limitations for agricultural production has been shown.

MISCELLANEOUS LAND UNITS

Miscellaneous land units are used to indicate salt flats, dunes and shifting sand, and glaciers and snow caps.

Where the extent of the land unit is large enough to be shown separately the sign may be printed over a blank background. In case the land unit occurs in combination with a soil association the sign may be printed over the colour of the dominant soil.

Sources of information

A map showing the sources of information of the Soil Map of North America (Figure 1) is shown as an inset on the soil map. A distinction is made between the areas compiled from systematic soil surveys, soil reconnaissance, and general information with local field observations.

About 29 percent of the continent is now covered by soil survey maps based on systematic field work. Inevitably, there is variation in accuracy among these maps, depending on a number of factors such as scale, date of survey and methods of classification, which makes correlation more difficult and directly reduces the reliability of the map. Further uncertainty is introduced by the influence on soil boundaries of differing concepts used in defining the units.

In approximately 16 percent of the continent, in areas extensively distributed throughout the western United States and central Canada, information about

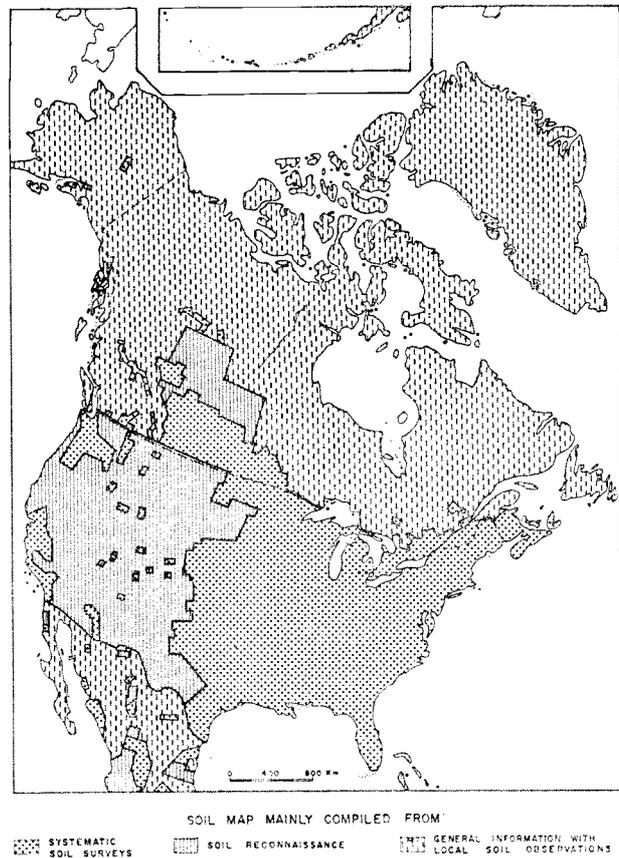


Figure 1. - Sources of information

soils is based on exploratory and reconnaissance studies designed to give, in combination with basic information on the natural environment, a fair idea of the composition of the soil pattern. Advantage was taken of marked changes in the vegetational, geomorphological, lithological and climatic patterns in the preparation of the soil maps of certain areas where there was insufficient coverage by soil surveys.

In the north, in an area which includes 55 percent of the continent, the land is either unexplored or soil studies have not supplied sufficient basic data for the compilation of more than a rough sketch of the soil pattern, even at the 1 : 5 000 000 scale. To understand the soil pattern of these regions, therefore, further studies still need to be undertaken. However, since these regions are for the most part thinly populated and have poor accessibility, they usually have a low priority for development. It may take a long time for the data necessary for improving the map to become available. Information obtained through remote sensing from spacecraft and satellites may eventually be used.

The main sources of information directly utilized in Canada and the United States for the compilation of the Soil Map of the World were the following:

Canada. A generalized soil map of Canada at 1 : 10 000 000 scale was published in the Atlas of Canada in 1957 (Department of Mines and Technical Surveys, Geographical Branch, Ottawa) and gives a general picture of the distribution of the great soil groups in the country. A new soil map at the approximate scale of 1 : 4 000 000 was issued in 1967. This map was later adjusted to the 1 : 5 000 000 scale and the legend correlated with the units of the Soil Map of the World.

United States. A general soil map at a scale of 1 : 5 000 000 using the "7th approximation of a comprehensive system of soil classification" was prepared by the U.S. Soil Conservation Service, and exhibited at the International Congress of Soil Science in Bucharest in 1964. The map is based on three levels of generalization: orders, great soil groups and slope phases.

A soil map of the western states had also been published in 1964 at the 1 : 2 500 000 scale by the Western Land Grant Universities and Colleges, in cooperation with the U.S. Soil Conservation Service. This map was essentially based on the 1938 classification. A similar map had been published in 1960 for the north central region of the United States.

A general soil map of the United States at 1 : 7 500 000 was published in 1969 by the U.S. Soil Conservation Service on the National Atlas base. The map units are mostly associations of great groups with slope phases. Soils information on the United States section of the Soil Map of the World was based on this last map.

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4. ENVIRONMENTAL CONDITIONS

In this chapter brief outlines are given of four aspects of the environment that are important in the development of soils. These are soil climate, vegetation, physiography and geology.

The outlines, each of which is accompanied by a small-scale map, indicate the location and nature of the major regions in which important variants of climate, vegetation, landscape and rock types occur.

SOIL CLIMATE

Weather and climate are abstract concepts involving the temperature-moisture-energy relationships of the biosphere with respect to time and place. Weather is the momentary state of the aerial portion of the environment resulting from the interaction of these factors. Climate involves a much longer period of time and includes the effects of the interrelationships of terrestrial as well as aerial conditions in the complete soil-air ecosystem.

Historically, most classification systems for climate have emphasized the aerial biosphere and have been based on direct interpretations of air temperature and precipitation distributions. Climatic types have also been identified and their boundaries determined empirically by noting the relationships of kinds of vegetation, soils and drainage features. None of these systems, however, account for the interaction between aerial climate and soil climate.

Soil climate relates to aerial climate, but the responses are affected in time and degree mainly by the water content, depth, surface cover (vegetative or snow), landscape position of the soils and human manipulation. The interactions are often indirect, complex and difficult to evaluate. Soil climate classification systems are relatively new and few have been published simply because data have been inadequate or not available on a scale comparable with that of standard aerial climate data.

The present attempt to organize a provisional classification of soil climate for North America integrates the available data with current concepts of soil temperature and moisture, the relationships of climate and vegetation to soils and recognized regional climatic separations which have stood the test of time and practical interpretation.

Comprehensive discussions of soil temperature and moisture regimes as considered in the United States are given in the U.S. Soil Conservation Service, *Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys*. The publication defines the soil temperature and moisture regimes used in the United States at various categorical levels for soil taxonomy.

Soil temperature regimes are based on consideration of mean annual soil temperature (MAST) and/or mean summer (June, July, August) soil temperature (MSST), and the mean seasonal soil temperature gradient within the root zone. Soil moisture regimes are defined in terms of the presence or absence of groundwater, or of the water available to plants within a specified control section of soil for varying periods of time when the soil temperature is above biologic zero, 5°C (41°F).

Soil temperature and moisture regimes and their use in preparation of a Soil Climate Classification and Map for Canada have been discussed in a series of papers and reports prepared for the Canada Soil Survey Sub-Committee on Climate.^{1,2,3} They involve definitions of a growing season (above 5°C) with mild (above 5°C) and thermal (above 15°C [59°F]) periods, and a dormant season (below 5°C) with cool (above 0°C [32°F]) and frozen (below 0°C) periods, based on soil-temperature measurements. Temperature classes are based on characterization of these periods in respect to length, mean soil temperature and accumulated degree days, above or below the threshold values on which the periods are defined. Temperatures at 50 cm are considered the standard

¹ Report of the Sub-Committee on Climate, 1970.

² Clayton, 1971.

³ Baier and Mack, 1971.

classification, but observations at 20 and 100 cm are also considered in evaluating the soil control section. Moisture subclasses are recognized on the basis of stated periods of saturation for aquic regimes, and on calculations for intensity and degree of water deficits during the growing season for moist and sub-moist regimes.

Discussions and correlative work among soil scientists and climatologists of the United States and Canada have resulted in broadly correlated criteria for categorizing soil temperature and moisture regimes as well as the nomenclature to be used. The resulting classification system is based on evaluations of those regimes. Seven soil temperature regimes, ranging from arctic (MAST below -7°C) to hyperthermic (MAST above 22°C), express the relationship of soil temperatures to length, magnitude and intensity of heat conditions during various seasons of the year. Ten moisture regimes evaluate the duration and amount of soil moisture, ranging from peraquic (with free water surfaces) through aquic (saturated) to moist and dry regimes. Tables 2a and 2b give short descriptions of the soil temperature and soil moisture regimes.

The soil climate map (Figure 2) shows the distribution of the soil climates of North America expressed in terms of dominant soil temperature and moisture regimes. The soil climate of the dominant and sub-dominant soils in the soil units in this report are described in terms of these same regimes. The delineation of areas having unique combinations of soil temperature and moisture regimes is based on regional generalizations of soil climate. Because of the small scale of the map and the range of soil climate that can be expected to occur within short distances, soil temperature regimes warmer and/or cooler than those characterizing any delineation on the map can be expected to occur. Similarly, soil moisture regimes wetter and/or drier than those characterizing any delineation can also be expected to occur. Soil climate data and classifications for selected localities in Canada and the United States are provided in Tables 3 and 4 respectively. The framework of classification used is preliminary and the nomenclature and combinations of parameters and codings used are provisional; they are subject to modifications in the light of further studies, increasing knowledge and additional pragmatic considerations.

The characteristics of the soil climate of North America are of great significance, not only because of their influence on the kinds of soils developed, but also because of the limitations they impose on the use of these soils in the development of the land resources of the continent. Tables 5a and 5b provide a generalized summary of the extent of each kind of soil climate in Canada and the United States

and the percentage of the land area each represents. Separate figures for the aquic soil moisture regimes in Canada are not given; data for these areas are included with those of other soil moisture regimes.

In nearly 56 percent of Canada, including the Arctic islands, soil climate regimes are so extreme that the soils are incapable of supporting any but the most limited growth of forest or tundra-forest vegetation, and that for only a very short growing period each year. In the remainder of the country soil climate regimes are mild enough to sustain productive vegetative growth, but two thirds of this area has limitations of temperature or moisture which restrict the range and variety of crop. Only about 2 percent of the total area of the country has soil climates suited to high productivity for a wide range of crops.

In the United States only about 15 percent of the country has soil temperature regimes too cold to support productive vegetation. However, an additional 30 percent of the soils have climatic regimes either too wet or too dry to support productive vegetation unless measures are taken to alter the soil climate for specific uses. In the remainder of the United States soil climate is generally conducive to production of a wide range of cultivated crops, pasture and forage, and forest.

Soil temperature

The arctic soil temperature regime, characteristic of soils extending in an east-west belt across northern Canada and Alaska and the northern islands, is associated with barren lands or treeless tundra. The soils include Gelic Cambisols, Gleysols, Regosols, Histosols and Lithosols. They are weakly developed, greatly disturbed by ice movements and usually underlain at shallow depths by permafrost. Problems associated with arctic soil climates and soils involve protection of natural vegetation from destruction by overgrazing, prevention of damage from vehicular traffic and other human activities, and the preservation of the natural equilibrium between the shallow active or unfrozen layer and the underlying permafrost during the short summer season.

The soils with subarctic temperature regimes extend in an east-west belt from Labrador to the Northwest Territories, Yukon and Alaska. Included are the subalpine areas of the higher elevations of the Cordilleran region mountain complex extending southward from Alaska to approximately the international border. Dominant soils include Cambisols, Podzols and Luvisols with associated Gelic Histosols and Gleysols, and extensive areas of Lithic Regosols and Lithosols. The soils usually thaw and warm suffi-

ciently to maintain limited biological activities during the summer months, but discontinuous permafrost occurs below the active layer. Undisturbed soils support a mixed vegetation of unproductive coniferous forest and subarctic woodlands with intermittent treeless tundra. Alpine areas above the tree line are characterized by heath vegetation. Soils with subarctic temperature regimes are unsuited for extensive cropping or commercial forestry, although isolated areas of productive forest occur in favoured or sheltered locations. Garden crops and some grain and forage for local needs are produced in areas adjacent to settlements, particularly where proximity to lakes or other bodies of water results in a local amelioration of the climatic conditions. Management problems involve the protection of vegetation as a vital component in the equilibrium of the natural environment.

From the areas with subarctic soil temperature regimes south to the northern part of the United States and extending from the east to the west coasts are soils with cryoboreal and boreal temperature regimes. In this area are more than one third of the soils of Canada but only a small part of the soils of the United States. Cold to moderately cold cryoboreal temperature regimes with relatively cool summers impose moderately severe limitations on the kinds of crops that can be matured and on the annual productivity of the native forest. The moderately cold cryoboreal areas are generally suitable for the production of small grains, including spring wheat and forage. The coldest portions of the area with cryoboreal temperatures extend beyond the limits of marginal crop production. Limitations are due mainly to shortness of growing season within both the aerial and subaerial portions of the plant environment.

Soils that have cool to moderately cool boreal climates are characterized by a longer growing season and a warmer summer period and by less severe limitations to their productive use than those of cryoboreal areas.

The soils of slightly more than one third of the United States have mesic temperature regimes; in Canada they are much less extensive, comprising only about 1.3 percent of the country. They extend in a broad band from the Pacific coast between northern California and southern British Columbia southeast toward Mexico, then northeast toward the Great Lakes and southernmost Ontario and east to the Atlantic coast. Limitations in farming potential are generally not related to soil temperature but to other soil features — particularly moisture regimes with seasonal or perennial deficits for crops, soil slope, and, in some, inherent lack of fertility. In the more humid east and west, the soils support forest and a variety of cultivated crops; in the midwest they

TABLE 2a. — GENERALIZED CHARACTERISTICS OF TEMPERATURE REGIMES USED FOR THE SOIL CLIMATE MAP OF NORTH AMERICA

-
1. ARCTIC
 - a. Extremely cold. MAST less than -7°C .
Continuous permafrost below active layer within the control section (1 m).
 - b. No significant growing season. Less than 15 days above 5°C .
 - c. Cold to very cool summer. MSST below 5°C .
No warm period above 15°C .
 2. SUBARCTIC
 - a. Very cold. MAST -7 to 2°C .
Discontinuous permafrost may occur below active layer.
 - b. Short growing season. Less than 120 days above 5°C .
Degree days, base: 5°C , fewer than 550.
 - c. Moderately cool summer. MSST $5-8^{\circ}\text{C}$.
No warm period above 15°C .
 3. CRYOBOREAL
 - a. Cold to moderately cold. MAST $2-8^{\circ}\text{C}$.
Undisturbed soils usually frozen in some part for a portion of the dormant season. Soils with aquic regimes may remain frozen for portions of the growing season.
 - b. Moderately short to moderately long growing season.
140-220 days above 5°C . Degree days, base: 5°C , 550-1 250.
 - c. Mild summer. MSST $8-15^{\circ}\text{C}$.
An insignificant or very short warm period. 0-60 days above 15°C . Degree days, base: 15°C , fewer than 30.
 4. BOREAL
 - a. Cool to moderately cool. MAST $5-8^{\circ}\text{C}$.
Undisturbed soils may or may not be frozen in part for a short portion of the dormant season.
 - b. Moderately short to moderately long growing season.
170-220 days above 5°C . Degree days, base: 5°C , 1 250-1 700.
 - c. Mild to moderately warm summer. MSST $15-18^{\circ}\text{C}$.
Significant very short to short warm period. More than 60 days above 15°C . Degree days, base: 15°C , 30-200.
 5. MESIC
 - a. Mild to moderately warm. MAST $8-15^{\circ}\text{C}$.
Undisturbed soils are rarely frozen during dormant season.
 - b. Moderately long to nearly continuous growing season.
200-365 days above 5°C . Degree days, base: 5°C , 1 700-2 800.
 - c. Moderately warm to warm summer. MSST $15-22^{\circ}\text{C}$.
Short to moderately short warm period. 90-180 days above 15°C . Degree days, base: 15°C , 150-650.
 6. THERMIC
 - a. Moderately warm to warm. MAST $15-22^{\circ}\text{C}$.
Soils never frozen.
 - b. Long growing season.
 7. HYPERTHERMIC
 - a. Very warm to hot. MAST above 22°C .
 - b. Continuous growing season.
-

TABLE 2b. — GENERALIZED CHARACTERISTICS OF MOISTURE REGIMES USED FOR THE SOIL CLIMATE MAP OF NORTH AMERICA

REGIMES OF SATURATED SOILS

- a. Peraquic Soil saturated for very long periods. Ground water level at or within capillary reach of the surface.
- b. Aquic Soil saturated for moderately long periods.
- c. Subaquic Soil saturated for short periods.

REGIMES OF UNSATURATED SOILS (*i* indicates United States criteria;¹ *ii* indicates calculated Canadian criteria^{2,3})

- d. Perhumid
 - i* Soil moist all year, seldom dry.
 - ii* No significant water deficits in the growing season. Water deficits 0-2.5 cm. Climatic Moisture Index (CMI) more than 84.
- e. Humid
 - i* Soil not dry in any part for as many as 90 cumulative days.
 - ii* Very slight deficits in the growing season. Water deficits 2.5-6.4 cm. CMI 74-84.
- f. Subhumid
 - i* Soil dry in some or all parts for 90 or more cumulative days when soil temperature is above 5°C; where soil temperature is above 5°C for less than 180 days, soil is dry for more than half of this period.
 - ii* Significant deficits within the growing season. Water deficits 6.4-12.7 cm. CMI 59-73.
- g. Semiarid
 - i* Soil dry in some parts more than half of time when soil temperature is above 5°C.
 - ii* Moderately severe deficits in growing season. Water deficits 12.7-19.1 cm. CMI 46-58.
- h. Subarid
 - i* Soil dry in some parts or all parts most of the time when soil temperature is above 5°C.
 - ii* Severe growing season deficits. Water deficits 19.1-38.1 cm in boreal and cryoboreal regimes, less than 50.8 cm in mesic or warmer regimes. CMI 25-45.
- j. Arid
 - i* Soil dry in all parts most of the time when soil temperature is above 5°C.
 - ii* Very severe growing season deficits. Water deficits more than 38.1 cm in boreal regimes and more than 50.8 cm in mesic or warmer regimes. CMI less than 25.
- k. Xeric
 - i* Soil dry in all parts 45 consecutive days or more within the four-month period following the summer solstice and moist in all parts 45 consecutive days or more within the four-month period following the winter solstice.

¹ U.S. Soil Conservation Service (in press).

² Sly, 1970.

³ Sly and Baier, 1971.

produce high yields of grains, in part under a system of dry-land farming; in the southwest, where soil moisture is very low, broad areas support only a sparse cover of xerophytic vegetation, or are barren, and crops can be grown only where irrigation is feasible.

Soils with thermic temperature regimes occupy about one fourth of the United States; none occur in Canada. These regimes also extend from coast to coast across most of the remaining southern part of the country. Like the soils with mesic temperature regimes, limitations in farming potential are due mostly to moisture regimes with slight to severe seasonal or perennial deficits.

Soils with hyperthermic temperature regimes are not extensive in the United States; there are none in Canada. These regimes occur in the southernmost parts of the country — southern California, southwestern Arizona, southern Texas, southeastern Louisiana and southern Florida. Limitations imposed on land use by temperature are minimal; they are mainly a matter of moisture deficits or surpluses. Limitations are most severe in the dry areas of the southwest where crops can be grown only under irrigation. They are somewhat less severe in southern Texas where some crops can be grown but where native grasses which support grazing are common. In Louisiana, the low-lying outer part of the Mississippi river delta is too wet for farming. In Florida, a wide variety of crops can be grown although shallow sandy soils and poor drainage limit choice of crops and intensive management is mandatory.

Soil moisture

Within all climatic regions, but particularly where soil climates are cryoboreal, boreal or mesic, the influence of soil moisture regimes is an additional factor in determining soil characteristics and use patterns.

In about 70 percent of the continent the dominant soils have aquic, perhumid or humid moisture regimes; by far the most extensive are those with humid regimes. Soils with these regimes have insignificant or very slight water deficits during the growing season. In the areas with perhumid regimes the occurrence of excess moisture for limited periods is common and the ability to achieve high crop production is often dependent on the provision of surface or subsurface drainage. Drainage is, of course, a prime consideration in the development of soils with aquic regimes. Under undisturbed conditions, most of the humid and perhumid soils support forest vegetation, ranging from the coniferous forests on soils with subarctic and cryoboreal temperature

regimes to the mixed forests on soils with thermic and hyperthermic moisture regimes. The major areas of crop production of the continent are associated with soils having humid and perhumid moisture regimes and boreal or warmer temperature regimes. In cryoboreal areas, the limitations of short season crop production are progressively more severe with increasing moisture content, and extension of cultivation on these colder wetter soils has been limited.

Slightly less than 10 percent of the continent has soils with a subhumid moisture regime with significant water deficits within the growing season. The major portion extends from the cryoboreal and boreal soils of western Canada toward the south to include the thermic and hyperthermic soils of central and southern Texas. Local areas with subhumid soil moisture regimes occur in the western part of the St. Lawrence lowland, on part of Vancouver Island and in the lower Fraser valley of British Columbia. Under natural conditions in the United States the soils in these areas sustain a variety of prairie grasses and xerophytic shrubs and grasses. In Canada they support a grassland-forest transition of parkland-prairie. Much of the area has been extensively developed for agriculture, particularly for small grains and forage production; cultivated crops require supplemental irrigation. In the interior plateau of British Columbia such areas are found at relatively higher elevations adjacent to the timberline and are used in the main for grazing.

Semiarid to subarid soil moisture regimes are dominant in soils of a little more than 10 percent of North America. These regimes, characterized by moderately severe to severe growing season water deficits, are of major occurrence in the southern interior plains in Saskatchewan and Alberta and south along the eastern piedmont of the Rocky mountains. Other areas occur in the valleys of the British Columbia interior plateau, in southeastern Idaho, central Oregon and at higher elevations in central Colorado and Wyoming. Most support a treeless mixed prairie vegetation. Small grains, particularly wheat, are grown on soils with these moisture regimes, with production being limited by the severity of the water deficits and by the moisture-holding capacities of the soils. Summer fallowing is widely used as a means of moisture conservation and irrigation is practised where adequate supplemental water is available.

Arid soil moisture regimes occur in the driest part of the southwestern United States; there are no soils in Canada with moisture regimes as dry. The total area of their occurrence comprises slightly less than 5 percent of the continent. These almost continuously dry soils support only sparse desertic grasses and shrubs and in many places they are barren.

LEGEND TO FIGURE 2

SOIL CLIMATE REGIMES¹

TEMPERATURE²

1	Arctic
2	Subarctic
3	Cryoboreal
4	Boreal
5	Mesic
6	Thermic
7	Hyperthermic

MOISTURE³

a	Peraquic
b	Aquic
c	Subaquic
d	Perhumid
e	Humid
f	Subhumid
g	Semiarid
h	Subarid
j	Arid
k	Xeric

¹ For definitions of soil temperature and soil moisture regimes, see Tables 2a and 2b. - ² Figures connected by a hyphen (-) identify an association of temperature regimes, the dominant regime preceding the hyphen. - ³ Multiple letters indicate an association of moisture regimes; those letters preceding or without a slash (/) are of approximately equal extent; those following are of lesser extent than those preceding the slash.

TABLE 3. - SOIL CLIMATE DATA AND CLASSIFICATION FOR SELECTED CANADIAN STATIONS

Station	Temperature (°C)										Moisture				Classification		
	Growing season > 5°			Thermal period > 15°			Dormant season < 5°		Freeze period < 0°		Observed precipitation		Calculated seasonal (May-Sept.)		Class	Subclass	Code
	Depth (cm)	Mean annual	Length (days)	Mean temp.	Degree days (C)	Length (days)	Mean temp.	Degree days (C)	Length (days)	Mean temp.	Length (days)	Mean temp.	Annual	Set-sonal			
Baker Lake	20	-10.2	64	6.8	117	0	—	0	301	249	—	15.2	14.2	—	—	Arctic	1
	50	-8.6	12	5.3	3	0	—	0	353	250	-9.1	—	—	—	—	—	—
	100	-8.0	0	—	0	0	—	0	365	263	-8.0	—	—	—	—	—	—
Haines Jct.	20	2.0	123	9.7	568	0	—	0	242	176	-1.9	3.4	—	—	Subarctic	2f	
	50	2.0	107	8.2	457	0	—	0	258	174	-0.6	2.0	—	—	—	—	—
	100	1.9	83	6.4	112	0	—	0	282	151	0.6	-0.7	—	—	—	—	—
Fort Chimo	20	-3.6	109	8.3	356	0	—	0	256	195	-8.6	-12.1	—	—	Subarctic	2e	
	50	-2.8	100	7.9	287	0	—	0	265	186	-6.9	-10.7	—	—	—	—	—
	100	-2.9	73	6.1	81	0	—	0	292	201	-5.1	-8.3	—	—	—	—	—
Beaverlodge	20	4.8	162	11.4	1 038	21	15.1	3	203	139	-0.4	-1.6	—	—	Cryoboreal	3f	
	50	5.1	164	10.8	952	0	—	0	201	115	0.4	-0.8	—	—	—	—	—
	100	5.1	167	9.1	687	0	—	0	198	0	1.7	—	—	—	—	—	—
Regina	20	4.9	170	12.7	1 300	62	17.0	123	195	139	-1.9	-3.6	—	—	Cryoboreal	3g	
	50	4.7	161	11.5	1 044	33	15.4	13	204	127	-0.8	-2.6	—	—	—	—	—
	100	4.4	155	9.9	766	0	—	0	210	121	0.4	-1.0	—	—	—	—	—
Normandin	20	5.9	164	12.3	1 189	44	15.5	20	201	81	0.8	-0.2	—	—	Cryoboreal	3d	
	50	6.1	168	11.7	1 125	0	—	0	197	10	1.3	-0.1	—	—	—	—	—
	100	6.0	176	10.2	919	0	—	0	189	2.1	2.1	—	—	—	—	—	—
Kapuskaing	20	7.2	177	13.2	1 454	84	16.2	146	188	1.6	—	—	—	—	Boreal	4d	
	50	7.3	185	12.2	1 338	66	15.8	52	180	2.3	—	—	—	—	—	—	—
	100	7.1	201	10.5	1 099	0	—	0	164	2.9	—	—	—	—	—	—	—
Saskatoon	20	4.9	174	13.8	1 533	82	17.2	177	191	3.3	-3.3	-5.6	—	—	Boreal	4g	
	50	5.8	178	13.4	1 502	84	16.8	152	187	1.4	-1.4	-3.4	—	—	—	—	—
	100	6.1	186	11.3	1 175	0	—	0	179	0.7	0.7	-0.8	—	—	—	—	—
Atikokan	20	6.8	174	13.7	1 521	87	17.4	207	191	0.5	-0.3	-0.3	—	—	Boreal	4f	
	50	7.3	180	13.5	1 524	86	17.2	183	185	1.2	1.2	-0.1	—	—	—	—	—
	100	7.2	187	11.9	1 290	55	15.6	32	178	2.2	2.2	—	—	—	—	—	—
Guelph	20	8.6	215	13.7	1 862	103	17.7	272	150	1.3	-0.2	-0.2	—	—	Mesic	5e	
	50	8.7	223	12.8	1 749	91	16.7	157	142	2.2	—	—	—	—	—	—	—
	100	8.8	235	11.9	1 624	75	15.9	71	130	3.1	—	—	—	—	—	—	—
Harrow	20	10.4	236	15.3	2 428	132	19.4	588	129	1.4	-0.1	-0.1	—	—	Mesic	5f	
	50	10.5	244	14.7	2 353	129	18.8	483	121	2.2	—	—	—	—	—	—	—
	100	10.5	262	13.4	2 191	117	17.6	303	103	3.1	—	—	—	—	—	—	—
Summerland	20	10.9	244	15.4	2 534	136	19.7	641	121	2.0	—	—	—	—	Mesic	5h	
	50	11.6	258	15.3	2 650	142	19.7	664	107	2.7	—	—	—	—	—	—	—
	100	11.9	278	14.6	2 654	141	19.2	588	87	3.7	—	—	—	—	—	—	—

¹ After Baier and Robertson. - * 5.1 cm readily available water.

TABLE 4. -- SOIL CLIMATE DATA AND CLASSIFICATION FOR SELECTED UNITED STATES STATIONS

Station	Temperature (°C)											Moisture				Classification					
	Depth (cm)	Growing season > 5°			Thermal period > 15°			Dormant season < 5°		Freeze period < 0°		Observed precipitation		Calculated seasonal (May-Sept.)		Class	Subclass	Code			
		Mean annual	Length (days)	Mean temp.	Degree days (C)	Length (days)	Mean temp.	Degree days (C)	Length (days)	Mean temp.	Length (days)	Mean temp.	Annual	Seasonal	PE				Deficit ¹	Index	
Archer	50	9.8	242	13.6	1 928	106	18.3	357	123	2.5	0	---	37.3	25.2	49.3	12.7	58	Mesic		5g	
Bushland, Tex. (Amarillo)	50	15.0	365	14.8	3 578	169	20.8	984	0	---	0	---	3...	33.3	3...	3...	3...	3...	Mesic-thermic		5-6f
Fort Collins ⁴																			Mesic		5g
Great Falls ⁴																			Boreal		4f
Hundley, Mont.	50	9.8	237	13.9	2 111	111	18.4	380	127	2.4	0	---	29.2	17.5	54.4	21.6	40	Mesic		5h	
Jackson ⁴																			Thermic		6d
Lincoln, Neb.	50	11.4	246	16.4	2 808	147	20.9	859	119	1.1	46	-0.5	125.2	47.8	31.0	0	91	Thermic		6d	
Lexington, Ky.	50	13.3	298	15.6	3 148	165	20.3	872	67	3.9	0	---	69.9	45.0	3...	3...	3...	Mesic		5c	
Lynchburg ⁴																			Mesic		5e
																			Thermic		6c
Medford ⁴																			Mesic		5h
Tempe, Ariz.	50	19.3	365	19.3	5 203	244	22.8	1 893	0	---	0	---	27.7	7.4	83.6	64.3	11	Thermic		6j	

¹ 5.1 cm readily available water. -- ² Thornthwaite PE. -- ³ Not calculated. -- ⁴ Soil temperature data missing. -- ⁵ After Baier and Robertson.

TABLE 5a. - EXTENT OF SOIL TEMPERATURE AND SOIL MOISTURE REGIMES IN CANADA

Soil moisture regimes \ Soil temperature regimes	Square kilometres						TOTAL	PERCENT
	Arctic	Subarctic	Cryoboreal	Boreal	Mesic			
Perhumid		77 466	1 497 169	196 452	26 363		1 797 450	19.6
Humid	2 759 836	1 823 564	786 793	55 605	49 007		5 474 805	59.6
Subhumid			244 717	43 218	11 976		299 911	3.3
Semiarid			32 267	96 924	666		129 857	1.4
Subarid				115 346			115 346	1.3
Complexes								
Perhumid and humid			120 821	231 889			352 710	3.8
Humid and subhumid		457 547	397 578	5 245	34 469		894 839	9.7
Subhumid and semiarid			75 459	31 478			106 937	1.2
Semiarid and subarid				11 541			11 541	0.1
TOTAL	2 759 836	2 358 577	3 154 804	787 698	122 481		9 183 396	100.0
PERCENT	30.0	25.7	34.4	8.6	1.3		100.0	

TABLE 5b. - EXTENT OF SOIL TEMPERATURE AND SOIL MOISTURE REGIMES IN THE UNITED STATES

Soil moisture regimes \ Soil temperature regimes	Square kilometres							TOTAL	PERCENT
	Arctic	Subarctic	Cryoboreal	Boreal	Mesic	Thermic	Hyper-thermic		
Peraquic							7 000	7 000	0.1
Aquic				202 800	1 009 400	354 430	88 000	1 654 630	18.0
Subaquic									
Perhumid		112 300	61 100	83 200	48 900			305 500	3.3
Humid	254 300	667 300		642 900	124 800	894 500	56 200	2 640 000	28.9
Subhumid				151 600	420 400	505 800		1 077 800	11.7
Semiarid				146 700	100 200			246 900	2.7
Subarid				124 600	867 700	14 700		1 007 000	11.0
Arid					259 100	357 000	85 600	701 700	7.6
Xeric				259 000	298 100	114 900		672 000	7.3
Complexes									
Aquic and humid					224 900			224 900	2.5
Aquic and subhumid				34 000				34 000	0.4
Humid and aquic		59 600	23 400					83 000	0.9
Humid and subhumid		442 500						442 500	4.8
Subhumid and semiarid						70 900		70 900	0.8
Arid and semiarid				7 000				7 000	0.1
TOTAL	254 300	1 281 700	84 500	1 651 800	3 353 500	2 312 230	236 800	9 174 830	100.0
PERCENT	2.8	14.0	0.9	18.0	36.5	25.2	2.6	100.0	

The mesic, thermic and hyperthermic soil temperature regimes of these dry soils are suited for production of a wide variety of crops where irrigation water is available.

Xeric moisture regimes characterize soils about equal in extent to those having arid moisture regimes. These regimes occur throughout much of California and on the western slopes and higher elevations of the Rocky mountains. Limitations are commonly a shortage of moisture during much of the growing season. In addition, many of the soils with xeric moisture regimes are steeply sloping or at elevations where soil temperature regimes are boreal; these features further limit potential for use. Where soil temperature regimes are warmer, slopes more moderate and water is available for irrigation, these soils can be used for cultivated crops; in their natural state, they support coniferous forest and grassland.

VEGETATION

The potential natural vegetation of North America is that which would exist if the influence of man were removed or had never occurred. It is distinguished from present vegetation, which is natural, semi-natural or cultivated, depending on the degree and extent of man's influence.

Much of the area of Canada and the state of Alaska is sparsely populated and undeveloped, and under these conditions the vegetation is essentially natural. It is only in areas of extensive agricultural or commercial forest activity and in the inextensive but established urban communities that the vegetation has been so changed that potential natural vegetation has to be inferred, in part, from that remaining in relict areas.

In the 48 conterminous states of the United States, extensive areas have been developed for agriculture, commercial forestry, industry and urban expansion. As a consequence, the potential natural vegetation of extensive areas of the United States must be inferred from that which remains in inextensive areas distributed throughout the country. In other parts of the country, the identity of the vegetation, as well as its habit of growth, its place in the succession to climax after disturbance, and its adaptation to regional environment are sufficiently known that reasonably accurate predictions about the potential natural vegetation can be made.

The geographic distribution of the potential natural vegetation of North America is shown on Fig-

ure 3. The vegetation is depicted and described in the following text on the basis of vegetative regions. These are extensive areas of apparently stable vegetation, each characterized by a distinctive association of plant communities or individual species and having a predictable relationship to regional climatic conditions, broad characteristics of physiography and land form and the kinds of soils on which they occur. The vegetative regions are divided into three broad groups: (1) forest and forest-grassland regions, (2) shrublands and shrub-grassland regions and (3) grassland regions.

In the descriptions of vegetation regions which follow, an evaluation of general use and productivity is provided. Forest lands, in many places, are described as "productive" or "nonproductive" (as used in the Canadian Forestry Service and Canada Land Inventory) or as "productive" or "unproductive" (as defined by the U.S. Forest Service). The two systems are similar in concept although they differ somewhat in the precise criteria on which the evaluations are made. Definitions of the broad categories in each system are as follows:

Canadian evaluative terms:

Productive. Land with trees having over 25 percent canopy and more than 6 metres in height. Productivity will usually be more than about 2.0 cubic metres per hectare (30 cubic feet per acre) per year.

Nonproductive. Land with trees or bushes exceeding 24 percent canopy cover and less than 6 metres in height. Productivity will usually be less than about 2.0 cubic metres per hectare (30 cubic feet per acre) per year and commonly will be less than 0.7 cubic metre per hectare (10 cubic feet per acre) per year.

United States evaluative terms:

Productive. Land producing or capable of producing crops of industrial wood. Productivity will be in excess of 1.4 cubic metres per hectare (20 cubic feet per acre) of annual growth.

Unproductive. Land not meeting the criteria for productive forest land.

Vegetation regions

1. BOREAL FOREST

This is the most extensive of the vegetative regions on the continent. It occupies a broad arc extending from Newfoundland west to the Rocky mountains and then northwest through central Alaska to the shore of the Bering Sea.

As the name implies, the boreal forest is in a region of cool to cold and generally moist climate, where neither excess periods of soil saturation nor growing season moisture deficits are significant limitations to forest growth.

Although many separate sections of the true boreal forest region in Canada have been recognized and described, there is a general relationship of vegetative pattern that characterizes the region as a whole. A dominance of conifers, with white and black spruce (*Picea glauca* and *P. mariana*) as the main species, is most common. Other less prominent but characteristic conifers are tamarack (*Larix laricina*), balsam fir (*Abies balsamea*) and jack pine (*Pinus banksiana*). Alpine fir (*A. lasiocarpa*) and lodgepole pine (*P. contorta*) extend into the western sections of the boreal forest from the mountain regions. Although dominantly coniferous there is a wide distribution of broadleaf trees, particularly white birch (*Betula papyrifera*) and aspen and balsam poplar (*Populus tremuloides* and *P. balsamifera*). These latter species, particularly the aspen poplar, are most numerous in the central and southern boreal sections, particularly in subhumid climatic areas transitional to the prairie grasslands. The wide distribution of aspen is partly due to its ability to quickly regenerate following fire, cutting or other disturbance. Black spruce and tamarack increase in dominance in the more northerly section bordering the tundra-boreal forest area of transition. Along the southern borders of the eastern sections there is a considerable mixing of species from the moderately cool southeastern mixed forest region, including white and red pines (*Pinus strobus* and *P. resinosa*), yellow birch (*Betula lutea*), sugar maple (*Acer saccharum*), black ash (*Fraxinus nigra*) and eastern white cedar (*Thuja occidentalis*).

Throughout the region there is general correlation between the vegetation association and site characteristics, including kinds of soil and soil moisture conditions. Jack pine, with associated shrub and forest floor species, is most prevalent on rapidly well-drained soils in dry and moist sites; it is commonly found in areas of coarse-textured Podzols and Cambisols. White spruce, birch and aspen poplar, with associated species, are widely distributed in rapidly to imperfectly drained moist and very moist sites. They occur mostly on well to imperfectly drained loamy to clayey soils, particularly Albic Luvisols and Cambisols. Balsam poplar and balsam fir occur on more poorly drained sites, whereas black spruce and tamarack, and associated species, are commonly found in very moist and wet sites with subaquic and aquic soil moisture regimes. The balsam fir and balsam poplar characteristically are found on gleyed phases of Luvisols and Cambisols, and black spruce and

LEGEND TO FIGURE 3

POTENTIAL NATURAL VEGETATION REGIONS

FOREST AND FOREST-GRASSLAND REGIONS

1	Boreal forest
2	Boreal forest and tall grass prairie
3	Subalpine forest
4	Interior montane forest
5	Columbia forest
6	Western coastal forest
7	Redwood forest
8	Rocky mountain coniferous forest
9	Pinyon-juniper woodland
10	Eastern hardwood-conifer forest
11	Southeastern broadleaf hardwood forest
12	Broadleaf hardwood forest and tall grass prairie
13	Southeastern mixed forest
14	River bottom forest

SHRUBLAND AND SHRUB-GRASSLAND REGIONS

15	Tundra and alpine meadow
16	Tundra and boreal forest
17	Western sagebrush steppe
18	California steppe
19	Desertic shrubs and grassland
20	Southwestern desert shrubs

GRASSLAND REGIONS

21	Tall grass prairie
22	Short grass prairie
23	Gulf coast prairie
24	Florida marsh and swamp

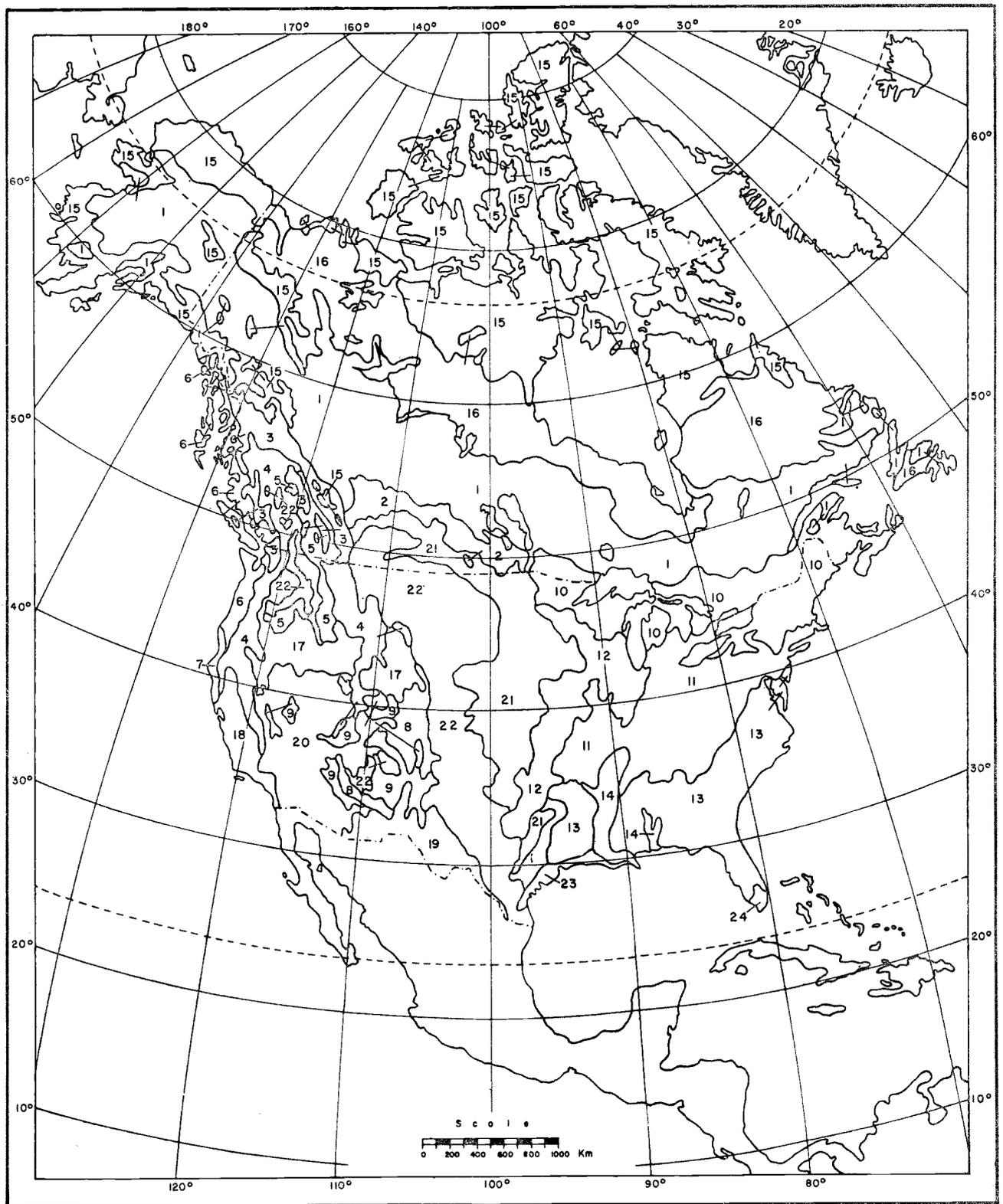


Figure 3. - Potential natural vegetation regions of North America

tamarack usually dominate treed areas of Histic Gleysols and Histosols.

The greater proportion of the boreal forest is productive forest, with growth rates from about 2 to 6 cubic metres per hectare per year. Nonproductive parts of the boreal forest occur on Lithosols and on other soils with a shallow regolith or stony or lithic phases. Forests are similarly unproductive on wet sites, particularly on Histic Gleysols and on Histosols. The jack pine forest, commonly sparse and stunted, is of low productivity.

In the more accessible parts of the boreal forest, extensive lumber and pulpwood operations have been undertaken. Hunting and trapping have been continuing activities within the forest. More recently, there has been an increased development of recreational activities. Agricultural development has made some inroads into the fringe of the boreal forest, particularly in western Canada and to a lesser extent in local areas of Ontario and Quebec. However, the principal use of this vast region is associated with the preservation of forest vegetation as a sustaining resource.

2. BOREAL FOREST AND TALL GRASS PRAIRIE

This region forms a belt between the closed cover of the boreal forest and the treeless grasslands of the tall grass prairie. It extends in a broad arc from south central and eastern Manitoba northwestward through Saskatchewan to its northern apex in north central Alberta; from there it continues southward to the eastern slopes of the Rocky mountains. Climatically, the region has moisture limitations sufficient to restrict forest growth but favourable enough to sustain productive grass cover; temperatures are cool to cold.

The forest component of this transition region is characterized by many groves and clumps of trees, which give the region a parklike appearance. These groves, locally referred to as "bluffs," are dominated by hardwoods, mostly aspen poplar (*Populus tremuloides*), but in the southeast part of the region, particularly in Manitoba, bur oak (*Quercus macrocarpa*) is a significant species, especially on slightly drier sites. Balsam poplar (*Populus balsamifera*) is an associated species in more moist locations.

The grassland component of the region is fescue prairie characterized mostly by rough fescue (*Festuca scabrella*) and dryland sedges (*Carex* spp.). Other grasses occurring in significant proportions include various wheat grasses (*Agropyron* spp.), porcupine grass (*Stipa spartea*) and june grass (*Koeleria cristata*). The latter species occur on slightly less humid sites. In areas with aquatic soil moisture regimes,

the dominant species are awned sedge (*Carex atherodes*), slough grass (*Beckmannia syzigachne*), marsh reed grass (*Calamagrostis* spp.) and shrub stages of willows (*Salix* spp.). In sites frequently submerged, pondweeds (*Potamogeton* spp.), water milfoil (*Myriophyllum* spp.), bulrushes (*Scirpus* spp.), cattails (*Typha latifolia*) and spangle top (*Scolochloa festucacea*) comprise the vegetative community.

The grass species of this region occur mostly on Chernozems; the hydrophytic species are on Mollic Gleysols. The tree species occur on Chernozems, Greyzems and Albic Luvisols; those tolerant of hydromorphic areas are on Gleysols, Planosols and Gleyic Luvisols.

A large proportion of the area of this region has been cleared and cultivated. The resulting drastic modification of the natural vegetation has reduced the areas of natural fescue prairie and aspen groves to sites of marginal arability. This has been compensated for to some degree by establishment of shelterbelts for farmsteads and as protection against wind erosion. Following agricultural development and the protection of prairies from fires, which occurred prior to and immediately following settlement, the establishment of natural aspen groves has advanced into many formerly treeless areas.

3. SUBALPINE FOREST

This is a dominantly coniferous region, located mainly on the uplands of the Cordilleran region. In many respects it is a counterpart of the boreal forest inasmuch as it occurs in a moderately cold to cold humid and subhumid environment, but it occupies higher mountain slopes as far as the limit of closed forest cover.

The more extensive areas occur on the eastern slopes and upper foothills of the Rocky mountains from approximately the latitude of the Canadian-United States border northwestward to the uplands of the interior plateau of central and northern British Columbia. In southern Alberta the subalpine forest occurs at elevations between about 1 500 and 2 100 m, in eastern British Columbia between about 1 100 and 1 200 m; to the north, this type of forest occurs at a successively lower elevation and at its northernmost limit is continuous across mountain slopes and intervening valleys. Less extensive areas are found at higher elevations in the mountains and highlands of southern British Columbia and northern Washington, and on the east slopes of the coastal range. This forest also occurs inextensively between elevations of about 600 and 900 m on islands along the west coast and on the west side of the mainland coastal range of Canada.

Characteristic species are Engelmann spruce (*Picea engelmanni*), alpine fir (*Abies lasiocarpa*) and lodgepole pine (*Pinus contorta*). Other species include spruce (*Picea* spp.), aspen (*Populus* spp.), firs (*Pseudotsuga* spp. and *Abies* spp.), hemlock (*Tsuga* spp.) and cedar (*Thuja* spp.), common to the adjacent, lower lying regions.

Forest growth on Albic Luvisols, Cambisols and Regosols is generally productive; that on Gleysols is moderately productive. On Lithosols and steep slopes and on Histosols forest growth is unproductive.

Commercial forest operations have been established in many parts of this region, particularly in the northern interior sections. In the eastern Rockies and Columbia mountains, however, the establishment of large areas of national and provincial parks for recreational use or as reserves for wildlife habitats has placed increasing restraint on commercial lumbering activities in the region.

4. INTERIOR MONTANE FOREST

Interior montane forest occupies much of the area between the eastern slope of the Rocky mountains and the seaward-facing slopes of Washington, Oregon, California and British Columbia. Elevations range widely from place to place and latitudinal distance from the northernmost part of the forest to the southernmost part is considerable. As a consequence, climate also varies widely from one part of the region to another. In general, rainfall ranges from a low of about 175 mm where the forest borders the more desertic areas to as much as 850 mm at the higher elevations. Temperatures range from cold in the north and at high elevations to temperate in the south and at lower elevations.

Because of the range in latitude and elevation over which this forest is distributed, there is a variety of tree species that are characteristic of the region. Commonly, most species are needleleaf evergreens. Species are vertically zoned; that is, they change with increasing or decreasing altitude according to the environmental requirements of specific kinds of trees.

At lower elevations, generally adjacent to the sagebrush steppe, the forest comprises mostly a moderately dense to open stand of ponderosa pine (*Pinus ponderosa*) with a ground cover of grasses and shrubs. At somewhat higher elevations the ponderosa pine is replaced by moderately dense stands of firs (*Pseudotsuga* spp.) with an admixture of other firs (*Abies* spp.), spruce (*Picea* spp.), lodgepole pine (*Pinus contorta*) and aspen (*Populus* spp.). With progressively cooler temperatures and increased rainfall, the firs give way to dense to open spruce-fir forest comprising mostly Engelmann spruce (*Picea engelmanni*)

and subalpine fir (*Abies lasiocarpa*). Black cottonwood (*Populus trichocarpa*) is found in inextensive moist sites on flood plains. Above the timberline are alpine meadows consisting of a variety of short grasses and sedges and many forbs. Areas barren of any vegetation are common and some are relatively extensive.

A variety of soils support the interior montane forest. Albic Luvisols, Cambisols, Vitric Andosols, Luvic Phaeozems and Haplic and Luvic Kastanozems are the more extensively distributed. Commonly they are stony and, locally, areas entirely devoid of soil occur.

Except for inextensive areas in broad valleys and on some high plateaus, most of the land in this vegetation region is not well suited for farming, generally because of large quantities of stones, shallow soils or steep slopes. Lumbering is carried on extensively. Productivity is generally lower than in other mountain forests because of the less humid conditions. It is mainly in the valleys that areas have been improved for farming. Most of these are dry-farmed to grains; near streams where water is available for irrigation, row crops are grown.

5. COLUMBIA FOREST

The Columbia forest clothes the steep slopes of mountains in northern and south central Idaho and northeastern Oregon and the central plateau of British Columbia. It occurs between elevations of about 750 and 1 200 m, below the lower limits of subalpine forest and commonly above the drier areas of the interior montane forest. It is an area of moderate rainfall (500 to 1 250 mm) and generally cool temperatures. Most of the precipitation falls as snow during the colder part of the year; summers are dry.

As in the region of the interior montane forest, the drier sites at lower elevations adjacent to the sagebrush steppe in Oregon and Idaho support open to dense stands of ponderosa pine (*Pinus ponderosa*) with a ground cover of grass and shrubs in the more open areas. In northern Idaho and southern British Columbia, stands of western white pine (*P. monticola*), western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) occupy the cooler and moister higher slopes, with blue Douglas fir (*Pseudotsuga taxifolia*) on drier sites, particularly in the north. Grand fir (*Abies grandis*), western larch (*Larix occidentalis*), western yew (*Taxus brevifolia*) and Douglas fir (*Pseudotsuga menziesii*) are also common on the slopes above the ponderosa pine. At the highest elevations and in the more northerly parts of the forest are stands of subalpine fir (*Abies lasiocarpa*) and Engelmann

spruce (*Picea engelmanni*). In general, mid-slopes of the Columbia forest are comparatively uniform in composition with an admixture of relatively few other species among the dominant trees.

On upland sites in British Columbia, dominant soils are Podzols and Albic Luvisols; Humic Gleysols occupy inextensive areas on lowlands and moist locations. Soils supporting the stands of the Columbia forest in the United States are mainly Vitric Andosols, Luvic Phaeozems and Luvic Kastanozems. As in other mountain areas, stony phases are common and lithic soils are locally important.

Forest growth is generally productive except on Lithosols. Commercial forestry is practised extensively throughout the region, but increased use of the forest for recreation and wildlife habitat is encouraging better forest maintenance. Only a very small proportion of the land, mostly in valleys, is used for farming. Except where irrigation water is available for cultivated crops, most cropland is dry-farmed to grains.

6. WESTERN COASTAL FOREST

The western coastal forest extends from Chichagof Island on the southern coast of Alaska, along the western coasts of British Columbia, Washington and Oregon to the northern border of California. It includes much of the rugged fiord-indented coastal mainland and adjacent islands of Canada and the western slopes of the coastal mountains in the United States.

Climatically, it ranges from cool to temperate and humid to very humid. In some areas abundant rainfall from moist Pacific air masses results in a luxuriant "rain forest" type of vegetation; in other areas of local rain shadow less humid conditions prevail. In the south, rainfall generally is low during the summer months.

The western coastal forest is essentially a dense forest of tall coniferous trees. Dominant species are western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*) and Douglas fir (*Pseudotsuga menziesii*). To the north where temperatures are colder, as well as at higher elevations throughout the region, Douglas fir is replaced by Sitka spruce (*Picea sitchensis*). In the warmer climate to the south, western white pine (*Pinus monticola*) and western yew (*Taxus brevifolia*) are part of the vegetative association.

In Canada, the soils which support this vegetative association include Podzols, Cambisols and Albic Luvisols; even some Lithosols and lithic phases of other soils support a forest on moist and very moist sites. In the United States, dominant soils supporting this forest are Humic Cambisols and Humic

Acrisols; some Luvic Phaeozems occur beneath the stands of western white pine in Oregon.

Currently, most of the land remains in forest. Environmental conditions for much of the region are optimal for the growth of conifers. In Canada, the forest productivity in the region is the highest of the country. Commercial forest enterprises are a major activity in this region. In the United States, some narrow valleys and coastal plains on the seaward aspect of the region have been cleared for production of grain and pasture. Inland, less than one fifth of the land is used for crops and pasture; farming is highly diversified, and some cash crops are irrigated.

7. REDWOOD FOREST

Least extensive of the vegetation regions, but unique in the characteristic trees which comprise it, is the redwood forest. It is found only on the seaward slopes of the coast range in northern California and southern Oregon. The climate is moist and temperate to warm. Rainfall is moderate to high (800 mm to 2 000 mm) and is generally distributed through most of the year except that it is low in summer; heavy fogs are common in summer.

Redwood (*Sequoia sempervirens*) is the dominant species on moist flats and cool, fog-shrouded slopes. Commonly the stands on the flats are relatively pure; on the slopes Douglas fir (*Pseudotsuga menziesii*) is a common associate and in some places comprises more than half the stand. A dense understorey of shrubs and small needleleaf evergreens is not uncommon.

Soils on which these forests occur are mostly Humic Acrisols. In general, it is the climate rather than the characteristics of the soil which determines the location and development of this unique forest.

Most of the region remains in forest. Lumbering is a major industry; farmland occupies only a small proportion of the region, and is located mostly in valleys.

8. ROCKY MOUNTAIN CONIFEROUS FOREST

This forest is characteristic of the mountain ranges of Arizona, New Mexico and Colorado. Species are vertically zoned — those tolerant of lower rainfall and warmer temperatures occur at lower elevations, whereas those requiring higher rainfall but withstanding cooler temperatures are found at the higher elevations. Because of the great range in elevation (approximately 1 300 to 3 200 m with peaks as high as 4 300 m), variations in climate are great. Rainfall ranges mainly from 250 mm on the lower slopes to

750 mm on the higher slopes, and on some of the higher mountains is 1 000 mm or more; most rain during the winter falls as snow. Temperatures range from temperate to cold.

At the lower elevations, just above the pinyon-juniper woodlands of the desertic areas, ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*) are the dominant species. With increasing elevation, these give way to corkbark fir (*Abies lasiocarpa* var. *arizonica*) and Engelmann spruce (*Picea engelmannii*). In northern Colorado, the corkbark fir is replaced by subalpine fir (*A. lasiocarpa*). At the highest elevations, above the timberline, vegetation is limited to short grasses, sedges and forbs, including bentgrass (*Agrostis* spp.), sedges (*Carex* spp.), hair grass (*Deschampsia caespitosa*), fescue (*Festuca viridula*), wood rush (*Luzula spicata*), mountain timothy (*Phleum alpinum*), bluegrass (*Poa* spp.) and spike trisetum (*Trisetum spicatum*). Extensive areas are barren. In central Arizona, white fir (*Abies concolor*), blue spruce (*Picea pungens*) and Douglas fir (*Pseudotsuga menziesii*) clothe the slopes above the pinyon-juniper woodland. Commonly the forests vary from open to dense; where they are open, grasses and low shrubs form the ground cover.

Albic Luvisols are the dominant soils in this vegetation region, except in central Arizona where they are Luvic Kastanozems.

Less than half the land in this region is used for farming, and of this area only the small proportion on the more gentle slopes is used for cropland. Hay, pasture and cultivated crops are grown under irrigation in the valleys, whereas the higher lying areas are dry-farmed to grains.

9. PINYON-JUNIPER WOODLAND

Pinyon-juniper woodland occupies the high tablelands of the southwestern United States, mostly in New Mexico, Arizona and Utah. It is an area of low rainfall, 150 to about 375 mm, commonly with the greater amount falling at the higher elevations. Temperatures are cool to warm, the latter occurring at lower elevations and in the more southerly parts of the region.

The vegetation consists of open groves of low needle-leaf evergreens with a variety of shrubs. Dominant species are oneseed juniper (*Juniperus monosperma*), Utah juniper (*J. osteosperma*), pinyon pine (*Pinus edulis*), and one-leaf pine (*P. monophylla*). Grasses and shrubs comprise the remaining vegetative cover, although areas of bare ground are not uncommon. In central Arizona, varieties of oak (*Quercus* spp.) and mountain mahogany (*Cercocarpus ledifolius*) occur in association with the junipers. On the higher mountain slopes distributed across the tablelands,

rainfall is adequate to support stands of ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*). Sagebrush, greasewood and shadscale occur in inextensive areas where moisture is in particularly short supply.

Soils supporting this woodland are mainly Calcaric Regosols and Calcic Yermosols. Haplic Kastanozems and Haplic Yermosols occur inextensively in parts of the region.

Less than half of the region is at present used for farming and ranching except in New Mexico where the proportion is somewhat higher. Most of the land is used as range for grazing cattle and sheep. Carrying capacity is generally low. A small percentage of the land is irrigated for row crops, but much of the cropland is dry-farmed to grains and hay.

10. EASTERN HARDWOOD-CONIFER FOREST

In the east-central part of the continent, from the Ontario-Manitoba-Minnesota border eastward in a broad arc encompassing the Great Lakes and ending at the Atlantic coast, the eastern hardwood-conifer forest is a transitional vegetative region between the evergreen needleleaf forest to the north and the deciduous broadleaf forest to the south. Climatically, it is also a region of transition — cool and continuously moist in the north and temperate and moist in the south.

The forest of this vegetative region is of a very mixed nature. In the northern Canadian portion of the region, white pine (*Pinus strobus*) and red pine (*P. resinosa*), eastern hemlock (*Tsuga canadensis*) and yellow birch (*Betula lutea*) are dominant. In the southern United States portion of the region, sugar maple (*Acer saccharum*) and beech (*Fagus grandifolia*), as well as those species common farther north, are characteristic. Associated with these dominant species are others, mainly maples (*Acer* spp.), elms (*Ulmus* spp.), oaks (*Quercus* spp.), spruce (*Picea* spp.), pines (*Pinus* spp.), poplars (*Populus* spp.) and birch (*Betula* spp.). In the eastern part of the region, mostly in Maine, New Brunswick and Nova Scotia, red spruce (*Picea rubra*) and balsam fir (*Abies balsamea*) are characteristic species in addition to those common to the remainder of the region.

The eastern hardwood-conifer forest is, in general, associated with Orthic Podzols, Albic and Orthic Luvisols and Dystric Cambisols. On these soils the forests have or are likely to attain commercial value as sources of timber. However, on the associated Lithosols, Dystric Gleysols and Histosols, growth of trees is insufficient to attain a productive forest of commercial value. On Lithosols, forest of value for other than wildlife habitats is precluded

by the extreme shallowness of the soil. On the Dystric Gleysols and Histosols adapted species do not produce growth of commercial value except where climate is milder. In many areas adjacent to the coast, stunted growth and low productivity have resulted from exposure to wind.

Clearing and development for farming has reduced and modified the forest resources of this region. Cleared land was at best only moderately productive, part was rough and steep and the climate restricted to some degree the crops that could be grown. Part of this marginally productive land is at present reverting to natural forest cover; some former cropland, intensively lumbered areas and burned-over areas are being reforested to reestablish stands having commercial value, for development of wildlife habitats and for expansion of recreation areas. In the southern part of the region, however, much of the land cleared of its natural vegetation has remained in farms and is used as cropland and pasture; the remaining natural vegetation is mostly in relatively inextensive forested areas and farm woodlots.

11. SOUTHEASTERN BROADLEAF HARDWOOD FOREST

The southeastern broadleaf hardwood forest extends from southern Ontario in Canada south into the northern part of Alabama, Mississippi and Arkansas, with a more or less isolated area in eastern Texas. Climatically, this region includes the temperate moist climate of the southern Great Lakes region, the warmer, moist climate of the Mississippi valley and the warm climate of eastern Texas with moisture-deficient summers.

Inasmuch as a distance of approximately 2 500 km separates its northern and southern limits, a variety of species is found in this forest region. In the north, species characteristic of the eastern hardwood-conifer forest are common — sugar maple (*Acer saccharum*) and beech (*Fagus grandifolia*) — as well as white elm (*Ulmus americana*), basswood (*Tilia americana*) and red and white oaks (*Quercus rubra* and *Q. alba*). To the south and west, butternut and shagbark hickories (*Carya cordiformis* and *C. ovata*) and black oak (*Quercus velutina*) are also included; many other varieties of oak and hickory are distributed among the dominant species. West of the Appalachian mountains, in an area extending from the northeast corner of Alabama north into southern Ohio and southwest Pennsylvania, is a mixed forest of maples, buckeye, beech, tulip, oak and basswood with an admixture of a wide variety of other species of trees and shrubs. On the slopes of the Appalachian mountains, from northern Georgia to southern Pennsylvania and east to Rhode Island, white and red oaks (*Quercus alba* and *Q. rubra*) are

by far the predominant species. White ash (*Fraxinus pennsylvanica*) and American elm (*Ulmus americana*) are the dominant forest trees in a discrete area on the plains west of Lake Erie.

The soils which support the southeastern broadleaf hardwood forest are predominantly Orthic and Albic Luvisols and Dystric Cambisols. A small proportion of the soils of this broad forest region comprise Chromic and Gleyic Luvisols, Eutric Planosols and Leptic Podzols. Dystric Cambisols on the slopes of the Appalachian mountains and the Leptic Podzols of Connecticut and Rhode Island support stands of red and white oak. West of Lake Erie, Gleyic Luvisols support the relatively inextensive stands of white ash and American elm. The remainder of the soils support the various associations of species of oak, hickory, maple and beech.

Only a small proportion of the natural forest remains in the region of the southeastern broadleaf hardwood forest. Some of the area is densely populated. In most of the region, however, the land is intensively farmed to annual crops and pasture or is used for grazing. Except in Texas, southern Missouri and the general area of the Appalachian mountains, where forest still comprises more than half the vegetative cover of the region, the forest vegetation is generally confined to farm woodlots, hedgerows and remnant stands of nonarable soils. Most of that which remains is, or has potential for, producing merchantable timber.

12. BROADLEAF HARDWOOD FOREST AND TALL GRASS PRAIRIE

Between the tall grass prairie of the central United States and the southeastern broadleaf hardwood forest in the eastern central United States is an area of transition between the tree species characteristic of the forested east and the grasses of the midwest. The eastern boundary of this transition area is not well defined. The mosaic of forest and grassland has been altered by nature and man, with at times the grassland encroaching on previously forested areas to the east and at other times the forest replacing the grasslands to the west. At present, forest occupies land recently dominated by grass; trees native to the region grow in many places and are becoming increasingly numerous to the west.

The forest component of this transition area consists mostly of bitternut hickory (*Carya cordiformis*) and shagbark hickory (*C. ovata*) and white, red and black oaks (*Quercus alba*, *Q. rubra* and *Q. velutina*). Common associates are black walnut (*Juglans nigra*), American elm (*Ulmus americana*), white ash (*Fraxinus americana*) and post oak (*Quercus stellata*). Composition of this forest varies consider-

ably from one locale to another, the change in species being gradual over considerable distance. Most are characteristic of the southeastern broadleaf hardwood forest adjoining the region on the east.

The grass component of this transition area consists of tall grasses and forbs. Dominant species are big and little bluestem (*Andropogon gerardi* and *A. scoparius*), switchgrass (*Panicum virgatum*) and Indian grass (*Sorghastrum nutans*).

Soils in this transition area are mostly Luvic Phaeozems and Orthic Luvisols. Relatively inextensive areas of Eutric Planosols occur with, in the southern part of the area, Chromic Luvisols and Eutric Cambisols.

Most of the land occupied by this association of forest and grassland is now in farms. The native grasses have been largely supplanted by cash crops. About one fifth of the land is in pasture of tame and native grasses. Forest is generally restricted to more strongly sloping areas along stream valleys.

13. SOUTHEASTERN MIXED FOREST

The southeastern mixed forest extends from southern New Jersey, Delaware, and Maryland south to Florida and west into the eastern part of Texas; it is interrupted principally by river bottom forest occupying the flood plains of the Mississippi river and of many others too small to show on a small-scale map. This forest covers much of the eastern and southern coastal plain, as well as the eastern piedmont of the Appalachian mountains. The climate is predominantly moist and temperate to hot.

On the piedmont slopes and the upper part of the coastal plain, the native vegetation comprises mainly hickory (*Carya* spp.), short leaf and loblolly pines (*Pinus echinata* and *P. taeda*) and white and post oak (*Quercus alba* and *Q. stellata*). At lower elevations, sweet gum (*Liquidambar styraciflua*) and yellow poplar (*Liriodendron tulipifera*) are an important part of the vegetative association. From central South Carolina to the south and as far west as southern Louisiana, the loblolly pine and white oak remain a significant part of the vegetative association; beech (*Fagus grandifolia*), southern magnolia (*Magnolia grandiflora*), slash pine (*Pinus Elliottii*) and laurel oak (*Quercus laurifolia*) are also among the dominant species. Sweet gum represents a greater proportion of the forest at lower elevations and in the more southerly part of the region. Throughout the region the forest has a variety of smaller trees and shrubs adapted to specific climatic or soil conditions. At the lowest elevations, where soils are generally wet much of the year, tupelo gum (*Nyssa aquatica*), adapted varieties of oak (*Quercus* spp.) and bald cypress (*Taxodium distichum*) are

common; a variety of maples (*Acer* spp.), ash (*Fraxinus*), evergreen shrubs and small trees are intermingled among them. In the south, varieties of palmetto (*Sabal* spp.) occur on the lower lying outer parts of the coastal plain in a wide range of moisture conditions.

The soils which support the southeastern mixed forest are predominantly Luvisols and Acrisols. Those on the piedmont slopes and upper coastal plain are mostly Albic Luvisols; those on the lower coastal plain are Ferric Acrisols and Gleyic Acrisols. In much of peninsular Florida and in a narrow strip along the Atlantic coast, the soils are Gleyic Podzols, Humic Podzols and Histosols.

One half to three fourths of this broad area is still in forest, the greatest proportion being in the west. About one fifth of the land has been cleared for cash crops, principally in the east. In recent years the amount of land used for improved pasture has tended to increase, with a corresponding decrease in the area under cultivation. The more sloping land is being returned to forest.

14. RIVER BOTTOM FOREST

River bottom forest extends from the confluence of the Ohio and Mississippi rivers southward on the Mississippi flood plain to the Gulf of Mexico; it also covers the flood plain of the Alabama and Tombigbee rivers in southern Alabama as well as the flood plains of many small rivers flowing into the Gulf of Mexico and the Atlantic Ocean. Climatically, the region is warm and humid, but the aspect of the environment of the river bottom forest most significant for the vegetation is the prevailing wet soil characteristic of much of the flood plains.

Dominant species in the river bottom forest are water tupelo (*Nyssa aquatica*), various species of oaks (*Quercus* spp.) tolerant of the hydrophytic conditions of the region, and bald cypress (*Taxodium distichum*). The forest varies considerably in composition from place to place. Drummond red maple (*Acer rubrum* var. *drummondii*), hickory (*Carya* spp.), swamp privet (*Forestiera acuminata*), ash (*Fraxinus* spp.), sweet gum (*Liquidambar styraciflua*), cottonwoods (*Populus* spp.) and black willow (*Salix nigra*) are variously distributed in adapted sites. At the outer edge of the Mississippi delta, forest vegetation is replaced by dense grasses, principally smooth cordgrass (*Spartina alterniflora*).

The soils supporting the river bottom forest are principally Eutric Gleysols. Some Dystric Gleysols occur in the northern part of the forest. On the outer edge of the delta of the Mississippi river, the dense hydrophytic grasses are on Histosols.

Only about one tenth of the area originally forested currently remains in forest. Most of the land has been cleared and drained for production of cash crops and pasture. The proportion of land in crops is highest in the north; land remaining in forest or marsh grasses is most extensive in the southern part of the region.

15. TUNDRA AND ALPINE MEADOW

The region of tundra vegetation extends across the northernmost part of the mainland of the continent from the Labrador coast of eastern Canada to the arctic and Pacific coasts of Alaska and across all the northern islands of Canada. Also included are the areas of alpine vegetation occurring above the treeline in the mountains of the Cordilleran region.

Tundra vegetation is mainly associated with the cold and very cold climates of the high latitudes of northern Canada. It is also commonly associated with areas of continuous or intermittent permafrost and with soils which are frozen within profile depth for all or a considerable portion of the short growing season. Soils supporting tundra vegetation are mostly shallow and weakly developed Gelic Regosols, Gelic Gleysols, Gelic Cambisols and Lithosols.

Tundra is essentially a treeless vegetation characterized by the absence of tall woody species. Tree species present are in dwarf form. Five major tundra types or plant associations are considered of significance. These include arctic desert, lichen-moss, heath, sedge grass and bush or scrub tundra.

Arctic desert, including fell-fields or rockfield tundra, is the most barren of all tundra communities, the most extensive species being crustaceous lichens forming a discontinuous cover with some mosses, and with a limited number of species of grasses, sedges and shrubs occurring as isolated plants or tussocks. For short periods in summer there are sufficient flowering plants to colour broad areas. This type of vegetative community is usually associated with Gelic Regosols and Lithosols and dominates the areas of the high arctic, becoming less prevalent further south. The lack of vegetative cover leaves the surface soil virtually unprotected and affords almost no opportunity for wildlife grazing.

Lichen-moss tundra forms a virtually continuous vegetative cover and is found in many relatively well-drained upper slope positions, including strandlines, old river terraces and coarse-textured stony or sandy tills, mostly associated with Gelic Regosols. Characteristic species are the lichens, particularly reindeer moss (*Cladonia* spp.), interwoven with sedges (*Carex* spp.), grasses, arctic willows (*Salix* spp.) and avens (*Dryas* spp.). Lichen-moss tundra is mainly found in the midarctic and is rare in the northern

high arctic. It provides a sparse cover of very limited grazing capacity for wildlife. To the south it intergrades with heath tundra.

Heath tundra is more prevalent in the southern arctic and in areas of alpine tundra, occupying more humid and imperfectly drained sites than the lichen-moss association. It is associated particularly with imperfectly drained Gelic Regosols and Gelic Cambisols. Heath tundra is characterized by the occurrence of numerous berry plants, including arctic blueberry and alpine cranberry (*Vaccinium* spp.), and by crowberry (*Empetrum nigrum*), in addition to many of the species associated with lichen-moss tundra. The grazing capacity of heath tundra, while limited, is greater than in lichen-moss sites.

Sedge grass tundra, sometimes known as wet tundra, usually develops in poorly drained habitats or under subaquic and aquic moisture regimes. It is mostly associated with Gelic Gleysols and with gleyed Gelic Regosols on loamy or clayey soil materials. Sedge grass tundra is found in all sections of the arctic and in alpine meadow sites. It is of limited occurrence in the more northerly sections of the high arctic. Major species include cotton-grass (*Eriophorum* spp.) and hydrophytic sedges (*Carex* spp.) held together by a thick moss cover. In more southerly areas, shrubs, including ground or dwarf birch (*Betula glandulosa*) and Labrador tea (*Ledum* spp.), form a significant component of the plant association. This type of vegetation provides a relatively productive portion of the limited grazing habitat of the tundra region.

Bush or scrub tundra is an association most prevalent in the southerly portion of the arctic, particularly where it intergrades to areas of boreal forest. It is generally found locally in favoured aspects where there is protection by snow cover and in sites having adequate summer moisture. Bush tundra is commonly associated with Gelic Regosols and Cambisols. The dominant bushes are willows (*Salix* spp.) and some alder (*Alnus crispa*) or birch (*Betula* spp.), usually with an herbaceous undergrowth. In areas near the treeline, thickets of willow and birch scrub interspersed with open tundra form a distinctive vegetative pattern and provide some shelter as well as a grazing habitat for wildlife.

16. TUNDRA AND BOREAL FOREST

Between the tundra region to the north and the boreal forest to the south is a broad area comprising a mosaic of vegetation characteristic of both regions. It extends from the Newfoundland highlands and eastern Labrador coast across the northern parts of Quebec, Ontario, Manitoba and Saskatchewan,

through the Northwest Territories and Yukon to the Yukon-Alaska border.

At the lower elevations in this cold region, the latitudinal limits of tree growth are reached and the forest consists of stands of sparse or severely stunted trees, forming lichen woodlands which merge into areas of open tundra. At the higher elevations of the Cordilleran mountains there is a similar and distinctive transition from the alpine tundra at the highest elevations to the subalpine forest below. In the east, the effects of climate are also reflected in the vegetative pattern. In the area known as the Newfoundland-Labrador barrens, the effects of exposure to wind and very humid conditions, as well as to low temperatures, have contributed to the development of semiforested barren lands in which stunted tree growth alternates with heath and moss bog.

Within this broad area of transition, the tundra vegetation is generally similar to that of the tundra region to the north. The forests are mainly unproductive coniferous stands, dominated by an open stunted cover of black spruce (*Picea mariana*), accompanied by alders (*Alnus* spp.), willows (*Salix* spp.) and tamarack (*Larix laricina*) in the more hydrophytic treed sites of swamp and muskeg. Trees associated with mixed wood associations, including white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), aspen (*Populus tremuloides*), balsam poplar (*P. balsamifera*) and white birch (*Betula papyrifera*), are less common except in particularly favoured sites, such as moderately well-drained river levees or in some gleysolic clay areas. Jack pine (*Pinus banksiana*), which is not widespread, is found in some sections of the region, usually on stony glacial till or on better drained, coarse-textured deposits. In the alpine transition, white spruce and alpine fir (*Abies lasiocarpa*) are more common, with black spruce occurring at lower altitudes. Tamarack is very sparsely distributed in these areas.

The forest of this region is unproductive with the exception of the few favourable sites where some local forestry practices are feasible. The mosaic of open scrub and tundra vegetation provides shelter for wildlife and affords some limited grazing.

17. WESTERN SAGEBRUSH STEPPE

The western sagebrush steppe occupies plains and plateaus in the northwestern part of the United States. The region is north of the dry southwest and is between the coastal range of western Oregon and Washington and the Rocky mountains of Idaho, Montana and Wyoming. Rainfall varies from low to moderate (150 mm in places in some valleys to as much as 1 500 mm on certain mountain slopes

in the area). Summers are usually dry. Temperatures are cool to temperate.

In general, the natural vegetation is uniform across broad areas. The dominant shrub is big sagebrush (*Artemisia tridentata*). Bluebunch wheat grass (*Agropyron spicatum*) occurs with the sagebrush in varying amounts; in some parts of the region the grasses are sparsely distributed and areas between sagebrush plants are bare of plant cover. As in the more arid region to the south, the vegetation on the mountain ridges and peaks occurring within the region changes markedly with increased elevation and the corresponding increase in precipitation and decrease in temperature. On the lower slopes, species of juniper (*Juniperus* spp.) and pine (*Pinus* spp.) occur in open stands. On the higher elevations, ponderosa pine (*Pinus ponderosa*) grows in the cooler and moister climate.

Luvic and Haplic Kastanozems are the dominant soils supporting this shrub-grass association. Some Calcic and Luvic Xerosols are in the somewhat drier eastern extension of the region and Haplic Xerosols occur inextensively in the north.

A little less than three fourths of this region is used at present for grazing. Sparse native grasses and sagebrush afford most of the browse and carrying capacity is low. About one tenth of the land is farmed; where irrigation water is available, cultivated row crops and improved pasture are grown. Some areas having favourable soils and adequate moisture are dry-farmed.

18. CALIFORNIA STEPPE

The vegetation in the southwestern third of California varies considerably within relatively short distances — a phenomenon which is the result of variations in topography, aspect, temperature, rainfall and soils. It is a region with low mountains and broad valleys. Rainfall varies from 1 000 mm to less than 250 mm annually, most of it occurring in the winter; summers are dry. Temperatures are temperate to warm but at higher elevations they are cool.

In the central valley of California, the natural vegetation consists of dense or moderately dense, low to moderately tall grassland. Dominant species tolerant of the warmer and drier climate are needle grass (*Stipa cernua*) and spear grass (*Stipa pulchra*). In the low-lying marshy area in the central part of the valley are a variety of bulrushes (*Scirpus* spp.), cattails (*Typha domingensis*) and soft flag (*Typha latifolia*). On the hills surrounding the central valley and on parts of the low mountains along the coast, where temperatures are lower and rainfall somewhat higher, is a mixture of evergreen and

deciduous forest. Coulter and digger pines (*Pinus coulteri* and *P. sabiniana*) are intermixed with a variety of oaks — coast live oak (*Quercus agrifolia*), canyon live oak (*Q. chrysolepis*), blue oak (*Q. douglasii*), valley oak (*Q. lobata*) and interior live oak (*Q. wislizenii*). In the southernmost part of the coastal range the vegetation is a dense growth of shrubs, commonly known as chaparral. The dominant species here are chamiso (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos* spp.) and California lilac (*Ceanothus* spp.).

Soils supporting these vegetative types are Chromic Luvisols. In the lowest part of the central valley are Eutric Gleysols and some Orthic Solonetz. On the coastal range are inextensive areas of Haplic Phaeozems. Calcaric Regosols are relatively extensive on hills in the south.

A high proportion of the lower lying land in this region is intensively farmed. In the central valley, native grasses have been replaced by row crops and fruits, mainly produced on irrigated land. On the surrounding slopes, the land is either dry-farmed to grain or remains in native grasses and open woodland in support of grazing.

19. DESERTIC SHRUBS AND GRASSLAND

In the southwestern part of the United States, the region of desertic shrubs and grassland is an area of transition between the short grass prairie of northern and central Texas and the desert of western Arizona. Rainfall is generally more than 200 mm but less than 500 mm per year; it is highest between mid-spring and mid-autumn, but in the western part of the region spring and early summer shortages of moisture are common. Temperatures are warm. Both rainfall and temperature vary with the changes in elevation; the cooler temperatures and higher rainfall occur at the higher elevations, generally in the central and northern parts of the region.

The grass component of this shrub-grass association is sparse and short. It consists mainly of black grama (*Bouteloua eriopoda*) and tobosa (*Hilaria mutica*). The desertic shrubs comprise mainly creosote bush (*Larrea divaricata*) and tarbush (*Flourensia cernua*); the latter is more common in western Texas and southeastern New Mexico.

Soils supporting this relatively sparse vegetation are mostly Calcic Yermosols. Haplic Yermosols and Calcaric and Eutric Regosols occur inextensively in the southern part of the region.

Between one half and three fourths of the land in this region is used for range, but because of the sparse distribution and short growth habit, carrying capacity is low. Only a very small proportion

of the region, mainly that located immediately adjacent to streams, is used for irrigated cropland. Land of approximately equal extent is dry-farmed to hay and grain.

20. SOUTHWESTERN DESERT SHRUBS

The region of southwestern desert shrubs occupies the driest part of the United States — the desert area of the southwest. Rainfall is very low — 150 mm to 300 mm annually. Temperature ranges from temperate to hot. Commonly, the cooler temperatures and higher rainfall are characteristic of the higher elevations.

The region is characterized by an open stand of shrubs. In southern California and Arizona, white bur sage (*Franseria dumosa*) and creosote bush (*Larrea divaricata*) are the dominant species. In this part of the region, open to dense stands of shrubs, low trees and succulents are distributed on the lower slopes and at the base of low mountains and rocky ridges and hills. Immediately to the north, in southeastern California and southern Nevada, creosote bush is the dominant shrub. Throughout this very dry sector, areas devoid of any vegetative cover are common. In the northern half of the region, where a series of ridges, peaks and mountains alternate with plains, big sagebrush (*Artemisia tridentata*), shad scale (*Atriplex confertifolia*) and greasewood (*Sarcobatus vermiculatus*) occur in open to dense stands. The intervening spaces between these shrubs are sparsely to moderately covered with short grasses. The area immediately south of Great Salt lake is virtually void of any vegetation.

Woodland covers much of the slopes of the hills, ridges and peaks distributed throughout the northern half of the region. On the lower slopes are one-seed juniper (*Juniperus monosperma*), Utah juniper (*J. osteosperma*), pinyon pine (*Pinus edulis*) and one-leaf pine (*P. monophylla*). Ponderosa pine (*P. ponderosa*) and an associated understorey of grasses and forbs are found on the crests.

Luvic Yermosols are by far the most extensive of the soils supporting this xerophytic vegetation. Less extensive areas of Haplic Luvisols occur in northwestern Nevada. On the hills, ridges and peaks Lithosols support some grassy vegetation but are too shallow to carry more than a stunted growth of pines and junipers.

More than 90 percent of the land in this vegetative region is owned by the U.S. Federal Government. Most of it has little economic value for farm use. Some areas are used for grazing but carrying capacity is extremely low. Only where irrigation water is available along streams or where wells can be drilled is the land used for any kind of farming enterprise.

21. TALL GRASS PRAIRIE

Tall grass prairie extends from the southern parts of the provinces of Manitoba, Saskatchewan and Alberta in southwestern Canada, southward through the centre of the United States into northeastern Texas. It is a region of contrasting temperatures and precipitation. Temperatures range from cool in southern Canada to warm in eastern Texas. Rainfall varies greatly from year to year, from as low as 350 mm in some years to as high as 600 mm in others in the north and 750 mm in the south; most falls during the warmer half of the year.

The prairie is an almost treeless landscape characterized by a cover of grasses and sedges, with forbs and shrubs occurring as subdominant species. Although dominated by tall grasses, grasses of medium height occur, most commonly as a transition between the tall grasses of the eastern and northernmost parts of the region and the short grasses which characterize the adjacent region to the west.

The dominant grasses of the tall grass prairie are western wheat grass (*Agropyron smithii*), big and little bluestem (*Andropogon* spp.), needlegrass (*Stipa spartea*), panic grasses (*Panicum* spp.) and Indian grass (*Sorghastrum nutans*); prairie dropseed (*Sporobolus* spp.) occurs as part of the association in Canada and in areas of Kansas, Nebraska and Oklahoma in the United States. In the southern part of the region, in western Kansas and Oklahoma, species of grama (*Bouteloua*) and little bluestem (*Andropogon scoparius*) are dominant. In the sand hills of Nebraska, big and little bluestem are associated with sand bluestem (*A. hollii*), sand reed (*Calamovilfa longifolia*) and needle-and-thread grass (*Stipa comata*). Although grasses are by far the dominant vegetation in this region, herbs and shrubs are abundant. Some narrow strips of trees, elm (*Ulmus* spp.), maple (*Acer* spp.) and ash (*Fraxinus* spp.), occur along streams and on scattered hills where moisture conditions are favourable, particularly in the northern half of the region.

Soils supporting this broad area of grassland are predominantly Luvic Kastanozems; important but less extensive are Haplic and Luvic Phaeozems, Haplic Chernozems, Eutric Regosols and Mollic Gleysols.

At present, most of the land in this broad region is in farms and one half to three fourths of it is in cropland, primarily dry-farmed for grain. Land along streams, where water for irrigation is available, is grown to cash crops. The remainder of the land is used for pasture and grazing, commonly on native grasses. Toward the south, the proportion of land used for grazing increases with a corresponding decrease in that under cultivation.

22. SHORT GRASS PRAIRIE

Short grass prairie extends from the southern part of Alberta and Saskatchewan southward along the foothills of the Rocky mountains to the southern tip of Texas. It occupies the higher elevations of the western part of the plains in the central part of the continent. Short grass prairie also occupies relatively inextensive areas of interior plateaus and valleys of southern British Columbia, eastern Washington and northeastern Oregon. As in the tall grass prairie, the climate of the short grass prairie is one of considerable contrast. Temperatures range from cool in southern Alberta to hot in southern Texas. Rainfall is low; generally it is less than 600 mm per year, and annual totals of 250 to 400 mm are common. Amounts fluctuate greatly from year to year, and precipitation is lower in the western part of the region. In British Columbia, Washington and Oregon maximum rainfall occurs during the winter, rather than during the summer as in much of the rest of the region.

As in the region of tall grass prairie, the landscape is covered by grasses, sedges and some forbs and shrubs. Dominant grasses are western wheat grass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), needle-and-thread grass (*Stipa comata*), buffalo grass (*Buchloë dactyloides*) and green needlegrass (*Stipa viridula*). Western wheat grass, blue grama and needle-and-thread grass are characteristic of the cooler climate of Montana, Wyoming and western North and South Dakota; green needlegrass is a part of the association in the Dakotas.

In Canada, porcupine grass (*Stipa spartea*) and northern wheat grass (*Agropyron dystachyum*) occur on soils of medium to fine texture. On clays with high moisture-holding capacity and properties of shrinking and swelling intergrading between Kastanozems and Vertisols, northern wheat grass and june grass (*Koeleria cristata*) are the dominant species. Plains reed grass (*Calamagrostis montanensis*), Sandbert's blue grass (*Poa secunda*) and prairie muhly (*Muhlenbergia cuspidata*) are common where soils are coarser in texture and have drier moisture regimes.

In western North Dakota and South Dakota, green needlegrass (*Stipa viridula*) is codominant with the western wheat grass, blue grama, and needle-and-thread grass. To the south, buffalo grass (*Buchloë dactyloides*) and blue grama are the dominant species. In central Texas, mesquite (*Prosopis juliflora*) and varieties of oak (*Quercus* spp.) are sparsely to densely distributed through the buffalo grass and little bluestem (*Andropogon scoparius*); in southern Texas, acacia (*Acacia* spp.) and mesquite are distributed singly and in groves through dense

to sparse cover of seacoast bluestem (*Andropogon littoralis*) and plains bristle grass (*Setaria macrostachya*). A variety of forbs and shrubs occur among the grasses but sages (*Artemisia* spp.) are most abundant.

The more extensive soils supporting the short grass prairie are Chernozems and Luvic and Haplic Kastanozems; Calcic Luvisols, Luvic Xerosols and Calcic and Eutric Regosols are inextensive but widely distributed. Pellic Vertisols and Chromic Luvisols support the prairie vegetation of southernmost Texas. Solonetz occur extensively in Canada and in several widely scattered locations in the region in the northern part of the United States.

In Washington, Oregon and southern British Columbia the prairie comprises an association of grasses similar to those much more extensively distributed on the plains east of the Rocky mountains. However, the vegetation is vertically zoned according to changes in temperature and moisture conditions resulting from differences in altitude, slope and aspect occurring within relatively short distances. The prairie is characterized primarily by grasses (*Agropyron* spp., *Festuca* spp.). These intergrade in the south to the sagebrush steppe of the northwestern United States and at higher elevations on the west, north and east to the forest species of the interior montane forest.

Most of the land within this vegetation region is in farms. In Canada much of the natural vegetation has been destroyed by extensive cultivation. That which remains is in areas of rough topography, stony land or soils suited only for native pasture or grazing. Areas formerly cultivated and now abandoned have been sown to pasture or have reverted to grassland vegetation; many such areas, together with virgin grassland, are now enclosed in community pastures. In the United States, about half the land in this vegetation region is cropped, mostly to grains. Approximately three fifths to three fourths of the remainder is under native grasses and shrubs which are used for grazing cattle and sheep. Only a small proportion of this remaining area is under tilled crops, commonly in zones located near streams or other sources of irrigation water. Where moisture is adequate, the more productive soils are dry-farmed; in Washington and Oregon, where the growing season is dry, the land is dry-farmed to wheat and peas.

23. GULF COAST PRAIRIE

The Gulf coast prairie is of limited extent, occupying the nearly level, low part of the coastal plain of southern Texas and southwestern Louisiana. Climate is humid and warm to hot.

Natural vegetation in this region is tall dense grass. Seacoast bluestem (*Andropogon littoralis*) and

coastal sacahuiste (*Spartina spartinae*) are dominant on the inland part of the plain; smooth cordgrass (*S. alterniflora*) occupies a narrow strip along the coast. They are supported by Gleyic Phaeozems. Little of the original grasses remain inasmuch as much of this land has been drained and improved for farming to cash crops, particularly rice and sugarcane. The native grasses remaining are grazed.

24. FLORIDA MARSH AND SWAMP

This vegetation region comprises most of the very wet southern area of the Florida peninsula in the southeastern United States. Climate is generally hot and humid. Much of the land is saturated most of the year and some of it is inundated all or part of the year.

Vegetation consists of medium tall to tall grassland with scattered groves of trees and shrubs. Dominant grasses are saw grass (*Mariscus jamaicensis*) and three-awn grasses (*Aristida affinis* and *A. patula*). Woody vegetation in a large part of the region consists of sweet bay (*Magnolia virginiana*), red bay (*Persea borbonia*) and bald cypress (*Taxodium distichum*). A wide variety of other hydrophytic trees and shrubs are distributed throughout the region. Along the coast, mangroves (*Avicennia nitida* and *Rhizophora mangle*) are the dominant species; they are interspersed with a variety of shrubs and, on drier sites, patches of tropical forest.

In the Florida marsh and swamp, Dystric Gleysols are the most extensive soils. Histosols are the principal soil in the very wet and commonly flooded area in the central part of the region, and also occur in depressions and flats in the area dominated by Dystric Gleysols.

About one fifth of this region has been developed for farming, most of the remainder is in game reserves, parks and reservations. Only a very small part of the farmed area is under crops; most is in improved pasture for beef and dairy cattle.

PHYSIOGRAPHY AND GEOLOGY

To facilitate description, the continent of North America has been divided into 12 physiographic regions. The names given to these regions have meaning when applied to the continent as a whole, and do not in all instances conform to national names (for example, the Great Plains of the United States and the interior plains of Canada are combined in one region, "Interior plains"). The physiographical

and geological features of these regions are described in this section, and are mapped on Figures 4 and 5.

1. INNUITIAN REGION

The Innuitian region comprises the northern half of the Canadian archipelago situated off the northernmost part of the continent. More rugged than the arctic lowland to the south, it extends over an area of deformed sedimentary rocks and minor igneous intrusions. The region has been affected by broad crustal warping. In general, the landscape comprises mountain ranges of varying degrees of ruggedness, plateaus with subdued relief and flat-floored valleys. Ridge-and-valley relief is common.

Pleistocene glaciation and postglacial marine submergence has affected the Innuitian region much less than the regions to the south. Glacial landforms and sediments are scarce, particularly in the low-lying areas in the western part of the region, indicating that the continental ice sheet could not have been very active.

The effect of mountain glaciation, however, is pronounced, especially on the mountains and uplands of the larger islands in the eastern half of the region. At present, mountain glaciation, ice fields and valley glaciers are still prominent features.

2. ARCTIC LOWLAND AND COASTAL PLAIN

The arctic lowland and coastal plain are the northern continuation of the interior plains situated between the subdued relief of the Canadian shield and the rougher terrain of the Innuitian region to the north. The lowland comprises flat or nearly flat Paleozoic and late Proterozoic rocks which form the southern half of the Canadian archipelago. Physiographically, they are divided into segments by north-northeast-trending uplifted belts and inliers of Precambrian rock. Throughout the arctic lowland the segments between the inliers appear to be basins that have experienced substantial subsidence.

The coastal plain lies along the shore of the Arctic Ocean from the northern coast of Alaska northeast to Meighen Island (80°N, 100°W) and includes the Mackenzie delta and the Yukon coastal plain on the northwesternmost part of the Canadian mainland. It is underlain by unconsolidated Tertiary or Pleistocene sands and gravels, including deltaic deposits of modern streams and remnants of earlier deltas.

All of the arctic lowland and coastal plain region was glaciated. The location of the northern perimeter of the Wisconsin ice sheet was approximately that of the northern periphery of this region but excluded most of Banks Island (73°N, 120°W). The ice sheet

modified the preglacial landscape with glacial landforms which have controlled the development of postglacial terrain over wide areas. In the eastern part of the region, the effect of glaciation has been restricted to a wide distribution of ground moraine with a few areas showing glacial lineation features. The eastern part of Victoria Island (80°N, 110°W) has many eskars and a great number of drumlins and belts of moraines; on the western part of the island glaciation has left a pattern of ground moraine with widespread areas of kames, hummocks and end moraines along the coastal fringes.

3. CANADIAN SHIELD

The Canadian shield is a broad land area centred on Hudson Bay. Most of it is in Canada, but it extends south into the United States west and south of Lake Superior. The shield resembles a huge basin or saucer; the depressed central part is occupied by Hudson Bay. At one time a mountainous area, it has been planed down during long periods of erosion so that its present surface resembles a vast peneplain, except the outward shelving rim to the northeast. The northeast rim is tilted upward, forming the mountains of Labrador and Baffin Island (68°N, 70°W).

Despite the effects of long periods of erosion and levelling, parts of the shield remain geologically distinct and exceedingly complicated. The shield is composed of Precambrian rocks of Archean and Proterozoic age, most of which are granite, granite gneiss, granodiorite and quartz diorite. Interbedded throughout this extensive area of acid rocks are volcanic and sedimentary assemblages of Archean age characterized by different degrees of erosion and reflected in various types of terrain. Basic rock formations in the form of large batholiths form more resistant upland areas in the southeastern part of the region.

Although the general surface of the Canadian shield dips at low angles under the bordering Phanerozoic strata, its most outstanding feature is the monotonously even erosion surface characteristic of an ancient peneplain. Local variations in relief include rounded or flat-topped knobs and ridges ranging in elevation from several metres to approximately 135 metres; most of the surface is between 70 and 100 metres. The relief is mountainous only in scattered areas, and even in these areas remnants of the old erosion surface occur on the summits.

The most significant period of the geological history of the Canadian shield has been the Pleistocene Ice Age. Ice masses formed centres of accumulation in the central and northeastern parts of the region, moved outward and coalesced into the large Lauren-

tide ice sheet. Little evidence of glacial and interglacial periods preceding the last ice advance has been left on the shield, although multiple glaciation is known to have occurred. The Wisconsin glaciation, the last major ice advance, is the most important of the ice advances due to its influence on the formation of landforms visible at the present time.

The Wisconsin ice advance greatly modified the surface topography of the shield by rounding and levelling rock ridges, scouring out hollows and depositing a shallow layer of stony, sandy till. Extensive areas were completely denuded of soils and parent material, leaving bare and sterile bedrock plains. Most of the till was carried outside the periphery of the shield into the interior plains region of Canada and the United States, although thick deposits of till exist in hollows and valleys. A great multiplicity of glacial and periglacial landform features are evident throughout the shield.

A major result of glaciation on the landscape of the shield has been the disruption of preexisting drainage that left the surface covered by an enormous number of freshwater lakes occupying basins scooped out by glacial quarrying, moraine-dammed depressions and erratic river systems. The main stream flow is in the direction of the general slope of the land surface and commonly follows elements of bedrock structure including fracture zones, folds, faults and joint patterns, usually dammed by glacial debris. Where drift deposits are scarce, larger lakes and rivers show parallel and angular patterns of development controlled by bedrock structures.

4. APPALACHIAN HIGHLANDS

Southeast of the Canadian shield the Appalachian highlands occupy that part of Canada which is southeast of the St. Lawrence river and the Gulf of St. Lawrence, and extend through the eastern part of the United States almost to the Gulf of Mexico.

The Appalachian highlands consist of an extensive and complex belt of mountains. In the late Paleozoic the sedimentary formations occupying the site of the region were folded and uplifted. Subsequent erosion has left a series of northeast-southwest-trending highlands and rolling uplands separated by valleys and broad lowland areas.

The northern third of the region, almost as far south as the 40° parallel, consists mainly of metamorphosed formations with intrusions of igneous rocks in domes. In the southern two thirds of the region, the folded sedimentary mountains occupy the central core of the region. They are flanked on the east by complex metamorphic structures truncated

LEGEND TO FIGURE 4

PHYSIOGRAPHIC REGIONS

- 1 Inuitian region
- 2 Arctic lowland and coastal plain
- 3 Canadian shield
- 4 Appalachian highlands
- 5 Gulf and Atlantic coastal plains
- 6 Interior highlands
- 7 Central lowlands
- 8 Interior plains
- 9 Cordilleran region
- 10 Basin and range province
- 11 Intermontane plateaus
- 12 Alaska highland and basin

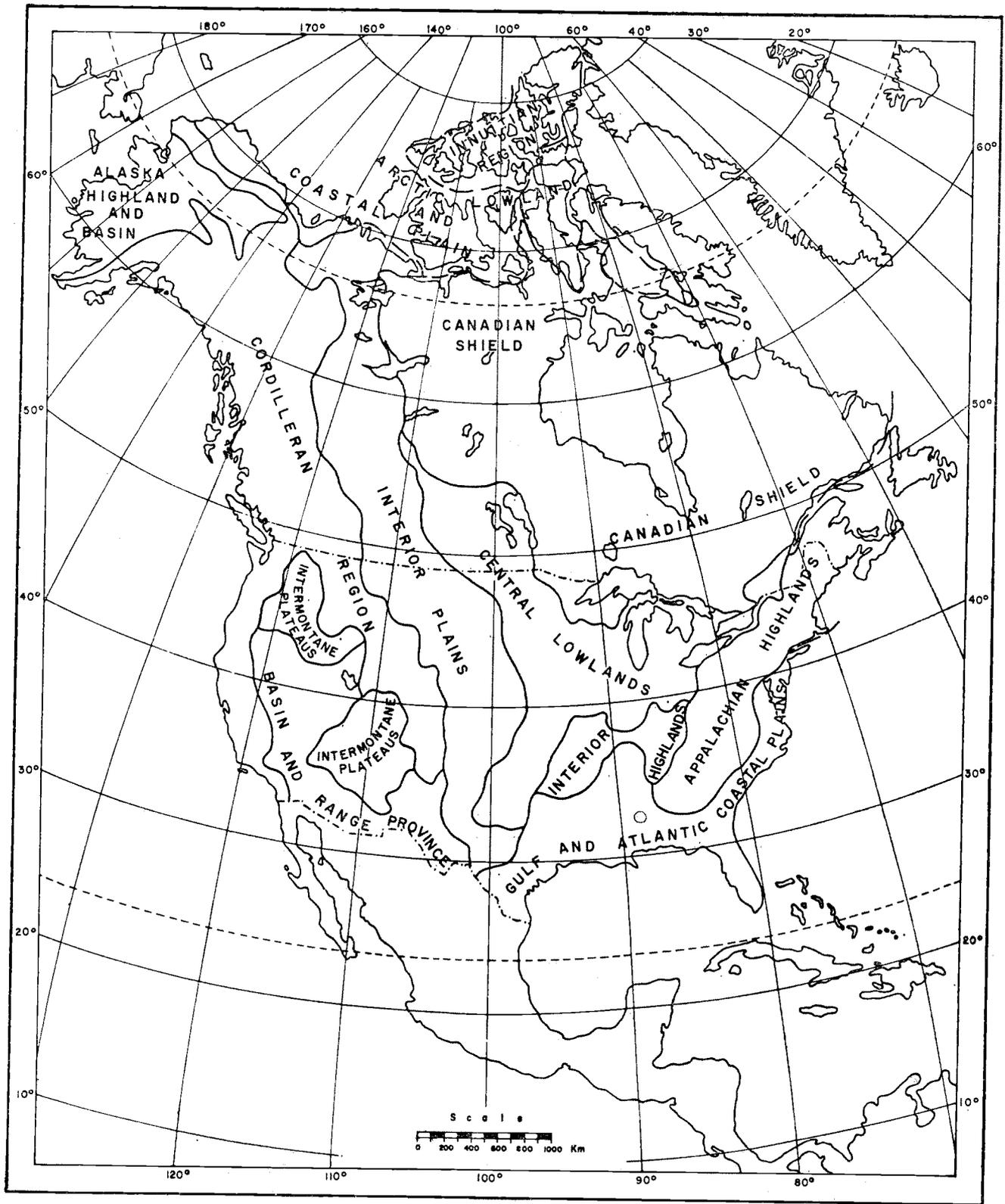


Figure 4. - Physiographic regions of North America

to a plateau surface. On the west, the mountainous core of the region is flanked by a plateau underlain by nearly horizontal sedimentary formations.

The Appalachian highlands as far south as the 42° parallel were covered by ice during the Wisconsin glaciation. Much of the preglacial surface has been scoured and subsequently covered by a layer of glacial till and morainic deposits varying in thickness from place to place. Landforms are rounded hummocky ridges of till, drumlins, outwash plains and terraces, U-shaped ice-eroded valleys and glacially scoured rock surfaces. In the southern unglaciated part of the region, landforms are often more angular. On the flanking plateaus, surfaces are gently sloping and dissected by many streams originating in the ridge-and-valley core of the region.

5. GULF AND ATLANTIC COASTAL PLAINS

The Atlantic coastal plain extends along the Atlantic coast from about 40°N to the Florida peninsula and the Gulf coastal plain from Florida along the Gulf of Mexico to the Mexican border. It has a width of from about 150 to a little more than 300 km, elevations are less than 150 m and more than half of it is below 35 m.

The region comprises extensive sedimentary deposits of various ages. Because the strata of sediments have a slight dip seaward, the upper and more recent strata occupy positions closest to the ocean; successively older strata outcrop at greater distances inland. Thus, Cretaceous sediments outcrop at the highest elevations along the inland margin of the coastal plain; Quaternary sediments occur along the shore and in alluvial plains; Tertiary strata occupy intermediate positions between the two.

In general, the surface of the coastal plains is nearly featureless. The plains are dissected by numerous streams originating in the adjacent Appalachian highlands. On the inland side of the region, slopes are strongest and low hills are not uncommon. The more resistant strata of the Cretaceous and early Tertiary formations form low ridges, particularly on the Gulf coastal plain. Toward the coast, the ridges are less prominent, and the outer part of the coastal plain is virtually flat.

6. INTERIOR HIGHLANDS

The interior highlands bear some geologic relationship to the formations of the Appalachian highlands. They comprise mainly Paleozoic sedimentary rocks and in places are folded and truncated, exposing a pre-Paleozoic core.

The sediments underlying the highlands are slightly upwarped into a low arch; in the southern part of

LEGEND TO FIGURE 5

SURFACE GEOLOGY

Rock types indicated are those most representative of the map unit; other rock types occur within the areas delineated, but they are relatively inextensive.

INTRUSIVE IGNEOUS AND PLUTONIC ROCKS

1

Mainly acidic rocks (granite, granodiorite, quartzdiorite, quartzmonzonite, schist, syenite, granitic gneiss, granulite); some basic and ultrabasic rocks (anorthosite, gabbro).

SEDIMENTARY AND VOLCANIC ROCKS

Precambrian

2

Metamorphosed sedimentary rocks (sandstone, shale, conglomerate, limestone, slate, greywacke, phyllite, quartzite, chert, iron beds); volcanic flows and pyroclastic rocks; some coal and evaporites.

3

Sedimentary rocks (sandstone, conglomerate, siltstone, limestone); some alkaline volcanic rocks.

Paleozoic

4

Sedimentary and metamorphosed sedimentary rocks (shale, sandstone, limestone, dolomite, conglomerate; slate, phyllite, schist, greywacke, quartzite, chert, cherty argillite, coal); some volcanic breccia, tuff and andesite; and some intrusive igneous and metamorphic rocks.

5

Mainly sedimentary rocks (limestone, dolomite, shale, sandstone, conglomerate) with quartzite and some Cenozoic volcanic rocks.

6

Sedimentary rocks (limestone, dolomite, sandstone, shale and evaporites).

Mesozoic

7

Limestone, argillite, andesite, volcanic breccia and tuff; some greywacke, sandstone and quartzite.

8

Mainly sandstone, shale and conglomerate; some argillite, greywacke, limestone, quartzite, andesite, volcanic breccia and tuff.

9

Mainly shale, sandstone, limestone and conglomerate; with coal beds, evaporites and some volcanic rocks.

Cenozoic

10

Sandstone, shale, conglomerate, and coal beds.

11

Sandstone and shale, weakly indurated; sand and clay; some limestone and marl.

12

Volcanic flows (basalt, andesite) and pyroclastic rocks.

13

Alluvium, glacial drift, and coastal and aeolian deposits — sand, clay, and gravel. (*Note:* Thick drift and loess sheets of north central and northeastern continental regions not shown.)

14

Alluvium and lacustrine and aeolian deposits of intermontane basins — sand, silt, clay, gravel; with Cenozoic volcanic rocks, Paleozoic and Mesozoic sedimentary rocks, and intrusive igneous and plutonic rocks of mountain ranges.

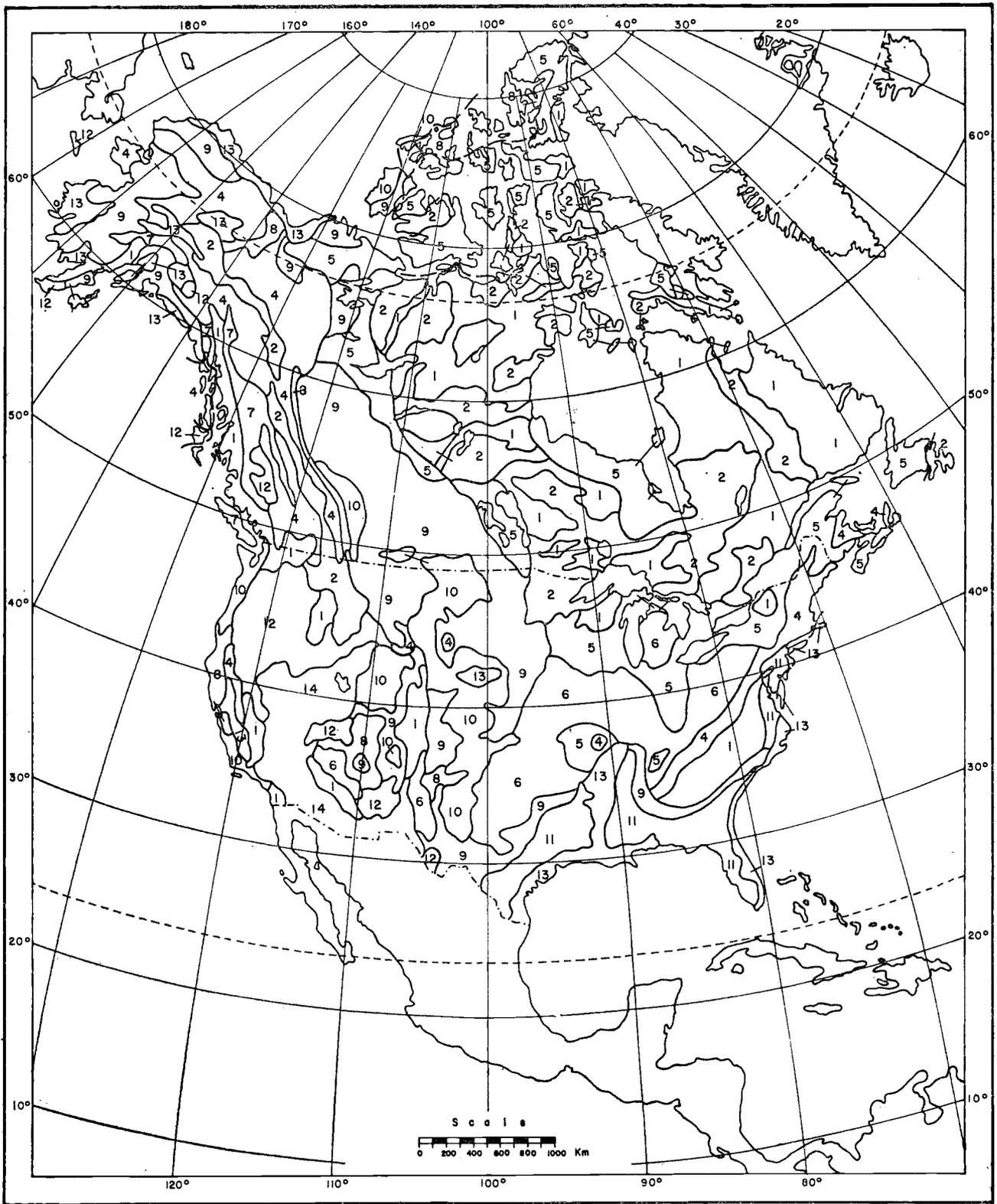


Figure 5. - Surface geology of North America

the region west of the Mississippi river, the strata have undergone some folding. Crests of the broad arch and the folds have been eroded and truncated so that the Precambrian core is exposed. Limestone commonly occurs at the surface stratum of rock although sandstone is exposed in many places west of the Mississippi river.

Topographically, much of the interior highlands is a dissected plateau. In the eastern part of the region, the surface is characterized by several large basins, the surrounding upland area being cut by meandering streams in steep-walled valleys. West of the Mississippi river, the strata more resistant to erosion form irregularly spaced ridges and escarpments. Dissection by streams has created broad, gently sloping interfluvial valleys between deep steep-walled valleys. Because of the abundance of carbonate rocks on the surface of the plateau, sinkholes are common.

7. CENTRAL LOWLANDS

The central lowlands comprise the low-lying generally featureless plains in the central part of the continent. In Canada, the lowlands are situated between the Canadian shield and the interior plains; in the United States, they are bordered on the east by the Appalachian highlands and on the west by the southern part of the interior plains.

The central lowlands are underlain by nearly horizontal beds of sedimentary rocks of Paleozoic age comprising various sequences of limestone, sandstone, conglomerate and shale. The region was the floor of a shallow Paleozoic sea. At the close of the Paleozoic era, there was a general uplift of the Appalachian highlands and the Canadian shield, and an accompanying uplift, to a lesser degree, of the interior of the continent and some warping of the sedimentary strata. Subsequent erosion cycles and development of drainage carved the modern landscape seen in the southern part of the lowland — scarped plains with streams entrenched in gorges that are most closely spaced in the southernmost part of the region.

The northern part of the central lowlands has been subjected to a succession of advances and retreats of glaciers. Continental ice sheets covered the region as far south as the present alignment of the Missouri and Ohio rivers in the United States. Kansan drift, the oldest of the glacial deposits, constitutes the surficial material of much of the southern part of the drift-covered area of the region along the lower reaches of the Missouri river. Of great age, landforms on this older drift are more strongly sloping and drainage is well developed. Illinoian drift is the surficial material in an area less extensive than

that in which the Kansan is exposed; it occurs north of the Ohio river and east of the Mississippi river. The landscape on this more recent glacial drift is somewhat less dissected by streams and slopes are moderate; the drift is less deeply weathered than that of the Kansan glaciation. Most of the remainder of the central lowland has a drift cover of Wisconsin age. Slopes are gentle, there are many lakes and ponds, drainage is not well developed and the drift is not deeply weathered.

Loess mantles most of that part of the central lowlands west of the 90° meridian and between the 37° and 46° parallels. The landscape on this highly erodible surficial material is a series of gently to moderately sloping interfluvial valleys separated by steep-walled ravines, gorges and stream valleys.

8. INTERIOR PLAINS

The interior plains form a region of low relief west of the central lowlands and the Canadian shield and east of the Cordilleran region. It extends from the shore of the Arctic Ocean in northern Canada to the Rio Grande on the southern border of the United States. Although the surface appears monotonously level, the interior plains slope from west to east at a rate of approximately 2 metres per kilometre. The western border is sharply defined by the slopes of the Rocky mountains; the eastern border by a much less well-defined series of low discontinuous ridges and scarps.

The region is underlain by sedimentary rocks of Cretaceous age. In some places, a veneer of Tertiary sediments covers the Cretaceous formation. During late Tertiary time, deposits of products of weathering in the Cordilleran region to the west covered much of the older formations. Subsequent erosion cycles have removed part, and in some places all, of this cover.

Glacial drift covers the interior plains from the Missouri river north to the Arctic Ocean. The topography is one of rolling plains and hills. There are also terrace-bordered stream valleys, lacustrine plains on the sites of former glacial lakes and myriad lakes, ponds and bogs in undrained depressions.

Immediately south of the glaciated area of the interior plains, the region is marked by nearly level areas of lacustrine sediments, sand dunes formed from coarser wind-blown particles from the broad dry watercourses of stream channels and a blanket of loess derived from the dry surface of barren plains.

In that part of the interior plains not subjected to glaciation or the deposition of postglacial materials, erosion has removed much of the late Tertiary cover and carved the modern landscape from late Cretaceous formations.

9. CORDILLERAN REGION

The Cordilleran region comprises a belt of mountain ranges along the western coast of North America. In part of the region, the ranges are massive and continuous; in other parts they are interrupted by valleys, broad basins and plateaus. In Canada the region comprises a closely spaced series of ranges that to the north extend along the southern coast of Alaska into the Aleutian islands, and in the northern part of Alaska include the Brooks range. In the United States, the region consists of two belts, the easternmost extending in a southeasterly direction into northern New Mexico and the western one along the Pacific coast to the Mexican border.

The mountains of the Cordilleran region were formed during the latter Mesozoic era and the early Tertiary period. The initial forms resulting from the general uplift have been eroded and partly buried by the resulting debris. But continuing uplift throughout the region during Tertiary and Quaternary time has maintained the height and extent of the mountains. The eastern half of the region is now considered to be stable, but the western half is still subject to crustal movement.

The southeastern extension of the Cordilleran region in the United States consists of a group of ranges having a Precambrian core of igneous and metamorphic rocks flanked by sedimentary strata that once extended across the now-exposed Precambrian core. Ranges are separated by broad intermontane basins covered by Tertiary and Quaternary sediments.

The western extension of the Cordilleran region in the United States is a series of mountain ranges paralleling the Pacific coast; as a group, they are of considerable complexity in their geology and evolution. However, most were formed by faulting and folding, followed during Tertiary and Quaternary time by processes that modified the original structure and resulted in the basic landscape of the present. Volcanism has occurred throughout the Cordilleran region but its effects are most obvious in Alaska, the northwestern part of the United States and southwesternmost Canada where lava and volcanic debris mask the underlying formations. After the original uplift of the region, extensive block-faulting occurred, creating not only the block mountains but also the intervening basins which were subsequently filled with sediments during the late Tertiary and Quaternary.

The continental ice sheet covered many of the ranges of the Cordilleran region; remnants of this ice sheet remain in these mountains. U-shaped valleys, many small lakes, cirques, terminal and recessional moraines, drumlins, outwash terraces and

eskers mark the areas formerly covered with ice. In the southern part of the region these features occur only at higher elevations, but they occur at progressively lower elevations at higher latitudes.

The southernmost part of the Cordilleran region remained unglaciated. The landscape is dominantly one of steep mountains and moderately sloping alluvial fans that taper to nearly level, broad valley floors and basins.

10. BASIN AND RANGE PROVINCE

The basin and range province is situated in the southwestern United States between the Rocky mountains and the Pacific coast ranges of the Cordilleran region. It consists of many mountain ranges and ridges, most of which are oriented in a north-south direction, separated by broad basins. Elevation above sea level varies greatly from one part of the province to another although it is generally greatest in the north; the lowest point, below sea level, is in the south and the highest peak is about 4 000 m in elevation.

The structure of the basin and range province comprises folded and faulted strata of Paleozoic and Mesozoic age that have been subjected to block faulting. The uplifted blocks form the mountains and ridges of the region, and the down-faulted blocks form the floors of the intervening basins. Weathering and erosion of the uplifted strata during Tertiary and Quaternary time produced the debris that filled the basins and partially buried the peaks and ridges.

Because of the complexity of crustal movements, the pattern of rocks at present exposed is also very complex. In general, granites and gneisses of Precambrian age are exposed on the severely eroded ranges in the south; elsewhere metamorphosed Paleozoic rocks and sediments of Tertiary age are dominant. In the northern part of the region, volcanic activity before and during the block faulting resulted in extensive areas having a cover of basalt flows.

Unconsolidated materials in coalescing alluvial fans fill most of the basins. Lacustrine sediments occur locally.

11. INTERMONTANE PLATEAUS

West of the Rocky mountains in the United States are plateau segments of the broad structural arch of which the Rocky mountains form the central and highest part. They are intermediate in elevation between the Rocky mountains on the east and the basin and range province to the west.

The Colorado plateau, the southernmost of the intermontane plateaus, consists of nearly horizontal

strata that range from Precambrian to Recent ages and are tipped gently to the northeast. Most of the strata are of sedimentary origin. There are igneous intrusions in the central part of the plateau, and volcanoes and their accompanying lava flows are distributed around the southern and western rims. Differential erosion of hard and soft rocks has produced angular escarpments, benches and pediments that impart a step-like appearance to much of the plateau. The nearly level upper surface of the plateau is deeply cut by steep-walled canyons.

The Columbian plateau is smaller than the Colorado plateau and lies north of the basin and range province in the northwestern part of the United States. It is somewhat lower in elevation than the basin and range province.

The Columbia plateau consists mainly of lava flows of Tertiary and Quaternary age interbedded with some sedimentary formations. In places on the surface of the plateau are ridges of folded or faulted lavas and several exposures of older igneous, metamorphic and sedimentary rocks on the eastern central part of the plateau.

The continental ice sheet extended into the northern part of the plateau, leaving behind moraines, sand and gravel terraces, and glacial lake sediments. South of the glaciated area thick deposits of loess mantle the uplands.

12. ALASKA HIGHLAND AND BASIN

The Alaska highland and basin includes much of the drainage basin of the Yukon river in central and southwestern Alaska. The floor consists of a complex of ancient metamorphic rocks, and some Tertiary sediments in a few places, which have been folded and faulted and then truncated by erosion. Over this complex floor is a cover of glacial drift partially mantled by loess, which in places is interbedded with volcanic ash.

Intricately dissected uplands are dominant in the eastern part of the region and broad lowland basins are found in the western part.

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5. THE SOILS OF NORTH AMERICA

The legend of the Soil Map of North America consists of 596 map units in 415 different soil associations, each of which is composed of one or more soils occupying characteristic positions in the landscape. The sequence of their occurrence is related mainly to topography, physiography and lithology.

Each soil association is characterized by the dominant soil—the soil with the widest extension¹—and by associated soils and inclusions which occur in lesser extension. Sixty different dominant soils have been indicated on the map.

For convenience and brevity the soil associations have been listed in Table 6.² The following information is given:

Map symbol. The map symbol of the dominant soil, followed by the number specifying the composition of the soil association, a second number indicating the textural class of the dominant soil and a small letter indicating the slope class of the soil association. Textural class numbers are: (1) coarse, (2) medium and (3) fine. Slope class letters are (a) level to undulating, (b) rolling to hilly and (c) steeply dissected to mountainous.

Associated soils. Subdominant soils with an extension of more than 20 percent of the mapping unit.

Inclusions. Inclusions of important soils occupying less than 20 percent of the mapping unit.

Phase. Phases related to the presence of indurated layers, hard rock, salinity or alkalinity in the soil.

¹Discrepancies in the summation of calculated areas for soil areas and total land surface of Canada are due to a number of factors, involving changes in size and shape of coastlines, lakes, islands and other features depicted under various cartographic projections and scales. Correction factors have been introduced to give a better correspondence between areas in the provinces and below the 60° parallel of latitude, allowing a greater margin of discrepancy in northern Canada and the arctic islands. It should be recognized, therefore, that figures given for areas of specific soil groups and comparisons of percentage relationships express generalized and comparative rather than precise relationships.

²The soil associations listed in Table 6 refer only to the soil maps of Canada and the United States. The soil associations of Mexico and Bahamas, shown on map sheet II/2, are listed in Volume III (Mexico and Central America).

Extension. An estimate of the area of the unit in thousands of hectares.

Climate. The soil climate, as defined in Chapter 4.

Occurrence. The regions of occurrence.

Vegetation. The predominant vegetation of the area.

Lithology. The predominant lithology of the area.

Distribution of major soils

Each of the major soil regions of North America is dominated by one or a few kinds of soils (see Figure 6). Most of the soil regions occur over a wide range of latitude and elevation, and as a consequence the physical environment in which the characteristic soil occurs varies considerably.

1. REGOSOLS

Regosols are the dominant soils across much of northern Canada, including the northern islands. They are very cold soils and permafrost is continuous. Gleysols, Cambisols and Lithosols are the principal associated soils. Natural vegetation is tundra, which affords limited grazing; some areas are barren. Because of low temperatures, economic use of the soils of this region generally is not feasible.

2. LITHOSOLS

Lithosols are extensive in the northern half of North America. They occur on steep mountain slopes in the western and northwestern part of the continent and on gentle and moderate slopes in northern Quebec, the coast of Labrador and the islands in the far north. Associated with the Lithosols, in areas with shallow superficial deposits, are Luvisols, Podzols and Regosols. Much of the region has a sparse cover of forest and shrubs. Shallowness or complete absence of soil and low temperatures generally preclude development of farm and forest enterprises.

3. CAMBISOLS

Cambisols are widely distributed across mountains, hills and plains in northern and northwestern Canada and Alaska; they are also the dominant soils in the Appalachian mountains in the eastern United States and in coastal mountain ranges along the central Pacific coast.

In Canada and Alaska, Cambisols are cold and moist. Because of the low temperatures, some Cambisols have permafrost near the surface. Principal associated soils are Luvisols, Gleysols and Histosols; Fluvisols occur in stream valleys. Lithosols are common throughout the region, particularly on the mountain slopes of northwestern Canada. Natural vegetation consists of boreal forest and tundra, although some mountain slopes are barren. Low temperatures preclude extensive farming.

In the United States, Cambisols have warmer temperature regimes. Principal associated soils are Luvisols and Podzols; Gleysols and Fluvisols occur inextensively. Natural vegetation is forest but about half of the region is used for livestock and dairy farming.

4. HISTOSOLS

Histosols occur throughout Canada and Alaska but they are the dominant soils in broad regions only in Canada. They occupy nearly level and gently sloping plains. In the northern part of the region permafrost is present. Principal associated soils are Luvisols, Cambisols and Lithosols on better drained, higher lying areas and Gleysols on poorly drained sites. In areas having a somewhat milder climate, some Histosols have been used for farming, but most are undeveloped and covered by forests or bogs.

5. PODZOLS

Podzols comprise the soil cover of the cool and moist eastern and northeastern parts of the continent; they occur much less extensively on mountain slopes along the northwest coast. Soil temperature regimes are cool to cold except in the southeasternmost part of the region where they are temperate. Principal associated soils are Gleysols and Histosols on the more gentle slopes and level areas and Cambisols on the higher lying parts of the landscape. Lithosols are inextensive but are widely distributed, particularly on the steeper slopes. Natural vegetation is forest. Only a small proportion of the Podzols is being farmed. Most of this is in the areas of milder climate in southeastern Canada and the northeastern United States. Forage and grains are the principal crops.

LEGEND TO FIGURE 6

MAJOR SOIL REGIONS

1	Regosols
2	Lithosols
3	Cambisols
4	Histosols
5	Podzols
6	Luvisols
6a	Luvisols of plains
6b	Luvisols of mountain areas
7	Acrisols
8	Chernozems
9	Kastanozems
10	Phaeozems
11	Xerosols
12	Yermosols
12a	Yermosols of desertic mountains and plains
12b	Yermosols of desertic plains
13	Vertisols
14	Gleysols and gleyic soils

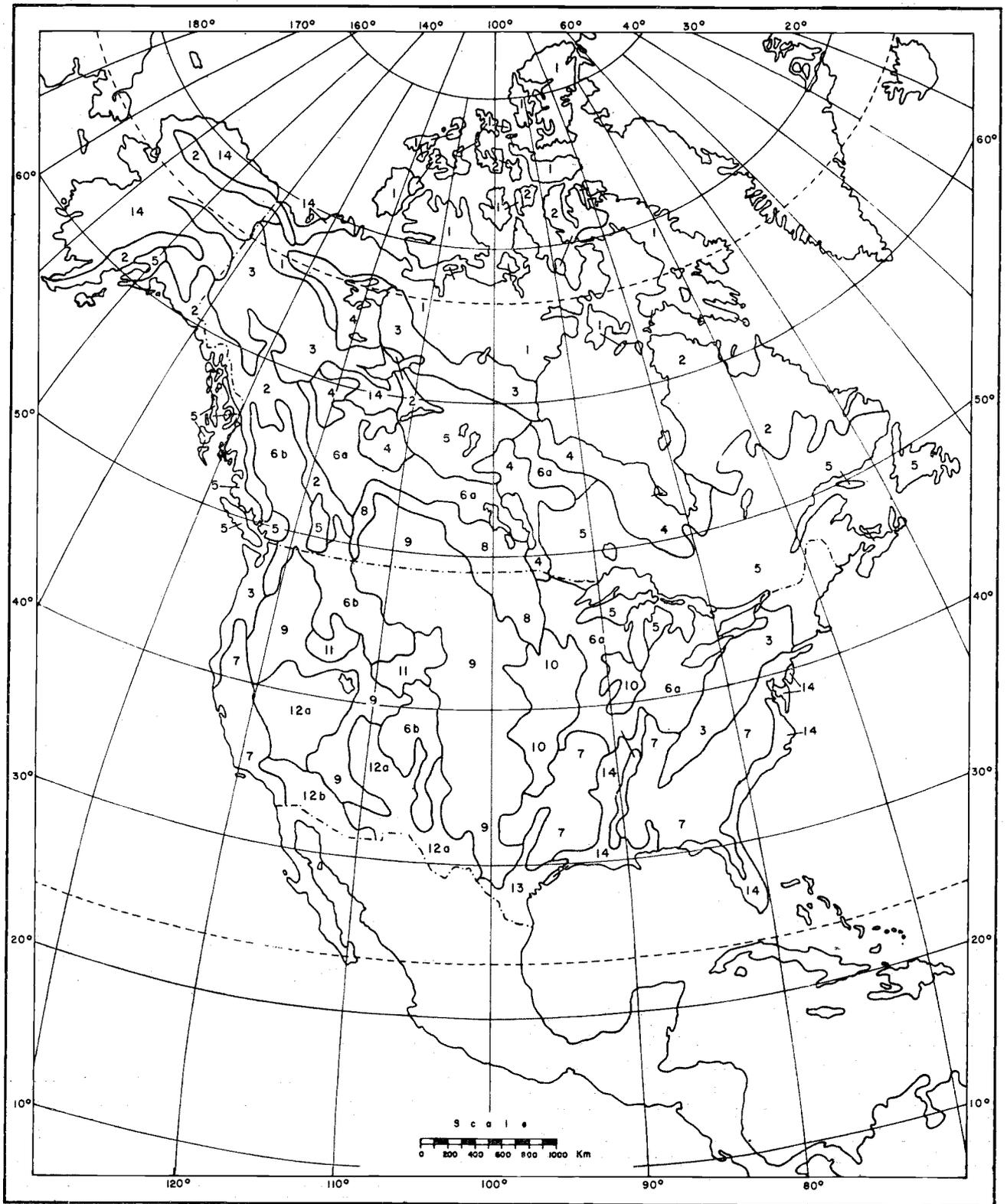


Figure 6. - Major soil regions of North America

6. LUVISOLS

Luvisols are widely distributed, from the St. Lawrence river in eastern Canada to the western slopes of the Rocky mountains and from central Canada nearly to the Gulf of Mexico.

6a. Luvisols of plains. These Luvisols range from cold in central Canada to warm in the southern United States. They are predominantly moist. Associated soils are principally Podzols and Cambisols on higher lying areas and Gleysols and Histosols on low-lying areas. Natural vegetation is forest. In the milder climate of southern Canada and the United States, Luvisols are widely used for cultivated crops and hay.

6b. Luvisols of mountain areas. Luvisols in these areas are cool or cold. Associated soils in Canada are principally Podzols and Lithosols; in the United States, Kastanozems and Phaeozems. Andosols are extensive in southern British Columbia, Washington and Idaho. Stony phases of these soils are common. Most of the region is forested but in the valleys, where slopes are less steep and temperatures mild, the soils are used for cultivated crops.

7. ACRISOLS

Acrisols are the dominant soils on the plains and hills of the southeastern United States and on the mountain and valley slopes along the southwest coast.

In the southeastern United States they are warm to hot, moist soils. The principal associated soils are Cambisols; Nitosols are extensive associated soils west of the Mississippi river. Natural vegetation consists of broadleaf and some needleleaf forest. Most of the land is in farms but less than half is cropland. In the more sloping areas, cropland is being converted to pasture and forest.

Along the southwest coast, the Acrisols are equally warm but soils are moist only during the winter. On the mountain slopes Cambisols are the principal associated soils; stony phases of Acrisols and Cambisols are common. Phaeozems occur on the more moist seaward slopes; Luvisols occupy the valley sides and Fluvisols are on the valley floors. Natural vegetation varies — open forest on mountain slopes and shrubs and grasses on the sides and floors of valleys. Lower slopes and valley floors are irrigated and intensively farmed, more strongly sloping land is dry-farmed to grain and the remainder is grazed.

8. CHERNOZEMS

Chernozems occur on the northern and northeastern perimeter of the plains of central North America. They are cool soils that are dry for appreciable periods during the warmer part of the year.

Dominant associated soils are Kastanozems, Luvisols and Gleysols; Solonetz soils occur in relatively extensive areas in southern Canada. Chernozems are highly fertile soils, and much of this region is being farmed. Because the growing season is short and rainfall limited, only a few crops other than grain can be grown.

9. KASTANOZEMS

Kastanozems are extensive in a broad area along the eastern side of the Rocky mountains from southern Canada almost to the Gulf of Mexico. They also occupy extensive areas in the intermontane area to the west of the Rocky mountains from Washington south to Arizona.

East of the mountains, the soils have temperature regimes ranging from cool in southern Canada to warm in the southern United States. Moisture regimes are moist to dry. Regosols, Solonetz soils and some Gleysols are the principal associated soils in the northern part of the area; Regosols, Luvisols and Yermosols are important associated soils in the southern part of the area. Native vegetation consists of short and tall prairie grasses and, in the southern part of the region, brush as well. Much of this part of the region is used for production of grain by dry-farming methods; the rest is being grazed. Where irrigation water is available, irrigated crops and pasture grasses are grown.

In the intermontane area, the Kastanozems have temperate temperature regimes and moisture regimes that range from seasonally moist to dry. In general, slopes are steeper than those of the Kastanozems east of the mountains. In addition to Kastanozems, Phaeozems and Regosols occur in broad areas. Stony phases are common, particularly on the steeper slopes. Native vegetation consists mainly of desert shrubs and sparse grasses which afford some grazing. In the northern part of the area, grains are grown by dry-farming methods; other cultivated crops are grown where irrigation is feasible.

10. PHAEOZEMS

Phaeozems occur on plains and hills in the central part of the United States. In contrast to the drier Kastanozems to the west, the Phaeozems are predominantly moist soils with temperate temperature regimes. Principal associated soils are Gleysols; Chernozems, Luvisols and Regosols occur inextensively. Phaeozems are highly productive soils and much of the region is farmed. Maize, feed grains and hay are the principal crops; a small proportion of the land is used for grazing and only the steeper slopes along stream valleys remain in forest.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Af5-2a	Ao Nd			1 430	Thermic, humid	Northern Alabama, eastern Texas	Field crops ¹	Limestone, alluvium
Af6-2a	Ap Nd	Ao		3 610	Thermic, humid	Southern Alabama	Field crops; mixed forest	Marine sediments
Af7-1a	Rd	Ap		750	Thermic, humid; hyperthermic, humid	North central Florida	Mixed forest, horticultural and field crops	Sandy marine sediments
Af7-1b	Rd	Ap		3 160	Thermic, humid	Western Florida, southern Alabama and Mississippi, central South Carolina, southwestern North Carolina	Mixed forest; grasses, forbs; field crops	Sandy marine sediments
Af8-2ab	Ag	Ap	Fragic ²	1 170	Thermic, humid, (thermic, aquic) ³	Southwestern Alabama	Field crops; mixed forest	Marine sediments
Af9-2ab	Ag	Wd	Fragic ²	6 150	Thermic, humid (thermic, aquic)	Western Tennessee, eastern Mississippi, southern Arkansas	Field crops; mixed forest	Loess over marine sediments
Af9-2ab	Ag	Wd	Fragic	2 110	Thermic, humid (thermic, aquic)	Northeastern Mississippi, southwestern Tennessee, southern Arkansas	Field crops; mixed forest	Loess over marine sediments
Af10-2b	Ag		Fragic ²	1 500	Mesic, humid (mesic, aquic)	Southwestern Missouri, northwestern Arkansas, northeastern Oklahoma	Hardwood forest; grasses, forbs; field crops. Outdoor recreation	Cherty limestone; miscellaneous sedimentary rocks; loess
Ag2-1a	Rd	Ap		2 890	Thermic, aquic (thermic, humid)	Southern South Carolina, eastern Georgia	Mixed forest; field crops	Sandy marine sediments and alluvium
Ag3-2a	Ao Wd	I Ap		6 580	Thermic, aquic (thermic, humid)	Eastern Virginia, North Carolina, South Carolina, southern Louisiana, southeastern Texas	Mixed forest; grasses, forbs, field crops	Marine sediments
Ag4-2a	Je	Ao		1 110	Mesic, aquic; thermic, aquic	Eastern New Jersey, southern Delaware, eastern Maryland	Mixed forest, marsh vegetation, field crops	Marine sediments
Ah2-2bc	Bh			1 350	Mesic, humid	Western Washington	Coniferous forest; field crops	Basalt, andesite, shale and sandstone; alluvium
Ah3-2bc	Bh Hh			5 290	Mesic, perhumid; mesic, humid	Western Oregon and California	Coniferous forest, field crops	Basalt, andesite, granite, shale; alluvium
Ao1-2b				3 070	Thermic, humid	Central and northern Alabama, northwestern Georgia, eastern Tennessee, western North Carolina	Field crops; grasses, forbs; mixed forest	Limestone; alluvium
Ao1-2c				1 740	Mesic, humid	Western Maryland, Virginia, North Carolina, central Alabama	Mixed forest; outdoor recreation, field crops	Granite, gneiss

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Ao25-2abc	Bd I		Stony	3 430	Mesic. humid	Western and eastern Kentucky, eastern Tennessee, southern Indiana	Hardwood forest; field crops	Sandstone, shale; loess
Ao31-2ab		Ag		5 890	Thermic, humid	Northern Alabama, Georgia, South Carolina, western Kentucky	Field crops; mixed forest	Sandstone, shale; loess
Ao32-2b		Nd J		15 750	Thermic, humid	Central Virginia, North Carolina, northern South Carolina, central Georgia, east central Alabama, eastern Mississippi, central Arkansas	Field crops; grasses, forbs; mixed forest	Granite, gneiss, schist, limestone, shale
Ao33-2abc		Bd		1 550	Mesic. humid	Southwestern Pennsylvania	Field crops; hardwood forest	Interbedded shale, limestone and sandstone
Ao34-2bc	Lo I Af			3 370	Thermic, humid	Central Tennessee, northern Arkansas, southern Missouri	Hardwood forest; grasses, forbs; field crops	Limestone and shale
Ao35-2c	Lo Bd Af			1 570	Thermic, humid	Western Arkansas, southeastern Oklahoma	Mixed forest; outdoor recreation; grasses, shrubs; field crops	Shale, slate, quartzite
Ao36-1/2a	Ag			1 630	Mesic. humid (mesic, aquic)	Southern New Jersey, northern Delaware, eastern Maryland	Field crops	Marine sediments
Ao37-2bc	Hh	Bh	Stony	1 300	Mesic. xeric	Southwestern Oregon	Coniferous forest; field crops	Basalt, andesite, tuff; sandstone and shale, alluvium
Ao38-2a	Af	Wd	Fragic *	1 050	Mesic, humid; thermic, humid	Southern Maryland, southern Mississippi, eastern Louisiana	Field crops; mixed forest	Marine sediments
Ao39-2c	Bh		Stony	8 140	Mesic, xeric; boreal, xeric	Northern Carolina, southern Oregon	Coniferous forest; grasses, forbs, shrubs	Granite, andesite, schist; shale and sandstone
Ao40-2abc	Bd	Nd		1 530	Thermic, humid	Eastern Tennessee	Field crops; hardwood forest	Limestone, shale, sandstone; alluvium
Ao41-2b	Bd			1 860	Mesic, humid	Central Maryland, southeastern Pennsylvania, western New Jersey	Field crops; horticultural crops; hardwood forest, built-up areas	Schist, gneiss
Ao42-2c	Bd	I	Stony	2 550	Mesic, humid	Southwestern Virginia, western North Carolina, northern Georgia	Hardwood forest; field crops; recreation area	Granite, schist, conglomerate
Ao61-2ab	Nd	Ne		8 820	Thermic, humid	Eastern Texas, western and northern Louisiana, southeastern Oklahoma	Field crops; mixed forest	Marine sediments; loess
Ao62-2abc	Nd	Bd		8 830	Thermic, humid	Western Alabama, northeastern Mississippi, central Tennessee, southern Kentucky, southern Missouri, northern Arkansas	Mixed forest; field crops	Limestone with loess cover
Ap4-2a	Ao Af	Lg		8 450	Thermic, humid	Eastern Virginia, North Carolina, South Carolina, southern Georgia	Field crops; mixed forest	Marine sediments
Ap24-1a	Ao Rd Af	Lg		—	—	South Carolina, southern Georgia	—	—
Bc1-2a	Oe	Bd		120	Mesic, humid (mesic, aquic)	Northern New York	Hardwood forest; field crops	Glacial till

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Bc2-2a	Bd Je			100	Mesic. humid (mesic. aquic)	Northern New York	Hardwood forest: field crops	Glacial till, lacustrine sediments
Bc3-2a	Bd	P G		400	Mesic. humid	Eastern New York, western Vermont, Massachusetts, Connecticut	Field crops: mixed forest	Glacial till and outwash
Bd2-1b	I		Stony	20 178	Subarctic, humid	Northwest Territories	Nonproductive coniferous forest	Glacial till and outwash
Bd2-2a	I			357	Cryoboreal, perhumid (maritime modification)	Quebec	Productive and nonproductive mixed forest	Calcareous glacial till, igneous and metamorphic rocks
Bd2-2b	I			287	Cryoboreal-boreal, perhumid	British Columbia	Productive coniferous forest, grasses, forbs	Calcareous glacial till, outwash, igneous rocks
Bd2-2b	I			489	Boreal, humid	Ontario	Productive and nonproductive mixed forest	Glacial till, lacustrine sediments, unspecified igneous and sedimentary rocks
Bd2-2c	I		Stony	722	Subarctic-cryoboreal, humid (maritime modification)	British Columbia	Productive and nonproductive coniferous forest	Calcareous glacial till, unspecified sedimentary rocks
Bd3-1b			Stony	1 023	Boreal, perhumid	Quebec	Productive mixed forest, horticultural crops	Glacial till and outwash
Bd3-2a				619	Mesic. boreal, subhumid to semiarid (maritime modification)	British Columbia	Productive mixed forest, horticultural crops	Glacial till and outwash, marine sediments
Bd3-2a				87	Mesic. humid	Quebec	Field crops, nonproductive hardwood forest	Glacial till
Bd3-2abc				2 660	Mesic. humid	Southern West Virginia, north central Pennsylvania, southeastern New York	Field crops: hardwood forest	Siltstone, shale, sandstone, slate
Bd3-2c			Fragic	880	Mesic. humid	Southeastern New York	Hardwood forest; field crops, recreation area	Glacial till
Bd9-2c	Ao I			8 840	Mesic, humid	Eastern West Virginia, Kentucky, Tennessee, western Virginia, central Alabama	Hardwood forest: field crops: mines, outdoor recreation	Sandstone and shale
Bd12-1b	La			142	Boreal, humid	Ontario	Productive and nonproductive mixed forest	Glacial till
Bd12-2/3a	La			365	Boreal, perhumid	Quebec	Field crops, productive mixed forest	Glacial till, lacustrine sediments
Bd12-3a	La			199	Cryoboreal, boreal subhumid to humid	British Columbia	Productive coniferous forest, pasture	Marine sediments, glacial outwash
Bd13-2c	La	I	Stony	401	Cryoboreal, subhumid (maritime modification)	British Columbia	Productive coniferous forest	Calcareous glacial till and outwash, unspecified igneous rocks
Bd14-2b	La Po			2 356	Cryoboreal, humid-subhumid	British Columbia	Productive and nonproductive coniferous forest	Glacial till and outwash, residual materials (local colluvium and solifluctate)

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Bd15-2a	Rd I			20	Boreal, humid	Northwestern Montana	Coniferous forest; field crops	Metamorphic rocks; alluvium
Bd16-1/2a	Je		Stony	207	Boreal-cryoboreal, semiarid to subarid	British Columbia	Productive coniferous forest	Calcareous glacial till and outwash; residual materials (local colluvium and solifluctate)
Bd17-2a	O			329	Cryoboreal, perhumid (maritime influence)	Quebec	Productive mixed forest	Calcareous glacial till
Bd18-2b	Po		Stony	30	Mesic, humid	Northwestern Washington	Coniferous forest	Glacial till and outwash
Bd18-2b	Po		Stony	122	Mesic, humid to subhumid	British Columbia	Productive coniferous forest	Glacial till and outwash
Bd20-2a	G		Fragic	740	Mesic, humid (mesic, aquatic)	Central New York	Field crops; horticultural crops	Glacial drift
Bd20-2abc	G		Fragic	4 030	—	Southern New York, northern Pennsylvania	Field crops; mixed forest	Glacial till
Bd20-2b	G			—	—	Southern New York, northern New Jersey	—	—
Bd20-2b	G		Fragic	1 570	—	Southwestern New York, northwestern Pennsylvania	Field crops; mixed forest	Glacial till
Bd22-2bc	L A	G		9 920	Mesic, humid	Western West Virginia, southeastern Ohio, southwestern Pennsylvania	Hardwood forest; field crops; horticultural crops	Shale, siltstone, sandstone, limestone
Bd23-2b		G	Fragic*	540	Mesic, humid	Eastern New York	Field crops	Glacial till; limestone
Bd24-2a		P		410	Mesic, humid	Eastern New York	Built-up areas; field crops	Sandy glacial drift
Be1-1a				285	Subarctic to cryoboreal, subhumid to humid	Alberta	Productive coniferous forest	Alluvium, lacustrine sediments, aeolian sand
Be1-2a				849	Mesic, humid	Ontario	Field crops, horticultural crops	Calcareous glacial till
Be1-2a			Lithic	—	—	Ontario	—	—
Be1-2a			Stony	49	Mesic, humid	Ontario	Field crops	Calcareous glacial till
Be1-2b			Stony	106	Mesic, humid	Ontario	Field crops, horticultural crops	Calcareous glacial till
Be1-2c				560	Mesic, humid	Southern Ohio, Indiana, western North Carolina	Hardwood forest; grasses, forbs; field crops	Calcareous shale and limestone
Be1-3a				93	Mesic, humid	Ontario	Field crops; horticultural crops	Calcareous lacustrine sediments
Be1-3a			Stony	572	Cryoboreal, humid	Alberta	Field crops	Calcareous glacial till, lacustrine sediments
Be2-1a	La		Stony	355	Subarctic to cryoboreal, humid	British Columbia	Productive coniferous forest	Calcareous glacial till

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Be2-2c	La		Stony	80	Subarctic to cryoboreal, humid (maritime modification)	Alberta, British Columbia	Productive and nonproductive coniferous forest	Calcareous glacial till, residual materials (local colluvium and solifluctate)
Be10-2c	La	Bh Tv	Stony	1 070	Boreal, humid	Western Wyoming, southern and northwestern Montana	Coniferous forest: grasses, forbs	Sandstone, shale, basalt, quartzite, argillite, granite; glacial drift; alluvium
Be11-2a	Je			1 830	Subarctic, subhumid-humid	Yukon	Productive and nonproductive coniferous forest	Alluvium, calcareous glacial till and outwash
Be11-2b	Je			2 452	Subarctic, subhumid to humid	Yukon, British Columbia	Productive and nonproductive coniferous forest	Alluvium, calcareous glacial till and outwash
Be11-3a	Je			898	Subarctic, subhumid to humid	Yukon	Productive and nonproductive coniferous forest	Lacustrine sediments, calcareous glacial till and outwash, alluvium
Be12-2a	Gm			583	Mesic, humid	Ontario, Quebec	Field crops, horticultural crops	Calcareous glacial till, marine and lacustrine sediments
Be12-2/3a	Gm			487	Mesic, humid (mesic, subaquic)	Quebec	Field crops, horticultural crops	Calcareous glacial till, marine sediments
Be13-2a	I		Lithic	347	Boreal, humid	Ontario	Field crops	Calcareous glacial till, lacustrine sediments, unspecified sedimentary rocks
Be13-3b	I			52	Boreal, perhumid-humid	Ontario	Field crops, productive mixed forest	Lacustrine sediments, unspecified igneous and metamorphic rocks
Be14-2b	Cl			150	Subarctic to cryoboreal, humid	British Columbia	Productive coniferous forest	Calcareous glacial till
Be15-2a	Bd Je			450	Cryoboreal, humid	British Columbia	Productive and nonproductive coniferous forest	Glacial outwash, alluvium
Be15-2b	Bd Je			1 724	Subarctic, perhumid to humid	Yukon	Nonproductive coniferous forest	Glacial drift
Be16-2a	Je Ox			681	Subarctic to cryoboreal, humid (subarctic to cryoboreal-subaquic)	Northwest Territories	Nonproductive coniferous forest, swamp forest	Calcareous glacial till, alluvium, organic sediments
Be17-1c	Je I		Stony	21 169	Subarctic (maritime modification)	Northwest Territories	Nonproductive coniferous forest	Alluvium, glacial drift, residual materials (local colluvium and solifluctate) unspecified sedimentary rocks
Be18-2a	Oe	Bd		96	Mesic, humid (mesic, subaquic)	Ontario	Field crops	Calcareous glacial till, organic sediments
Be19-1b	Re I		Stony	14 576	Subarctic, perhumid-humid	Yukon	Nonproductive mixed and coniferous	Glacial drift, alluvium, unspecified igneous and sedimentary rocks
Be20-1a	Ge			971	Subarctic, perhumid-humid (subarctic, subaquic)	Yukon, British Columbia	Nonproductive upland and lowland, coniferous forest	Calcareous glacial till and outwash
Be20-1/2a	Ge			119	Subarctic-cryoboreal, perhumid to humid (subarctic-cryoboreal, subaquic)	Northwest Territories	Nonproductive coniferous forest	Glacial outwash, alluvium, aeolian sand

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Be20-2a	Ge			396	Subarctic-cryoboreal, humid to perhumid (subarctic-cryoboreal, subaquic)	Northwest Territories	Nonproductive upland coniferous forest and productive lowland	Lacustrine sediments, alluvium
Be21-1/2a	Ge Ox		Stony	3 500	Subarctic, humid-perhumid (subarctic sub-aquic)	Northwest Territories	Nonproductive coniferous forest, swamp forest	Lacustrine sediments, calcareous glacial till, organic sediments
Be21-2ab	Ge Ox			425	Subarctic, humid-perhumid (subarctic, sub-aquic)	Yukon	Nonproductive upland coniferous forest and productive lowland	Alluvium
Be22-2b	Lc		Lithic	2 620	Thermic, sub-humid	Central Oklahoma, southeastern Kansas	Grasses, forbs: field crops	Sandstone and shale
Be23-2ab	Gd Od	Pg		4 103	Subarctic, perhumid (subarctic, aquic)	Central Alaska	Wildlife areas: field crops	Alluvium; glacial drift
Be43-2c	La Mo	Bh Tv	Stony	—	—	Wyoming	—	—
Be44-2a	Ox			551	Subarctic (maritime modification)	Northwest Territories	Nonproductive coniferous forest, swamp forest	Calcareous glacial till, marine sediments
Bh5-2ac	Hh	Tv	Stony	2 500	Mesic, perhumid; mesic, xeric	Western Washington, Oregon	Coniferous forest: field crops	Shale, sandstone, basalt; volcanic ash; alluvium
Bh6-2ab	Po	Gh Gd Od		1 730	Mesic, humid	Northwestern Washington	Coniferous forest: field crops; horticultural crops	Glacial till and outwash; volcanic ash
Bh7-2c	Po		Stony	1 980	Boreal, sub-humid	Western Oregon	Coniferous forest	Volcanic ash, cinders, pumice, andesite
Bk6-3a	Vc			630	Thermic, humid	Central Alabama	Field crops: mixed forest	Chalk, limestone, shale
Bx1-1a			Stony	2 162	Arctic	Manitoba, Northwest Territories	Barren, nonproductive coniferous forest	Marine sediments, glacial till and outwash
Bx2-1b	I		Stony	4 287	Arctic	Northwest Territories	Barren, nonproductive coniferous forest	Glacial till and outwash, unspecified, igneous and metamorphic rocks
Ch1-2a				1 006	Cryoboreal, subhumid	Saskatchewan	Field crops	Calcareous glacial till, lacustrine sediments
Ch1-2a				100	Boreal, humid	Western Montana, eastern and central Minnesota	Grasses, forbs: field crops	Alluvium; loess; glacial drift
Ch1-2b				125	Cryoboreal, subhumid	Saskatchewan	Field crops, grasses, forbs, shrubs	Calcareous glacial till
Ch1-2b				880	Boreal, sub-humid	Central North Dakota	Field crops: grasses, forbs	Calcareous glacial till
Ch2-1a		Gm		957	Cryoboreal-boreal, subhumid	Manitoba	Field crops	Lacustrine sediments, aeolian sand
Ch2-1a		Gm		2 690	Boreal, sub-humid	Eastern North Dakota	Field crops	Sandy lacustrine sediments and alluvium
Ch3-2abc	La	Kl		450	Boreal, xeric	Northeastern Utah	Grasses, forbs and shrubs; coniferous forest	Granite, gneiss, quartzite, schist, sandstone, shale; glacial drift

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Ch4-2b	La			237	Cryoboreal, sub-humid	Saskatchewan	Field crops, grasses, forbs, shrubs, hardwood forest	Calcareous glacial till
Ch6-2a	Ck Gm			879	Boreal, sub-humid (boreal, subaquic)	Saskatchewan, Manitoba	Field crops	Calcareous glacial till
Ch7-2b	Re Yl			170	Boreal, humid	Central Colorado	Grasses, forbs; field crops	Sandstone, shale, basalt; alluvium; glacial drift
Ch8-2a	Kh			140	Cryoboreal, semisubarid	British Columbia	Grasses, forbs, shrubs	Calcareous glacial till and outwash, alluvium
Ch9-2a	Kh We			170	Cryoboreal, subhumid	Saskatchewan	Field crops	Calcareous glacial till
Ch10-2a	Gm Gc			2 565	Cryoboreal, boreal, subhumid (cryoboreal, boreal-subaquic)	Saskatchewan, Manitoba	Field crops	Calcareous glacial till and outwash
Ch10-2a	Gm Gc			8 090	Boreal, sub-humid; boreal, humid (boreal, aquic)	Eastern North Dakota, northeastern South Dakota, western Minnesota	Field crops	Calcareous glacial till
Ch10-2b	Gm Gc			277	Cryoboreal, sub-humid (cryoboreal, subaquic)	Saskatchewan	Field crops	Calcareous glacial till
Ch11-3a	Gm			1 178	Cryoboreal-boreal subhumid (cryoboreal-boreal, subaquic)	Manitoba	Field crops	Lacustrine sediments
Ch12-2a	Cl Mo			62	Mesic, boreal, semiarid	British Columbia	Field crops, grasses, forbs, shrubs, horticultural crops	Calcareous glacial till, lacustrine sediments, residual materials (local colluvium and solifluctate)
Ch12-3a	Cl Mo			104	Cryoboreal, sub-humid	Saskatchewan	Field crops	Lacustrine sediments
Ch13-2a	We			1 024	Cryoboreal, sub-humid (cryoboreal, subaquic)	Saskatchewan	Field crops	Calcareous glacial till
Ch13-2b	We			1 142	Cryoboreal, sub-humid (cryoboreal, subaquic)	Saskatchewan, Manitoba	Field crops, grasses, forbs, shrubs, hardwood forest	Calcareous glacial till, alluvium
Ck2-2a	Ch Gm	We		1 582	Cryoboreal, sub-humid (cryoboreal, subaquic)	Saskatchewan	Field crops, grasses, forbs, shrubs	Calcareous glacial till, lacustrine sediments
Ck3-2a	Gm			274	Cryoboreal, sub-humic (cryoboreal, subaquic)	Manitoba	Field crops, grasses, forbs, shrubs	Calcareous glacial till, lacustrine sediments
Ck3-2a	Gm			2 100	Boreal, subhumid (boreal, aquic)	Northeastern North Dakota, northwestern Minnesota	Field crops; grasses, forbs	Calcareous glacial till
Cl1-2a				212	Boreal, subhumid (boreal, per-aquic)	Saskatchewan, Alberta	Grasses, forbs, shrubs, field crops	Calcareous glacial till, aeolian loess over till
Cl1-2a				4 790	Boreal, humid	Western Montana	Field crops; grasses, forbs	Glacial till and outwash; alluvium

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Cl1-2b				526	Cryoboreal-boreal, subhumid	Alberta	Grasses, forbs, shrubs, field crops	Calcareous glacial till
Cl1-2b				390	Boreal, humid	Northwestern Montana	Grasses, forbs; coniferous forest	Glacial till and outwash; alluvium
Cl1-3a				83	Boreal, sub-humid	Alberta	Field crops, forbs, shrubs, grasses	Calcareous glacial till, lacustrine sediments
Cl2-3a		Ch Gm		337	Boreal, sub-humid-humid (boreal, sub-aquic)	Alberta, Saskatchewan	Field crops, forbs, shrubs, grasses, partly barren	Lacustrine sediments
Cl3-1ab	Ch	Gc		890	Boreal, humid	Western Minnesota, eastern Idaho	Field crops; grasses, forbs; hardwood forest (Minnesota) coniferous forest (Idaho)	Sandy lacustrine sediments and beach deposits
Cl4-2abc	Ch			1 140	Boreal, humid	Western and southern Wyoming	Grasses, forbs, shrubs; field crops	Basalt, rhyolite, miscellaneous sedimentary and metamorphic rocks; alluvium
Cl5-2a	Sm	We Gm		150	Cryoboreal, subhumid	Saskatchewan	Field crops, grasses, forbs, shrubs, nonproductive hardwood forest	Calcareous glacial till
Cl6-2a	Sm	Ch		1 260	Boreal, sub-humid	Northeastern South Dakota, southeastern North Dakota	Field crops, grasses, forbs	Glacial till
Cl7-1/2a	Ch	Gm		296	Cryoboreal, sub-humid	Alberta	Field crops	Glacial till and outwash
Cl7-2a	Ch	Gm		3 438	Cryoboreal, subhumid-semi-arid	Alberta	Field crops, grasses, forbs, shrubs, nonproductive hardwood forest	Calcareous glacial till
Cl7-2b	Ch	Gm		816	Cryoboreal, sub-humid	Saskatchewan, Alberta	Field crops, grasses, forbs, shrubs, nonproductive hardwood forest	Calcareous glacial till
De1-2a		Ge		220	Boreal, humid	Central Michigan	Field crops	Calcareous glacial till
De2-2ab		Ge O		2 370	Boreal, humid	Northern Minnesota	Coniferous forest; outdoor recreation; field crops	Glacial drift
De3-2ab	Ge	I		2 450	Boreal, humid (boreal, aquic)	Northern Michigan, northeastern Minnesota	Mixed forest	Glacial till and outwash
De4-2a	O			430	Boreal, humid (boreal, aquic)	Northern Minnesota	Field crops	Calcareous glacial till
E1-2a	Gm	Ck Oe	Stony	1 328	Cryoboreal, sub-humid (cryoboreal, subaquic)	Manitoba	Grasses, forbs, shrubs, field crops, nonproductive hardwood forest	Calcareous glacial till, unspecified sedimentary rocks
Gd7-2a	Ao	Ag		1 280	Thermic, aquic (thermic, humid)	Southwestern Alabama, southeastern Mississippi	Mixed forest; grasses, forbs	Alluvium
Gd8-1a	Pg	O		3 550	Hyperthermic, aquic (thermic, aquic)	Southern Florida, southern Mississippi, southern Arkansas	Swamp forest; marsh; field crops; outdoor recreation	Marine sand; alluvium
Gd8-2a	Pg	O		1 130	Mesic, aquic	Eastern Michigan	Field crops	Lacustrine sediments
Gd9-1a	Pg O			660	Boreal, aquic; mesic, aquic	Northern and eastern Michigan	Forest; outdoor recreation, field crops	Sandy glacial till and outwash; lacustrine sediments

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Gd12-3a	Gh J			1 330	Thermic. aquic (thermic. humid)	Northeastern Arkansas. southeastern Missouri	Field crops	Alluvium
Gd17-2ab	Rd	Bd		14 890	Subarctic. aquic (subarctic. sub-humid)	Central Alaska	Mixed forest: field crops	Alluvium
Gd18-2ab	Rx Od	I		14 480	Subarctic. aquic; subarctic. humid (subarctic. sub-humid)	Central Alaska	Coniferous forest: field crops	Alluvium
Gd19-2ab	Bd Od	I	Stony	19 500	Subarctic. aquic; subarctic. humid (subarctic. humid)	Northern and southern Alaska	Mixed forest: tundra: grasses, forbs and shrubs	Glacial drift: alluvium
Gd19-2bc	Bd Od	I	Stony	36 980	Subarctic. aquic; subarctic. humid (subarctic. sub-humid): arctic. humid: arctic. aquic	Northern and southern Alaska	Mixed forest: tundra: grasses, forbs and shrubs	Glacial drift
Gd19-2bc	Bd Od	I	Stony	1 261	Subarctic. humid. subhumid. maritime modification (subarctic. subaquic)	Yukon	Nonproductive coniferous forest	Alluvium, residual materials (local colluvium and solifluctate)
Ge3-3a	La Ox			5 509	Subarctic-cryoboreal. humid to subhumid (subarctic-cryoboreal. subaquic)	Alberta. Northwest Territories	Productive coniferous forest. swamp forest	Lacustrine sediments: glacial outwash
Ge3-3a	La Ox			1 711	Subarctic. humid (subarctic. subaquic)	Ontario	Nonproductive coniferous forest. swamp forest	Calcareous glacial till. lacustrine sediments. organic sediments
Ge3-2b	La Ox			249	Boreal-cryoboreal. humid to subhumid (boreal-cryoboreal. subaquic)	Alberta	Productive coniferous forest. swamp forest	Glacial till
Ge4-3a	Lg Gh So			7 250	Thermic. aquic	Mississippi flood plain from southern Illinois to southern Louisiana	Field crops	Alluvium
Ge11-3ab	I			391	Boreal. perhumid-humid	Ontario	Productive mixed and coniferous forest	Calcareous glacial till. lacustrine sediments. igneous and metamorphic rocks
Ge11-3b	I			733	Cryoboreal. perhumid (cryoboreal. subaquic)	Ontario	Productive coniferous forest. field crops	Lacustrine sediments. igneous and metamorphic rocks
Ge12-1a	Be			428	Cryoboreal. perhumid (cryoboreal. subaquic)	Alberta. Northwest Territories	Nonproductive coniferous forest	Alluvium
Ge12-2a	Be			287	Boreal. subhumid-semiarid (boreal. subaquic)	British Columbia	Grasses, forbs, shrubs. productive coniferous forest	Alluvium, lacustrine sediments. calcareous glacial till
Ge13-3a		J		93	Cryoboreal. humid-subhumid (cryoboreal. subaquic)	Alberta	Nonproductive coniferous forest. marsh	Alluvium, lacustrine sediments

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Ge13-3a		J		1 261	Subarctic, humid (subarctic, sub-aquic)	Ontario	Nonproductive coniferous forest, tundra, marsh	Lacustrine and marine sediments
Ge14-2/3a	Bd			950	Boreal, per-humid-humid (boreal, subaquic)	Quebec	Productive mixed forest, field crops	Glacial till; lacustrine and marine sediments
Ge15-3a	Od			575	Cryoboreal, per-humid (cryoboreal, aquic-subaquic)	Ontario	Nonproductive coniferous forest, marsh	Calcareous glacial till, lacustrine and marine sediments, organic sediments
Ge15-3a	Od			924	Boreal, per-humid (boreal, subaquic)	Ontario	Field crops, productive upland coniferous forest, nonproductive lowland	Calcareous glacial till, lacustrine and organic sediments
Gh5-2a	Bd Jd			313	Mesic, humid-subhumid, maritime modification	British Columbia	Field crops, barren, nearly barren	Marine sediments; glacial outwash
Gh6-1a	Gd	O Jt		580	Thermic, aquic	Eastern Georgia, southwestern South Carolina	Mixed forest; grasses, forbs	Sandy marine sediments
Gm3-2a				620	Boreal, aquic; mesic, aquic	Southern Oregon	Field crops	Alluvium; lacustrine sediments
Gm3-3a				1 165	Mesic, humid-subhumid (mesic, subaquic)	Ontario, Quebec	Field crops	Calcareous glacial till, lacustrine and marine sediments
Gm3-3a				217	Boreal, humid-subhumid (boreal, aquic)	Alberta	Nonproductive hardwood forest, marsh	Lacustrine sediments, alluvium
Gm3-3a				44	Mesic, humid (mesic, subaquic)	Ontario	Field crops	Lacustrine sediments, alluvium
Gm6-3a	Ck			109	Boreal, sub-humid (boreal, subaquic)	Manitoba	Field crops	Lacustrine sediments
Gm6-3a	Ck			1 570	Boreal, aquic (boreal, sub-humid)	Eastern North Dakota and western Minnesota	Field crops	Lacustrine sediments
Gm7-2a	Je			36	Boreal, sub-humid (boreal, subaquic)	British Columbia	Field crops, grasses, forbs	Alluvium
Gm7-3a	Je			792	Subarctic-boreal, humid-subhumid (subarctic-boreal, subaquic)	Northwest Territories	Nonproductive coniferous forest	Alluvium
Gm8-2a	Oe			409	Cryoboreal, humid-subhumid (cryoboreal, sub-aquic)	Manitoba	Nonproductive hardwood, productive mixed forests, field crops, marsh	Alluvium, lacustrine sediments, calcareous glacial till
Gm8-2a	Oe			540	Boreal, aquic	Northwestern Minnesota	Field crops; grasses, forbs	Glacial till; lacustrine sediments
Gm9-3a	Kh			104	Boreal, semiarid	Saskatchewan	Field crops	Alluvium, lacustrine sediments
Gx1-2a				810	Arctic, humid (arctic, aquic)	Yukon	Nonproductive coniferous forest	Alluvium, glacial till and outwash

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Gx2-1b	Je			136	Arctic, humid (arctic, aquatic)	Yukon	Tundra	Glacial till and outwash
Gx2-2a	Je			251	Arctic, humid (arctic, aquatic)	Yukon	Tundra	Glacial till and outwash, alluvium
Gx3-1a	Rx			194	Arctic, humid (arctic, aquatic)	Northwest Territories	Tundra, nonproductive coniferous forest	Glacial till and outwash, alluvium
Gx3-2/3a	Rx			2 164	Arctic, humid (arctic, aquatic)	Northwest Territories	Tundra, nonproductive coniferous forest	Glacial till and outwash, alluvium
Gx4-2ab	Rx	Bx		970	Arctic, aquatic (arctic, humid)	Northern Alaska	Wildlife areas; grasses, forbs, shrubs	Glacial drift; miscellaneous rocks
Gx5-2ab	Bx Ox	I	Stony	2 640	Arctic, aquatic (arctic, humid)	Northern Alaska	Wildlife areas; grasses, forbs, shrubs	Glacial drift; miscellaneous rocks
Gx5-2bc	Bx Ox	I	Stony	168	Arctic	Yukon	Tundra	Residual materials (local colluvium and solifluctate)
Gx5-2bc	Bx Ox	I	Stony	1 270	—	Northern Alaska	Wildlife areas; grasses, forbs, shrubs	Glacial drift; miscellaneous rocks
Hg1-1a	Re			400	Mesic, aquatic (mesic, humid)	Northeastern Illinois, northwestern Indiana	Field crops	Sandy alluvium and loess
Hg2-2a	Je Hh Lo			5 600	Thermic, aquatic; mesic, aquatic (mesic, humid)	Northern Mississippi flood plain	Field crops; hardwood forest	Alluvium
Hg3-1/3a	Gm Re			970	Thermic, aquatic (thermic, humid)	Southwestern Louisiana, southeastern Texas	Grasses, forbs; field crops	Marine sediments
Hh1-1a				1 410	Mesic, subhumid; mesic, humid	Northeastern Nebraska, northwestern Iowa	Field crops	Loess
Hh1-2ab				1 140	Mesic, humid	Southwestern Iowa	Field crops; grasses, forbs	Loess over glacial till
Hh2-2a	Re			1 810	Mesic, humid; mesic, sub-humid	Northeastern Nebraska, southeastern South Dakota	Field crops	Loess over glacial till
Hh3-2a	Be Je			1 170	Thermic, humid	Northern Louisiana, southwestern Arkansas	Field crops; mixed forest	Alluvium
Hh4-2a	Gm			7 250	Mesic, humid (mesic, aquatic)	Northern Iowa, southern Minnesota	Field crops	Calcareous glacial till
Hh5-2b	Kl	Hl	Lithic	3 780	Mesic, humid; thermic, humid	Eastern Kansas, northeastern and southeastern Oklahoma	Grasses, forbs; field crops	Sandstone, shale and limestone
Hh6-2a	Hl			710	Mesic, subhumid	Central Kansas	Field crops	Alluvium
Hh7-2ab	Hl	Re Lo		1 410	Mesic, humid	Western Iowa, northwestern Missouri	Field crops; hardwood forest	Loess
Hh8-2c	Hl	Vc I		2 390	Thermic, xeric	Western California	Grasses, shrubs and forbs; field crops	Basalt, granite; sedimentary rocks; alluvium
H19-2ab	Lo Gm	Hg Wm		2 690	Mesic, humid (mesic, aquatic)	Northwestern Illinois, southern Wisconsin, southeastern Minnesota	Field crops; hardwood forest	Loess; glacial till
H115-2a	Hg			4 510	Mesic, humid; mesic, sub-humid	Eastern Nebraska, northeastern Kansas	Field crops	Loess over glacial till; limestone, shale and sandstone

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
HI20-2a	Hh Gm			520	Mesic, xeric (mesic, aquic)	Western Oregon	Field crops; urban areas	Alluvium; lacustrine deposits
HI21-2ab	Hh			1 440	Mesic, xeric	Southeastern Washington, northeastern Oregon	Grasses, forbs; field crops	Basalt, rhyolite; sedimentary rocks, loess
HI22-2a	Gm	Hg Wm		7 350	Mesic, humid (mesic, aquic)	Northern Illinois, east central Iowa	Field crops	Loess; glacial drift
HI23-2ab	Gm Wm			3 020	Mesic, humid (mesic, aquic)	Northern Missouri, southern Iowa	Field crops	Loess over glacial till
HI24-2c	I	Lo	Stony	—	Mesic, xeric	Southern Idaho, northeastern Nevada	Grasses, forbs and shrubs; coniferous forest	Igneous and sedimentary rocks
HI24-2c	I	Lo	Lithic	3 240	—	Idaho	—	—
HI25-2a	Kl	Hg Re		930	Thermic, humid; thermic, sub-humid	South central Kansas	Field crops; grasses, forbs	Glacial outwash; loess
HI26-2b	Cl	Gm		310	Boreal, xeric	Northeastern Utah	Grasses, forbs and shrubs	Limestone, sandstone, shale, quartzite
HI27-2c	Cl	Hh		390	Boreal, xeric	Northeastern and central Utah	Grasses, forbs and shrubs	Glacial drift; igneous, sedimentary and metamorphic rocks
HI28-2a	We			4 470	Thermic, humid	Southeastern Kansas, northeastern Oklahoma	Field crops	Shale and sandstone
HI29-2bc	Tv	Hh	Stony	3 000	Mesic, xeric; boreal, xeric	South and northeastern Oregon	Grasses, forbs and shrubs; coniferous forest; field crops	Basalt, andesite, granite
HI30-2ab		Wm		2 320	Mesic, humid	South central Iowa, northwestern Missouri	Field crops; grasses, forbs	Loess over glacial till
HI32-2c	I	Lo Mo	Lithic	500	Boreal, xeric	Southeastern Idaho	Grasses, forbs, shrubs; coniferous forest	Granitic and sedimentary rocks
HI33-2c	Cl	Hh Mo		6 890	Boreal, xeric	Central Utah	Grasses, forbs, shrubs	Glacial drift; miscellaneous rocks
HI34-2ab	Mo Wm			700	Mesic, xeric	Southeastern Washington, northeastern Oregon, western Idaho	Grasses, forbs, shrubs; field crops	Basalt, rhyolite, sedimentary rocks; loess
I-a				18 627	Arctic, humid (arctic, aquic)	Quebec, Northwest Territories	Tundra	Glacial till; igneous and metamorphic rock
I-b				7 712	Subarctic, humid (subarctic, aquic)	Quebec	Tundra, nonproductive coniferous forest	Glacial till, igneous and metamorphic rock
I-bc				3 500	Arctic, humid (arctic, aquic)	Quebec	Tundra	Glacial till, igneous and metamorphic rock
I-c				764	Arctic, humid (arctic, aquic)	Labrador	Tundra	Igneous and metamorphic rock
I-Be-1c				9 183	Subarctic-cryoboreal, humid; mountain complex	British Columbia	Nonproductive coniferous forest	Calcareous glacial till and outwash, residual materials (local colluvium and solifluctate); sedimentary rock

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
I-G-3b				1 059	Subarctic. humid	Northwest Territories	Nonproductive coniferous forest	Igneous and metamorphic rock. glacial till. lacustrine sediments
I-La-3b				1 892	Cryoboreal. perhumid-humid	Ontario. Manitoba	Productive coniferous forest	Igneous and metamorphic rock. glacial till. lacustrine deposits
I-La-Bd-1/2c				6 364	Subarctic-cryoboreal. humid. mountain complex	British Columbia	Productive coniferous forest	Glacial till and outwash. igneous and sedimentary rock
I-Po-1ab				9 260	Subarctic-cryoboreal. perhumid	Quebec. Labrador	Nonproductive coniferous forest	Igneous and metamorphic rock. glacial till
I-Po-1b				2 335	Cryoboreal. perhumid	Ontario	Productive coniferous forest	Igneous and metamorphic rock. glacial till
I-Po-1b				287	Boreal. humid	Ontario	Productive mixed forest	Igneous and metamorphic rock. glacial till
I-Po-1bc				2 079	Cryoboreal. perhumid	Newfoundland. Labrador	Nonproductive coniferous forest	Igneous and metamorphic rock. glacial till
I-Po-1c				259	Subarctic. cryoboreal-boreal (mountain complex). perhumid	British Columbia	Productive coniferous forest	Igneous and metamorphic rock. glacial till: residual materials (local colluvium and solifluctate)
I-Po-1c				2 421	Cryoboreal	Quebec	Productive coniferous forest	Igneous and metamorphic rock. glacial till
I-Po-Bd-1/2a				19 585	Subarctic. humid	Quebec	Nonproductive coniferous forest	Igneous and metamorphic rock. glacial till and outwash
I-Po-Bd-1c				5 532	Subarctic to cryoboreal (mountain complex). humid	British Columbia	Productive coniferous forest	Igneous. sedimentary and metamorphic rock. glacial till: residual materials (local colluvium and solifluctate)
I-Po-Bx-1/2b				4 427	Arctic. humid (arctic. aquic)	Newfoundland. Quebec	Tundra	Glacial till and outwash. igneous and metamorphic rock
I-Po-Ox-1b				1 905	Subarctic-cryoboreal. humid	Alberta	Tundra	Igneous and metamorphic rock. glacial outwash
I-R-B-1bc				27 740	Arctic. humid: subarctic. humid: subarctic. subhumid	Alaska	Mixed forest: tundra. grasses. forbs and shrubs	Miscellaneous rocks: glacial drift
I-R-B-1bc				13 820	Subarctic-cryoboreal. humid (mountain complex)	British Columbia. Yukon	Nonproductive mixed forest. productive coniferous forest. tundra	Sedimentary and igneous rock. residual materials (local colluvium and solifluctate)
I-R-B-1c				—	—	British Columbia	—	—
I-Rx-1a				8 805	Arctic. humid (arctic. aquic)	Northwest Territories	Tundra	Sedimentary rock. glacial till
I-Rx-1c				1 149	Arctic (mountain complex)	Yukon	Tundra	Sedimentary rock. glacial till
I-Rx-2a				963	Arctic. humid (arctic. aquic)	Northwest Territories	Tundra	Sedimentary rock. glacial till

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
I-Rx-2b				4 567	Arctic, humid (arctic, aquatic)	Northwest Territories	Tundra	Sedimentary rock, glacial till
I-Rx-2c				1 212	Arctic, humid (arctic, aquatic)	Northwest Territories	Tundra	Sedimentary rock, glacial till
I-Rx-Bx-1bc				1 287	Arctic, humid (mountain complex) (arctic, aquatic)	Northwest Territories	Tundra	Sedimentary rock, glacial till
I-Rx-Bx-1bc				11 940	Arctic, humid	Northern Alaska	Wildlife area; tundra grasses, forbs, shrubs	Miscellaneous rocks; glacial drift
Jc3-2a	Z		Saline	360	Hyperthermic, arid; hyperthermic, xeric	Southern California	Field crops, irrigated; grasses, forbs, shrubs	Alluvial and lacustrine sediments
Jc7-2ab	Re			1 570	Mesic, arid	Central and eastern Utah	Grasses, forbs and shrubs; field crops, irrigated	Sandstone, shale, basalt
Jc8-2ab	Z	Yl S	Saline	1 220	Mesic, arid; mesic, xeric	Western Nevada	Grasses, forbs and shrubs; field crops, irrigated	Alluvium; lacustrine sediments
Jd1-3a				280	Boreal, perhumid	New Brunswick	Field crops	Marine sediments
Je2-2a				494	Subarctic to cryoboreal, humid to subhumid	Alberta	Forest coniferous nonproductive	Alluvium
Je24-2a	Lc	Gh		1 020	Thermic, xeric	North central California	Field crops, irrigated; grasses, forbs	Alluvium; lacustrine sediments
Je25-2a	Lc	Z	Duric *	1 930	Thermic, xeric	Central and southern California	Field and horticultural crops, irrigated	Alluvium; lacustrine sediments
Je26-2b	Be Ge			2 690	Subarctic, humid (subarctic, sub-aquic)	Northwest Territories	Forest, coniferous nonproductive, shrubs	Alluvium, calcareous glacial till, lacustrine sediments
Je27-3a	Ox			823	Arctic	Northwest Territories	Forest, coniferous nonproductive	Alluvium, organic sediments
Kh1-1a				295	Boreal, subarid	Alberta	Field crops, grasses, forbs	Lacustrine sediments, aeolian sand
Kh1-1a				409	Boreal, semiarid	Alberta	Field crops	Lacustrine sediments, aeolian sand
Kh1-1b				91	Cryoboreal, semiarid	Alberta	Field crops	Aeolian sand
Kh1-1/2a				—	—	Alberta	—	—
Kh1-2a				2 074	Boreal, subarid	British Columbia, Alberta, Saskatchewan	Field crops, grasses, forbs	Calcareous glacial till, lacustrine sediments
Kh1-2b				1 445	Boreal, subarid	Alberta	Field crops, grasses, forbs	Calcareous glacial till, lacustrine sediments
Kh1-2/3a				191	Boreal, subarid	Saskatchewan	Field crops	Calcareous glacial till, lacustrine sediments
Kh1-3a				753	Boreal, subarid	Saskatchewan	Field crops	Lacustrine sediments
Kh1-3a				373	Boreal, semiarid	Saskatchewan	Field crops	Lacustrine sediments

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Kh1-3ab			Lithic	5 360	Thermic, sub-humid	South central Texas	Grasses, forbs; field crops	Limestone, chalk and marl
Kh4-2bc	Yk		Lithic	2 020	Mesic, semiarid	Southeastern New Mexico	Grasses, forbs	Limestone, sandstone, shale, quartzite
Kh7-2ab	Gc	Kl		1 070	Mesic, xeric (mesic, aquic)	Northern Utah	Grasses, forbs and shrubs; field crops, irrigated	Limestone, quartzite, shale, sandstone, gneiss, schist granite
Kh8-1b	Re			269	Boreal, subarid	Saskatchewan, Alberta	Field crops, grasses, forbs	Lacustrine sediments, glacial outwash
Kh8-2a	Re		Stony	117	Boreal, semiarid	Saskatchewan	Field crops, grasses, forbs, shrubs	Calcareous glacial till and outwash
Kh8-2b	Re			1 364	Boreal, semiarid to subarid	Saskatchewan, Alberta	Grasses, forbs, field crops	Calcareous glacial till, alluvium
Kh8-2b	Re			500	Boreal, semiarid	Northeastern Montana, northwestern North Dakota	Field crops; grasses, forbs	Calcareous glacial drift
Kh8-3b	Re			2 670	Mesic, subhumid	Central South Dakota, northeastern Nebraska	Grasses, forbs; field crops, some irrigated	Shale
Kh9-3b	Re Yh			2 800	Mesic, subarid; mesic, sub-humid	Western South Dakota	Grasses, forbs; field crops	Shale
Kh10-2ab	Ch			381	Boreal to mesic; semiarid to subarid (maritime modification)	British Columbia	Field crops, forbs, grasses, shrubs, horticultural crops	Calcareous glacial till, alluvium, lacustrine sediments
Kh10-2ab	Ch			40	Mesic, xeric	Northern Washington	Field crops; grasses, forbs	Calcareous glacial till; alluvium
Kh11-2bc	Yh	Yk	Lithic ²	2 070	Mesic, xeric	Southwestern and northeastern Utah	Grasses, forbs and shrubs; field crops, irrigated	Limestone, sandstone, shale, quartzite, rhyolite, granite, tuff
Kh12-2b	Gm			629	Boreal, subarid (boreal, sub-aquic)	Saskatchewan	Field crops, grasses, forbs	Calcareous glacial till
Kh12-2b	Gm			122	Boreal, semiarid (boreal, sub-aquic)	Saskatchewan	Field crops, grasses, forbs, shrubs	Calcareous glacial till
Kh12-3a	Gm			621	Boreal, semiarid (boreal, sub-aquic)	Saskatchewan	Field crops, barren or nearly barren	Lacustrine sediments
Kh13-2b	Gm	I		2 140	Mesic, xeric (mesic, aquic)	Eastern Washington	Grasses, forbs and shrubs; field and horticultural crops, irrigated	Loess over sandstone, shale, basalt; alluvium, and glacial outwash
Kh14-2a	Sm	Z	Saline	260	Boreal, humid (boreal, semiarid)	Western Montana	Grasses, forbs; field crops, irrigated	Glacial drift; alluvium; lacustrine sediments
Kh15-2a	Kl			396	Cryoboreal, semiarid	Saskatchewan	Field crops	Calcareous glacial till, lacustrine sediments
Kh15-2a	Kl			2 485	Boreal, semiarid	Saskatchewan	Field crops	Calcareous glacial till, lacustrine sediments

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Kh15-2b	Kl			1 033	Boreal, subarid	Saskatchewan, Alberta	Field crops, grasses, forbs	Calcareous glacial till
Kh15-2b	Kl			466	Cryoboreal, semi-arid	Saskatchewan	Field crops, grasses, forbs	Calcareous glacial till
Kh15-2b	Kl			642	Boreal, semiarid	Alberta, Saskatchewan	Field crops, grasses, forbs	Calcareous glacial till, till over residual materials (local colluvium and solifluctate)
Kh15-2b	Kl			100	Boreal, semiarid	Western Montana	Grasses, forbs; field crops, irrigated	Glacial till and outwash; alluvium
Kh16-2a	Kl	Re		2 460	Mesic, subarid; boreal, semiarid	Western Nebraska, eastern Wyoming, central and western North Dakota, eastern Montana	Grasses, forbs; field crops, irrigated	Alluvium; loess; shale and siltstone
Kh16-2abc	Kl	Re		2 550	Mesic, xeric; boreal, xeric	Central Washington, southeastern Idaho	Grasses, forbs and shrubs; field and horticultural crops, irrigated	Basalt, andesite, rhyolite, granite; sedimentary rocks; alluvium
Kh17-2a	Kl Kk		Lithic *	170	Mesic, subarid	Northeastern New Mexico	Grasses, forbs; field crops	Limestone, shale and sandstone
Kh18-2a	Kl Lc			760	Hyperthermic, subhumid	Southern Texas	Grasses, forbs and shrubs; field crops, irrigated	Alluvium
Kh19-2b	Kl I		Stony	910	Mesic, xeric	North central Oregon	Field crops; grasses, forbs and shrubs	Basalt, andesite, rhyolite; sedimentary rocks; loess, alluvium
Kh20-3a	Vp			2 180	Thermic, subhumid	Central Texas	Field crops; grasses, forbs	Limestone and marl
Kk2-2ab	Kh	Kl I		2 880	Thermic, subhumid; mesic, subhumid	Northern Texas, western Oklahoma, southern Kansas	Grasses, forbs; field crops	Loess; alluvium
Kk4-2a	Kl		Lithic	410	Thermic, subhumid; mesic, subarid	Southeastern and north-eastern New Mexico	Grasses, forbs and shrubs; field crops	Limestone, shale and sandstone
Kk5-3a	V		Lithic	880	Thermic, subhumid;	Southern Texas	Grasses, forbs and shrubs	Limestone and marl
Kl1-1a	Re			830	Mesic, subhumid	Northern and southern South Dakota, northern Nebraska, southeastern Montana, north central Texas, southwestern Oklahoma	Field crops; grasses, forbs	Calcareous sandstone
Kl1-2a	Re			18 910	Mesic, subhumid	Southwest Nebraska, western Kansas, eastern Colorado, southwestern North Dakota, eastern Montana	Field crops; grasses, forbs	Calcareous sandstone
Kl1-2bc	Re		Lithic *	3 260	Mesic, subhumid	Western Nebraska, eastern Wyoming, southwestern South Dakota, north-eastern Colorado	Field crops, grasses, forbs	Sandstone, shale, alluvium
Kl4-2a				15 370	Mesic, subhumid; thermic, subhumid	Central South Dakota, southern Nebraska, central Kansas, north central Oklahoma	Field crops, nonirrigated and irrigated; grasses, forbs	Calcareous glacial till
Kl4-2a				199	Cryoboreal, semiarid	Saskatchewan, Alberta	Field crops	Calcareous glacial till

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
K16-3a		Sm		184	Boreal, semiarid	Alberta	Field crops	Lacustrine sediments
K17-2c	I		Lithic	1 860	Mesic, xeric	Western Idaho, northwestern Nevada	Grasses, forbs and shrubs; field crops; irrigated	Igneous and sedimentary rocks
K19-2a	Kk			3 880	Thermic, subhumid	Western and central Texas, eastern New Mexico	Field crops; grasses, forbs	Loess; alluvium
K112-2abc	C			1 300	Mesic, semiarid	Southern and northwestern New Mexico	Grasses, forbs and shrubs; coniferous forest	Sandstone, limestone, quartzite, granite, basalt, andesite; alluvium
K112-2b	C			1 390	Mesic, subarid; boreal, subarid	Northwestern Colorado	Grasses, forbs and shrubs; field crops, irrigated	Shale, sandstone, basalt, granite, gneiss; alluvium
K114-2abc	Vc Lc	C I	Stony	4 200	Mesic, semiarid	Eastern Arizona, western New Mexico	Grasses, forbs and shrubs; coniferous forest; field crops, irrigated	Sandstone, limestone, quartzite, granite, basalt, rhyolite; alluvium
K116-2c	Re	La	Stony	3 330	Boreal, subarid; boreal, humid	Central and southern Wyoming	Grasses, forbs and shrubs; field crops, irrigated	Limestone, shale, sandstone, quartzite
K117-2a	Kh			1 740	Boreal, subarid	Alberta	Field crops	Calcareous glacial till
K117-2a	Kh			1 525	Cryoboreal-boreal, semiarid	Saskatchewan, Alberta	Field crops; grasses, forbs	Calcareous glacial till
K117-2a	Kh			14 290	Boreal, subhumid	South central North Dakota, north central and southeastern South Dakota, southeastern Wyoming, western Montana	Field crops; grasses, forbs	Calcareous glacial drift; alluvium
K117-2abc	Kh			250	Mesic, subarid	Northern Arizona	Grasses, forbs, and shrubs	Sandstone, limestone, quartzite, granite, basalt
K117-2b	Kh			1 520	Mesic, xeric; boreal, xeric	Central Washington	Field crops; grasses, forbs and shrubs	Sandstone, shale; alluvium
K117-2b	Kh			1 046	Cryoboreal-boreal, semiarid	Alberta	Field crops, grasses, forbs	Calcareous glacial till
K117-2b	Kh		Stony	6 920	Mesic, xeric; boreal, xeric	Northern California and Nevada, central Oregon	Grasses, forbs and shrubs, field crops	Basalt, andesite; sedimentary rocks; loess
K117-3a	Kh			75	Boreal, semiarid	Saskatchewan	Field crops	Calcareous glacial till, lacustrine sediments
K118-2ab	Kh Gm			650	Boreal, semiarid	Saskatchewan	Field crops, grasses, forbs	Calcareous glacial till
K119-2ab	Kh	Vc Re		2 800	Mesic, semiarid; mesic, xeric	Northwestern and central Arizona	Grasses, forbs and shrubs	Sandstone, limestone, shale, basalt; alluvium
K120-2a	Kh Kk			1 360	Mesic, subhumid	Northern Texas, western Oklahoma	Field crops; grasses, forbs	Calcareous sandstone and shale
K121-2a	Kh Re		Lithic *	1 580	Thermic, subhumid	Central Texas	Grasses, forbs; field crops	Calcareous sandstone and shale
K122-1/2abc	Kh I	Cl		300	Mesic, subarid	Southeastern Utah, southwestern Colorado	Grasses, forbs and shrubs; field crops	Sandstone and shale; loess
K123-2/3bc	Kh V			2 050	Boreal, xeric; mesic, xeric	Northeastern California, northwestern Nevada, southern Oregon	Grasses, forbs and shrubs; field crops, irrigated	Basalt, rhyolite, tuff; sedimentary rocks; alluvium; lacustrine sediments

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
K124-2ab	Sm	Z	Saline	790	Mesic, subarid; mesic, xeric	Northwestern South Dakota	Grasses, forbs; field crops	Calcareous sandstone and shale
K125-3a	Sm	Kh Z		220	Boreal, semiarid	Western North Dakota	Grasses, forbs	Calcareous shale and sandstone; glacial deposits
K126-2a	Sm Gm	Kh		430	Boreal, semiarid (boreal, sub-aquic)	Saskatchewan	Field crops	Calcareous glacial till
K127-2a	Yl	Re		3 510	Mesic, subarid	Northeastern Colorado	Field crops, nonirrigated and irrigated; grasses, forbs	Sandstone and shale; loess, alluvium
K128-2ab	Yl	Kh Yh		5 790	Boreal, xeric; mesic, xeric	Central and southeastern Oregon, southwestern Utah, northern Nevada	Grasses, forbs and shrubs; field crops, irrigated	Basalt, rhyolite, tuff; sedimentary rocks; alluvium
K129-2a	So	Sm Xh Kh		2 630	Boreal, semiarid	North central Montana	Grasses, forbs; field crops, nonirrigated and irrigated	Calcareous glacial till and outwash; lacustrine deposits
K129-2a	So	Sm Xh Kh		523	Boreal, subarid	Saskatchewan	Field crops	Calcareous glacial till
K129-2b	So	Sm Xh Kh		576	Boreal-cryoboreal, semiarid to subarid	Alberta	Grasses, forbs, shrubs; field crops	Calcareous glacial till
K129-2b	So	Sm Xh Kh		170	Boreal, semiarid	Northern Montana	Grasses, forbs; field crops	Calcareous glacial till
K131-1ab	R Be			2 100	Thermic, sub-humid	Central Oklahoma	Grasses, forbs; field crops	Sedimentary rocks; loess; aeolian sand
La1-1b			Stony	41	Mesic, humid	Ontario	Field crops	Glacial outwash
La1-1/2a				1 186	Mesic, humid to subhumid	Ontario	Field crops	Calcareous glacial till, lacustrine sediments
La1-1/2b			Stony	171	Mesic, humid	Ontario	Field crops	Calcareous glacial till and outwash
La1-2a				671	Mesic, humid	Ontario	Field crops, horticultural crops	Calcareous glacial till
La1-2b				—	—	Alberta	—	—
La1-3a				1 261	Mesic, humid to subhumid	Ontario	Field crops, horticultural crops	Lacustrine sediments, calcareous glacial till
La1-3a				1 250	Cryoboreal, humid	Ontario	Productive mixed and coniferous forest, field crops	Lacustrine sediments
La1-3a				316	Boreal, humid	Ontario	Productive mixed forest	Lacustrine sediments
La2-1a		G O		65	Cryoboreal, sub-humid	Saskatchewan	Field crops	Lacustrine sediments
La2-1/2a		G O		293	Cryoboreal, sub-humid	Alberta	Field crops	Lacustrine sediments
La2-2a		G O		5 817	Cryoboreal, humid-subhumid	Saskatchewan, Alberta	Field crops, productive mixed forest	Calcareous glacial till
La2-2b		G O		2 636	Cryoboreal, humid	Manitoba, Alberta, Saskatchewan	Productive mixed and coniferous forest; field crops	Calcareous glacial till

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
La2-2/3b		G O		476	Cryoboreal, humid	Manitoba, Saskatchewan	Productive coniferous forest	Calcareous glacial till
La3-2a	Od			6 449	Cryoboreal, humid-subhumid (cryoboreal, aquic)	Manitoba, Alberta, Saskatchewan	Productive and nonproductive coniferous forest; field crops	Calcareous glacial till, lacustrine sediments
La3-2b	Od			5 439	Cryoboreal, humid (cryoboreal, aquic)	Saskatchewan, Alberta, British Columbia	Productive and nonproductive coniferous forest; field crops	Calcareous glacial till
La3-2/3a	Od			1 486	Cryoboreal, humid-subhumid (cryoboreal, aquic)	Saskatchewan, Manitoba	Productive mixed forest	Calcareous glacial till, lacustrine sediments
La3-3a	Od			564	Cryoboreal, humid (cryoboreal, aquic)	British Columbia, Alberta	Productive and nonproductive coniferous forest	Lacustrine sediments, calcareous glacial till
La4-2b	Ox I		Lithic	7 891	Subarctic-cryoboreal, humid (subarctic-cryoboreal, subaquic)	Manitoba, Ontario	Productive coniferous forest	Glacial till, lacustrine sediments over igneous and metamorphic rocks
La5-2a	Ox			192	Subarctic-cryoboreal, humid to subhumid (subarctic-cryoboreal, subaquic)	Alberta, Northwest Territories	Productive upland coniferous forest, nonproductive lowland	Calcareous glacial till
La5-2ab	Ox			—	—	British Columbia, Alberta	—	—
La5-3a	Ox			453	Subarctic to cryoboreal, humid (subarctic-cryoboreal, subaquic)	British Columbia, Alberta	Productive upland, nonproductive lowland, coniferous forest	Calcareous glacial till and outwash, lacustrine sediments
La6-2a	Be	Od		344	Cryoboreal, subhumid	British Columbia	Field crops	Lacustrine sediments
La6-2b	Be	Od		6 330	Cryoboreal, humid	British Columbia, Alberta	Productive coniferous and mixed forest	Calcareous glacial till and outwash
La7-2b	Be Ox			1 222	Subarctic to cryoboreal, humid	British Columbia	Nonproductive coniferous forest	Calcareous glacial till and outwash
La7-2b	Be Ox			2 418	Subarctic, humid	Manitoba	Nonproductive coniferous forest	Glacial till, unspecified sedimentary, igneous and metamorphic rocks
La8-2abc	Kh	Re I		1 110	Boreal, subhumid	Western South Dakota; eastern Wyoming	Coniferous forest; grasses, forbs	Sandstone, shale and granite; alluvium
La9-2a	Gm	Mo		54	Cryoboreal, humid-subhumid (cryoboreal, subaquic)	Manitoba	Field crops	Calcareous glacial till
La9-3a	Gm	Mo		119	Cryoboreal, humid-subhumid (cryoboreal, aquic)	Manitoba	Productive mixed upland forest, nonproductive coniferous lowland forest	Lacustrine sediments
La10-2a	Gh			352	Boreal, perhumid (boreal, subaquic)	Ontario, Quebec	Field crops	Calcareous glacial till, lacustrine sands

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
La10-3a	Gh			243	Boreal, humid to subhumid (boreal, subaquic)	Ontario	Field crops	Lacustrine sands
La11-2b	Po	Od		1 137	Cryoboreal, humid to subhumid	British Columbia	Productive coniferous forest	Calcareous glacial till and outwash
La12-2c	Po			425	Cryoboreal, humid to subhumid	British Columbia	Productive and nonproductive coniferous forest	Calcareous glacial till, alluvium, residual materials (local colluvium and solifluctate)
La12-2c	Po			7 950	Boreal, humid	Western Montana, northwestern Wyoming, southeastern Idaho	Coniferous forest; grasses, forbs and shrubs; field crops, irrigated	Sandstone, shale, basalt, quartzite, argillite, granite; alluvium
La12-2/3a	Po			150	Cryoboreal, perhumid	Newfoundland	Productive coniferous forest	Glacial till and outwash
La12-2/3a	Po			2 597	Boreal, perhumid-humid	Nova Scotia, New Brunswick	Field crops, productive mixed forest	Glacial till and outwash, marine sediments
La13-1/2a	Po Od			1 825	Cryoboreal, humid	Saskatchewan	Productive coniferous forest, field crops	Calcareous glacial till and outwash
La13-2a	Po Od			—	—	Saskatchewan	—	—
La14-1/2b	Po Od	Bd		740	Cryoboreal, humid	Saskatchewan	Productive coniferous forest, field crops	Calcareous glacial till and outwash
La15-2c	Po I	Ch Gm	Stony	4 540	Boreal, humid; boreal, subarid	Central Colorado, northern New Mexico, southern Wyoming	Coniferous forest; grasses, forbs, shrubs; field crops, irrigated	Sandstone, limestone, andesite, basalt, granite, gneiss; glacial drift
La16-3b	I			603	Cryoboreal, humid	Ontario	Nonproductive coniferous forest	Glacial till, lacustrine sediments, unspecified igneous and metamorphic rocks
La17-2a	Cl Mo			3 319	Cryoboreal, subhumid-semiarid	British Columbia, Alberta, Saskatchewan	Productive coniferous forest; field crops	Calcareous glacial till and outwash
La18-3a	Cl Gm Mo			399	Cryoboreal, humid-subhumid	Saskatchewan, Alberta	Field crops, productive mixed forest	Lacustrine sediments, calcareous glacial till
La19-2b	Bd			3 058	Cryoboreal-boreal, subhumid to semiarid	British Columbia	Productive coniferous forest; field crops	Calcareous glacial till and outwash, lacustrine sediments
La20-3a	Bl Cl Mo			184	Cryoboreal, humid-subhumid	British Columbia	Productive coniferous forest, field crops	Lacustrine sediments
La21-2b	Bd Po		Stony	3 402	Cryoboreal, humid-subhumid	British Columbia	Productive coniferous and mixed forests	Glacial till and outwash
La22-2b	Bd I		Lithic	1 077	Cryoboreal, humid	British Columbia	Productive coniferous forest	Glacial till and outwash, unspecified igneous and metamorphic rocks
La23-1/3a	Gd Po	Od		4 109	Cryoboreal-boreal, perhumid	Ontario, Quebec	Productive coniferous forest, field crops	Calcareous glacial till and outwash, lacustrine sediments
La24-2a	We	Od		1 157	Cryoboreal, humid-subhumid	British Columbia, Alberta	Productive mixed and coniferous forests; field crops	Calcareous glacial till and outwash, lacustrine sediments

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
La24-3a	We	Od		955	Cryoboreal, humid-subhumid	British Columbia	Field crops, productive coniferous forest	Lacustrine sediments
La25-3a	So			70	Cryoboreal, sub-humid	Saskatchewan	Field crops	Lacustrine sediments
La26-1a	Rd Oe	Gh		52	Cryoboreal, sub-humid	Saskatchewan	Productive coniferous forest	Glacial outwash
La27-3a	Gm			106	Mesic, humid	Ontario	Field crops	Lacustrine sediments
La28-2c	Po I	Mo Gh Gm	Stony	5 830	Boreal, humid	Western Colorado	Coniferous forest; grasses, forbs and shrubs; field crops	Sandstone, limestone, andesite, basalt, granite, gneiss; glacial drift
La29-2c	Mo Po			2 640	Boreal, humid	Northwestern Wyoming, southern Montana, southeastern Idaho	Coniferous forest; grasses, forbs and shrubs; field crops, irrigated	Sandstone, shale, basalt, quartzite, argillite, granite; alluvium
La31-1a		Be Gm	Stony	80	Mesic, humid	Ontario	Field crops	Calcareous glacial till, lacustrine sediments
La31-1/2a		Be Gm		1 010	Mesic, humid-subhumid	Ontario	Field crops	Calcareous glacial till, lacustrine sediments
La32-2b		O We		295	Cryoboreal, humid-subhumid	Saskatchewan	Field crops	Calcareous glacial till
Lc3-2a			Duric	2 190	Thermic, xeric	Central and southern California	Grasses, forbs, and shrubs; field and horticultural crops, irrigated and nonirrigated	Alluvium
Lc3-2a				7 800	Thermic, sub-humid	Eastern Texas	Mixed forest, grasses, forbs; field crops	Alluvium
Lc3-3a				1 490	Thermic, sub-humid; hyperthermic-subhumid	Southern Texas	Grasses, forbs; field crops	Marine sediments
Lc14-2b	Ao Hh			1 840	Mesic, humid	Northern Kentucky	Field crops; hardwood forest	Limestone and calcareous shale
Lc15-2ab	Ao I	Ne		840	Thermic, humid	Central Tennessee	Field crops	Limestone and shale
Lc16-2abc	Bd		Fragic ^a	2 430	Mesic, humid	Southeastern Pennsylvania, central Maryland, western Virginia, southern Indiana	Field crops; hardwood forest	Limestone
Lc17-2a	Je	Gm		480	Thermic, xeric	West central California	Field crops	Alluvium; lacustrine sediments
Lc18-2a	Gm Re			400	Thermic, xeric (thermic, aquic)	Southwestern California	Grasses, forbs and shrubs; field and horticultural crops, irrigated	Alluvium
Lc19-2bc	Re I		Stony	4 390	Mesic, xeric	Central California	Grasses, forbs and shrubs; field crops	Sedimentary and metamorphic rocks
Lc20-3bc	Re Vc	I	Stony	1 180	Thermic, xeric	South central California	Grasses, forbs and shrubs; field crops	Calcareous sedimentary and basic igneous rocks
Lc21-2a	Kk	Kl		940	Thermic, sub-humid	Northern Texas, southwestern Oklahoma	Grasses, forbs; field crops, irrigated	Alluvium; loess

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Lc22-2a	Re		Lithic *	890	Thermic. sub-humid	North central Texas	Grasses, forbs: field crops	Calcareous sandstone and shale
Lc23-2a	Kh	Kk	Duric *	1 350	Hyperthermic. subhumid	Southern Texas	Grasses, forbs; field crops	Sandstone
Lc24-2a	Kl			830	Hyperthermic. subhumid	Southern Texas	Grasses, forbs: field crops	Calcareous sandstone and shale
Lc24-2ab	Kl		Stony *	540	Thermic. sub-humid	South central Texas	Grasses, forbs: field crops	Limestone, sandstone, granite, gneiss, schist
Lg17-2a	Lo			620	Thermic. aquic (thermic. humid)	Northwestern Mississippi	Field crops: mixed forest	Alluvium: loess over alluvium
Lg18-2a	Ge Lo			1 400	Thermic. aquic (thermic. humid)	Northern Ohio, southeastern Michigan	Field crops: urban areas	Lacustrine sediments
Lg19-1a	Ge	Re O		880	Hyperthermic. aquic; thermic. aquic	Northern and southeastern Florida	Mixed forest: grasses, forbs: field and horticultural crops	Marine sand
Lk1-2a	Kk	Kl		6 920	Thermic. sub-humid; mesic. subhumid	Western and northwestern Texas, eastern New Mexico, western Oklahoma, southwestern Kansas	Grasses, forbs: field crops, irrigated	Alluvium: loess
Lk2-1a	Re			3 550	Thermic. sub-humid	Western Texas, eastern New Mexico	Grasses, forbs: field crops, irrigated and nonirrigated	Loess: alluvium
Lo8-2a		G Lg	Fragic	3 560	Thermic. humid; mesic. humid	Southeastern Louisiana, southwestern Mississippi, western Tennessee and Kentucky, southern Indiana	Field crops: mixed forest	Loess: glacial till
Lo8-2a		G Lg		2 360	Thermic. humid	Central and western New York, northern Indiana	Field crops: hardwood forest	Glacial till
Lo9-2b		G		970	Mesic. humid	Central and southeastern Wisconsin, central New York	Field crops: hardwood forest	Glacial till
Lo10-2a	Lg	We Gh		13	Mesic. humid	Quebec	Field crops	Calcareous glacial till, lacustrine sediments
Lo10-2a	Lg	We Gh		2 560	Mesic. humid (mesic. aquic)	Northern and western New York, southwestern Washington, northeastern Ohio	Field crops, nonirrigated and irrigated: urban areas	Alluvium: glacial till, lacustrine and marine sediments
Lo11-2abc	Lg Hh	l	Fragic	1 010	Mesic. humid (mesic. aquic)	Southwestern Ohio	Field crops: hardwood forest	Glacial drift: loess: sedimentary rocks
Lo12-2a	Lg G ^a		Fragic	560	Mesic. humid (mesic. aquic)	Southeastern Indiana	Field crops: hardwood forest	Loess: sedimentary rocks
Lo13-2a	Hg		Fragic *	9 430	Mesic. humid (mesic. aquic)	Northwestern Ohio, central Indiana, southeastern and central Michigan	Field crops: hardwood forest	Calcareous glacial till and outwash
Lo14-1a	Re Gm	O		300	Mesic. humid (mesic. aquic)	Southeastern Michigan, northwestern Ohio	Hardwood forest: outdoor recreation, field crops: urban areas	Glacial outwash: lacustrine sediments
Lo15-2b	Ao			560	Thermic. humid	Western Tennessee and Kentucky	Field crops: hardwood forest	Loess over marine sediments

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Lo16-3a	Gm	Lg		1 180	Mesic, humid (mesic, aquic)	East central Wisconsin	Field crops; mixed forest	Glacial drift
Lo17-2a	Gm De	Lg Wm		4 260	Mesic, humid; boreal, humid (boreal, aquic)	Southeastern and northern Wisconsin, southeastern Minnesota	Field crops; mixed forest	Glacial drift
Lo18-2bc	I	J	Fragic	1 570	Mesic, humid	Southern Illinois, southwestern Indiana	Field crops; horticultural crops; hardwood forest	Glacial drift; loess; sedimentary rocks
Lo18-2bc	I	J		3 890	Mesic, humid	Southwestern Wisconsin, northeastern Iowa, western Indiana, eastern and northwestern Illinois	Field crops; horticultural crops; hardwood forest	Glacial drift; loess; sedimentary rocks
Lo19-2a	Hl	Lg G		2 530	Mesic, humid	Southwestern Michigan, northern Indiana	Field crops; hardwood forest	Glacial till and glacial outwash
Lo20-2a	Bd	Lg G	Fragic	1 150	Boreal, humid	Central Minnesota	Hardwood forest; field crops	Glacial drift
Lo21-2a	Sg		Fragic	700	Thermic, humid (thermic, aquic)	Northeastern Arkansas	Field crops	Loess
Lo22-2bc	Tv Mo			440	Mesic, humid; boreal, humid	Northern Idaho, eastern Washington	Coniferous forest; field crops	Igneous and sedimentary rocks; loess; volcanic ash
Lo23-2ab	Hl	Lg G Wm		6 940	Mesic, humid	Central Minnesota, eastern Missouri, northeastern Iowa, western Illinois	Hardwood forest; shrubs and forbs; field crops	Loess over glacial till
Lo24-2a	Ld Dg		Fragic	1 470	Mesic, humid (mesic, aquic); thermic, humid (thermic, aquic)	Northeastern Ohio, central Louisiana, southeastern Missouri	Field crops	Alluvium; loess; glacial till, lacustrine and marine sediments
Lo25-2a	De		Fragic ^a	700	Thermic, humid	Northeastern Arkansas, southwestern Missouri	Grasses, forbs; hardwood forest; field crops	Loess; glacial till
Lo25-2b	De		Fragic ^a	3 100	Thermic, humid	Western Kentucky, Tennessee, Mississippi, eastern Missouri	Field crops; hardwood forest	Loess; glacial till
Mo2-3a	Sm	Gm		85	Cryoboreal, subhumid	British Columbia	Field crops	Calcareous glacial till, lacustrine sediments
Mo2-2/3a	Sm	Gm		205	Cryoboreal, subhumid	Saskatchewan	Field crops	Lacustrine sediments
Mo3-2a	Ch	Gm		585	Cryoboreal, subhumid	Saskatchewan, Manitoba	Field crops	Alluvium, lacustrine sediments, calcareous glacial till
Mo4-2b	La			210	Cryoboreal to boreal, subhumid	Manitoba	Field crops	Calcareous glacial till
Mo4-2b	La			140	Boreal, subhumid	Northern North Dakota	Grasses, forbs; field crops	Glacial till
Mo5-2a	La	Ch Gm		482	Cryoboreal, subhumid	Saskatchewan	Field crops	Calcareous glacial till, alluvium, lacustrine sediments
Mo5-2b	La	Ch Gm		668	Boreal, semi-humid to semi-arid	British Columbia	Field crops	Calcareous glacial till and outwash

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Mo6-2a	La	Gm		259	Cryoboreal, sub-humid	Saskatchewan	Field crops	Calcareous glacial till, lacustrine sediments
Mo6-3/2a	La	Gm		386	Cryoboreal, sub-humid	Saskatchewan	Field crops	Calcareous glacial till, alluvium, lacustrine sediments
Mo7-2a	Gm			820	Cryoboreal, sub-humid (cryoboreal, subaquic)	Manitoba	Field crops	Calcareous glacial till
Mo7-2a	Gm		Stony	829	—	Manitoba	Field crops	Calcareous glacial till
Mo8-3a		Ch Gm		104	Cryoboreal, sub-humid	Manitoba	Field crops	Lacustrine sediments
Mo9-2a	Cl La			518	Boreal, sub-humid to semi-arid	British Columbia	Field crops	Calcareous glacial till and outwash
O1-a				2 710	Thermic, aquic; hyperthermic, peraquic	Southern Florida and Louisiana, southeastern Georgia, eastern North Carolina, southeast Virginia, central California	Field crops, irrigated; swamp forest; wildlife areas	Organic sediments
O5-1a	G P			2 120	Boreal, aquic (boreal, humid)	Northern Minnesota, northern and north central Michigan	Swamp forest; field crops	Organic sediments; glacial outwash
Od1-a				4 898	Cryoboreal, per-humid (cryoboreal, aquic)	Ontario, Saskatchewan	Swamp forest, productive coniferous forest	Organic and lacustrine sediments, glacial outwash
Od2-1/3a	La			1 626	Cryoboreal, humid-subhumid (cryoboreal, aquic to sub-aquic)	Manitoba, Alberta	Productive mixed forest, swamp forest; field crops	Organic sediments, calcareous glacial till
Od2-2a	La			6 633	Cryoboreal humid (cryoboreal, aquic)	Saskatchewan, Alberta	Swamp forest, nonproductive-productive coniferous forest, field crops	Organic sediments, calcareous glacial till, lacustrine sediments
Od2-2b	La			189	Cryoboreal, humid (cryoboreal, aquic)	Alberta	Productive coniferous forest, swamp forest	Organic sediments, calcareous glacial till
Od2-3a	La			3 174	Cryoboreal, humid-subhumid (cryoboreal, aquic-subaquic)	Manitoba	Swamp forest, nonproductive coniferous forest, field crops	Organic and lacustrine sediments, calcareous glacial till
Od3-3a	La I			6 956	Cryoboreal, humid-subhumid (cryoboreal, aquic-subaquic)	Ontario, Manitoba	Swamp forest, productive coniferous forest	Organic and lacustrine sediments, unspecified igneous and metamorphic rocks
Od3-3a	La I		Lithic	—	—	Ontario, Manitoba	—	—
Od3-3b	La I		Lithic	3 720	Cryoboreal, humid (cryoboreal, aquic)	Manitoba	Swamp forest, productive coniferous forest	Organic and lacustrine sediments, unspecified igneous and metamorphic rocks
Od4-1a	Be			577	Cryoboreal, humid (cryoboreal, aquic)	Alberta	Swamp forest, productive coniferous forest	Organic sediments, alluvium

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Od5-1a	Po			1 838	Cryoboreal, perhumid-humid (cryoboreal, aquic)	Quebec, Saskatchewan, Alberta	Swamp forest, productive coniferous forest	Organic sediments, glacial till and outwash
Od6-a	I		Lithic	396	Cryoboreal, perhumid (cryoboreal, aquic)	Quebec	Swamp forest, nonproductive coniferous forest	Organic sediments, unspecified igneous and metamorphic rocks
Od8-2a	Ge			—	—	Alberta	—	—
Od8-3a	Ge		Stony	1 792	Cryoboreal, perhumid-humid (cryoboreal, aquic)	Ontario, Quebec	Swamp forest, productive coniferous forest	Organic sediments, calcareous glacial till, lacustrine sediments
Od9-1/2/3a	Po Gd			3 562	Cryoboreal, perhumid (cryoboreal, aquic)	Quebec	Swamp forest, productive coniferous forest	Organic sediments, glacial outwash and till, lacustrine sediments
Oe2-2a	Gm Je			466	Cryoboreal, boreal, perhumid (maritime influence)	Saskatchewan	Productive mixed forest	Glacial till and outwash
Ox1-a				54	Subarctic, humid-subhumid (subarctic, subaquic)	Alberta	Swamp forest, productive coniferous forest	Organic sediments, glacial till, lacustrine sediments
Ox1-a				13 408	Subarctic to cryoboreal, perhumid (subarctic-cryoboreal, subaquic)	Labrador, Ontario	Swamp forest, nonproductive coniferous forest	Organic sediments, glacial outwash
Ox2-2a	La			329	Subarctic, humid (subarctic, subaquic)	Alberta	Nonproductive mixed forest	Organic sediments, calcareous glacial till, residual materials (local colluvium and solifluctate)
Ox2-2b	La			513	Subarctic, humid (subarctic, subaquic)	Alberta	Nonproductive mixed forest	Organic sediments, calcareous glacial till, residual materials (local colluvium and solifluctate)
Ox2-3/2a	La			6 211	Subarctic, humid (subarctic, subaquic)	Alberta	Nonproductive coniferous forest	Organic sediments, calcareous glacial till
Ox2-3/2b	La			104	Subarctic, humid (subarctic, subaquic)	Northwest Territories	Nonproductive coniferous forest	Organic sediments, calcareous glacial till
Ox3-1b	Be			350	Subarctic, humid (subarctic, subaquic)	Northwest Territories	Swamp forest, nonproductive coniferous forest	Organic sediments, glacial till and outwash
Ox3-2a	Be			8 590	Subarctic, humid (subarctic, subaquic)	Manitoba, Ontario	Swamp forest, nonproductive coniferous forest	Organic sediments, glacial till and outwash
Ox4-1/2/3a	Po Gd			3 213	Subarctic-cryoboreal, perhumid (subarctic to cryoboreal, subaquic)	Quebec	Swamp forest, nonproductive coniferous forest	Organic sediments, lacustrine sediments
Ox5-2/3a	Ge			15 678	Subarctic, humid (subarctic, subaquic)	Northwest Territories	Swamp forest, nonproductive coniferous forest	Organic sediments, calcareous glacial till and outwash

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Ox6-a	I		Lithic	2 711	Subarctic to cryoboreal, perhumid to humid (subarctic-cryoboreal, subaquic)	Quebec	Swamp forest, nonproductive coniferous forest	Organic sediments, unspecified igneous, metamorphic and sedimentary rocks
Pg2-1a	Rd	O		6 540	Thermic, aqic (thermic, humid); hyperthermic, aqic; (hyperthermic, humid)	Central and northern Florida, southeastern Georgia, eastern South Carolina, southeastern North Carolina	Mixed forest; outdoor recreation; field and horticultural crops; grasses and forbs	Sandy marine sediments
PI1-2a			Fragic ²	1 080	Mesic, humid	Eastern Massachusetts, southeastern New Hampshire, Rhode Island	Field crops	Glacial till
PI2-1b	Po Gd		Stony	3 050	Mesic, humid (mesic, aqic)	Central Massachusetts, eastern Connecticut, southern New Hampshire, southeastern Maine	Field and horticultural crops; mixed forest	Glacial till
PI2-2ab	Po Gd		Stony	410	Mesic, humid (mesic, aqic)	Central Connecticut, western Massachusetts	Field crops; mixed forest	Acid glacial till
PI3-2a	Po Gd	Lg		1 080	Mesic, humid (mesic, aqic)	Southeastern New Hampshire, Maine	Field crops	Glacial till
PI4-1c	Po Gd I		Stony	190	Mesic, humid (mesic, aqic)	Western Massachusetts, southwestern Vermont	Mixed forest	Glacial till
Po1-1a				119	Mesic, humid	Quebec, Ontario	Field crops, productive hardwood forest	Glacial till and outwash
Po1-1a				85	Cryoboreal, humid to subhumid	Alberta	Productive coniferous forest	Glacial outwash, lacustrine sediments
Po1-1a				2 879	Cryoboreal-boreal, humid	Ontario, Quebec	Nonproductive coniferous forest, field crops	Calcareous glacial till and outwash
Po1-1b				704	Boreal, perhumid	British Columbia	Productive coniferous forest, grasses, forbs, shrubs	Glacial till, residual materials (local colluvium and solifluctate)
Po1-1b			Fragic	8	Boreal, humid	Quebec	Productive hardwood forest	Glacial till
Po1-1b			Fragic	540	Mesic, humid	Northern and central New York	Field crops; mixed forest	Acid glacial till
Po1-1b			Stony	3 583	Boreal, humid	Quebec	Productive mixed forest	Glacial till
Po1-1/2a				75	Cryoboreal to boreal, humid	British Columbia	Productive coniferous forest	Glacial till and outwash
Po1-1/2a				135	Mesic, humid	Ontario	Field crops	Glacial till and outwash
Po1-1/2ab				3 539	Cryoboreal, perhumid	Quebec	Productive mixed forest	Glacial till
Po1-1/2ab				20 090	Subarctic-cryoboreal, perhumid	Quebec	Nonproductive coniferous forest	Glacial till and outwash
Po1-1/2b				541	Cryoboreal, humid	British Columbia	Productive coniferous forest	Glacial till and outwash, residual materials (local colluvium and solifluctate)
Po1-1/2b				13	Mesic, humid	Quebec	Field crops, horticultural crops	Glacial till

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Po1-2b				427	Cryoboreal to boreal, perhumid (maritime modification)	British Columbia	Productive coniferous forest	Glacial till and outwash
Po1-2b				1 287	Boreal, perhumid	Quebec, New Brunswick	Productive coniferous forest, marsh, field crops	Glacial till and outwash
Po2-1a	Od			7 637	Cryoboreal, perhumid (cryoboreal, subaquic)	Quebec	Productive coniferous forest, field crops	Glacial till and outwash, organic sediments
Po2-1a	Od		Stony	953	Boreal, perhumid (boreal, subaquic)	Quebec	Productive and nonproductive mixed and coniferous forest, field crops	Glacial till and outwash, organic sediments
Po2-1a	Od			220	Cryoboreal, humid (cryoboreal, subaquic)	Saskatchewan	Productive coniferous forest	Glacial outwash, lacustrine sediments
Po2-1b	Od		Stony	6 180	Cryoboreal, humid (cryoboreal, subaquic)	Saskatchewan	Productive and nonproductive coniferous forest	Glacial till and outwash, organic sediments
Po2-1/2b	Od		Lithic	104	Mesic, humid (mesic, subaquic)	Ontario	Productive mixed forest	Calcareous glacial till, organic sediments, unspecified igneous and metamorphic rocks
Po2-2a	Od			528	Cryoboreal, perhumid (maritime modification); (cryoboreal, subaquic)	British Columbia	Productive coniferous forest	Glacial till and outwash, organic sediments
Po3-1b	Od I		Stony	13 188	Cryoboreal, humid (cryoboreal, aquic)	Saskatchewan, Manitoba	Productive upland and nonproductive lowland, coniferous forest	Glacial till and outwash, unspecified igneous and metamorphic rocks
Po4-1a	Bd	Rd		564	Cryoboreal, subhumid	Alberta	Nonproductive coniferous forest	Aeolian sand, alluvium, glacial outwash
Po4-1b	Bd	Rd		510	Cryoboreal, humid-subhumid	Saskatchewan	Nonproductive coniferous forest, barren or nearly barren	Lacustrine sediments, aeolian sand
Po5-1a	Rd Ao			320	Mesic, humid	Southern New Jersey	Mixed forest; field crops	Sandy marine sediments
Po6-1a	De			3 570	Mesic, humid; boreal, humid	Central and northern Michigan	Hardwood forest; outdoor recreation; field crops	Glacial till and outwash; lacustrine sediments
Po7-1b	De Rd	O G		1 630	Mesic, humid; boreal, humid	Central and northern Michigan	Hardwood forest; field and horticultural crops	Glacial till and outwash; lacustrine sediments
Po8-2ab	O G			4 230	Cryoboreal, humid (cryoboreal, aquic) subarctic, humid (subarctic, aquic)	South central Alaska	Mixed forest; field crops	Loess over glacial till and outwash
Po9-2bc	O Tv		Stony	3 460	Cryoboreal, perhumid (cryoboreal, aquic); subarctic, perhumid (subarctic, aquic)	Southeastern Alaska	Field crops; coniferous forest	Volcanic ash over metamorphic and igneous rocks
Po10-1a	I			1 085	Cryoboreal to boreal, perhumid	Quebec	Productive coniferous and mixed forests; field crops	Glacial till and outwash, igneous and metamorphic rocks

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Pol0-1a	I			173	Boreal, humid	Ontario	Productive mixed forest, field crops	Glacial till and outwash, igneous and metamorphic rocks
Pol0-1b	I			5 797	Subarctic, cryoboreal, perhumid	Ontario, Quebec	Productive coniferous forest, tundra	Calcareous glacial till, igneous and metamorphic rocks
Pol0-1b	I			21 273	Boreal, perhumid-humid	Ontario	Productive and nonproductive mixed forest, field crops	Glacial till, igneous and metamorphic rocks
Pol0-1b	I			2 115	Subarctic-cryoboreal, perhumid	Ontario, Quebec	Productive coniferous forest, field crops	Glacial till, igneous and metamorphic rocks
Pol0-1b	I		Stony	40 641	Cryoboreal, perhumid	Ontario, Quebec	Nonproductive and productive coniferous forest	Glacial till, igneous and metamorphic rocks
Pol0-1b	I		Stony	740	Boreal, humid	Northeastern Minnesota	Coniferous forest; wildlife area	Glacial till
Pol0-1/2c	I		Stony	6 993	Cryoboreal, perhumid (maritime modification and mountain complex)	British Columbia	Productive coniferous forest	Glacial till and drift, residual materials (local colluvium and solifluctate), unspecified igneous and metamorphic rocks
Pol0-2b	I			228	Cryoboreal, perhumid (maritime modification and mountain complex)	British Columbia	Productive coniferous forest	Glacial drift, calcareous glacial till, unspecified igneous and metamorphic rocks
Pol0-2b	I		Stony	—	—	British Columbia, Quebec	—	—
Pol0-2b	I			782	Cryoboreal, perhumid (maritime modification and mountain complex)	British Columbia	Productive and nonproductive mixed forest	Calcareous glacial till and drift, unspecified igneous and metamorphic rocks
Pol0-2b	I			2 252	Boreal, perhumid	Quebec	Field crops, productive mixed forest	Calcareous glacial till, unspecified sedimentary rocks
Pol0-2bc	I		Stony	340	Boreal, perhumid; boreal, humid	Northern Michigan, central Maine	Mixed forest; outdoor recreation, mines	Glacial till
Pol0-2c	I			5 144	Cryoboreal, humid-subhumid; (cryoboreal, aquic) (maritime modification)	British Columbia	Productive coniferous forest, grasses, forbs, shrubs	Glacial till and outwash, residual materials (local colluvium and solifluctate), unspecified sedimentary and igneous rocks
Pol1-1a	Bd			287	Cryoboreal, humid-subhumid	British Columbia	Productive coniferous forest	Glacial till and outwash
Pol1-1b	Bd			—	—	British Columbia	—	—
Pol1-1/2b	Bd			365	Mesic, perhumid (maritime modification)	Nova Scotia	Productive mixed forest, field crops	Glacial till and outwash
Pol1-2b	Bd			236	Cryoboreal, humid-subhumid	British Columbia	Productive coniferous forest	Glacial till and outwash
Pol1-2bc	Bd			986	Boreal, perhumid	Nova Scotia	Productive mixed forest, field crops	Glacial till and outwash

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Po11-2c	Bd			803	Boreal, per-humid	Quebec	Productive and nonproductive coniferous forest	Glacial till
Po11-2c	Bd			—	—	British Columbia	—	—
Po12-1a	Gh Od I		Stony	274	Subarctic, humid	Manitoba	Nonproductive coniferous forest, tundra	Glacial till and outwash, igneous and metamorphic rocks
Po12-1b	Gh Od I		Stony	18 759	Subarctic, humid	Manitoba	Nonproductive coniferous forest, tundra	Glacial till and outwash, unspecified igneous and metamorphic rocks
Po12-2a	Gh Od I			—	—	Newfoundland	—	—
Po13-1a	Gd	I Od		52	Mesic, humid (mesic, subaquic)	Nova Scotia	Field crops, horticultural crops	Glacial till and outwash, alluvium
Po13-1a	Gd	I Od		150	Boreal, per-humid (boreal, subaquic)	Quebec	Field crops	Lacustrine sediments, glacial outwash
Po13-1a	Gd	I Od	Stony	1 152	Cryoboreal, per-humid (cryoboreal, aquic)	Newfoundland	Nonproductive coniferous forest	Glacial till and outwash, unspecified igneous and metamorphic rocks
Po13-1b	Gd	I Od	Stony	135	Boreal, per-humid (boreal, subaquic)	Quebec	Field crops, productive mixed forest upland, nonproductive lowland	Calcareous glacial till and outwash
Po13-1b	Gd	I Od	Stony	11 110	Boreal, per-humid; boreal, humid (boreal, aquic)	Northern Michigan, Minnesota; Maine, southern New Hampshire, eastern Vermont, New York	Field and horticultural crops; mixed forest	Glacial till
Po13-1/2a	Gd	I Od		2 027	Cryoboreal-boreal, perhumid (cryoboreal-boreal, subaquic) (maritime modification)	Newfoundland, Prince Edward Island, New Brunswick	Field crops, productive coniferous forest	Glacial till and outwash
Po13-1/2a	Gd	I Od		31	Mesic, humid (mesic, subaquic)	Ontario	Productive hardwood forest	Glacial till
Po13-1/2b	Gd	I Od		2 120	Mesic, perhumid (maritime modification) (mesic, subaquic)	Nova Scotia	Productive mixed forest, field crops	Glacial till
Po13-1/2b	Gd	I Od		186	Boreal, per-humid (maritime modification)	Prince Edward Island	Field crops, productive mixed forest	Glacial till
Po13-2a	Gd	I Od		3 270	Cryoboreal, per-humid (cryoboreal, subhumid)	Newfoundland	Productive coniferous forest upland and nonproductive lowland, field crops	Glacial till and outwash, unspecified sedimentary rocks
Po13-2a	Gd	I Od		3 045	Boreal, perhumid (boreal, subaquic) (maritime modification)	Quebec, Nova Scotia	Field crops, productive mixed forest	Glacial till and outwash, lacustrine sediments
Po13-2a	Gd	I Od		770	Boreal, per-humid (boreal, aquic)	Northeastern Maine	Field crops	Glacial till
Po13-2a	Gd	I Od	Stony	—	—	Newfoundland	—	—

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Po13-2b	Gd	I Od		3 441	Cryoboreal, perhumid (cryoboreal, aquic-subaquic) (maritime modification)	Newfoundland	Nonproductive coniferous forest	Glacial till and outwash
Po13-2b	Gd	I Od		2 089	Boreal, perhumid (boreal, subaquic)	Nova Scotia, New Brunswick	Field crops, productive mixed forest	Glacial till
Po13-2bc	Gd	I Od	Stony	2 053	Cryoboreal, perhumid (cryoboreal, subaquic)	Newfoundland, New Brunswick	Productive mixed forest, nonproductive coniferous forest, field crops	Glacial till, unspecified sedimentary rock
Po13-2bc	Gd	I Od	Stony	453	Boreal, perhumid (boreal subaquic)	Nova Scotia	Nonproductive coniferous forest, productive mixed forest, field crops	Glacial till, unspecified sedimentary and igneous rocks
Po13-2c	Gd	I Od	Lithic	2 742	Cryoboreal, perhumid (cryoboreal, aquic) (maritime modification)	Newfoundland	Nonproductive coniferous forest	Glacial till, unspecified igneous and sedimentary rocks
Po14-2a	Gd	Lg		110	Boreal, perhumid	Southern Maine	Field crops	Acid glacial till
Po15-1c	Gd I		Stony	142	Boreal, perhumid (boreal, subaquic)	Quebec	Productive mixed forest, field crops	—
Po15-1c	Gd I		Stony	3 510	Boreal, perhumid; boreal, humid (boreal, aquic)	Northern New Hampshire, Maine, northern New York, Michigan, Minnesota	Mixed forest	Acid glacial till
Po20-1a		Rd		20	Boreal, humid	Northeastern Wisconsin	Mixed forest; outdoor recreation; field crops	Sandy glacial outwash
Po20-1ab		Rd		1 850	Mesic, humid	Northern New York, eastern Rhode Island	Mixed forest, recreation area	Glacial outwash, marine sediments
Rc3-2c		I	Lithic	4 090	Mesic, subarid	Northern and eastern Montana, western North Dakota, southwestern South Dakota	Grasses, forbs and shrubs	Sandstone, shale and siltstone
Rc4-2abc	Yk	Kh Kl		980	Mesic, arid; mesic, xeric	Central Utah	Grasses, forbs; field crops, irrigated and nonirrigated	Alluvial and lacustrine sediments
Rc5-2c	Lc		Lithic	1 920	Mesic, xeric	Southern California	Grasses, forbs and shrubs	Sandstone, shale, greenstone, basalt, granite
Rc6-2bc	Kh			2 730	Mesic, subarid; boreal, semiarid	Central and southeastern Montana	Grasses, forbs	Sandstone and shale; alluvium
Rc7-2c	Yh I		Lithic	3 660	Thermic, arid	Western Texas	Grasses, forbs and shrubs	Sedimentary and igneous rocks
Rc8-2ab	I	Yh Yl		—	—	New Mexico	—	—
Rc8-2ab	I	Yh Yl	Lithic	5 020	Thermic, arid; mesic, arid	Western Texas, northwestern New Mexico	Grasses, forbs and shrubs; field crops; irrigated	Shale, sandstone, siltstone; alluvium
Rc8-2bc	I	Yh Yl	Stony	1 060	Mesic, subarid	Southeastern Colorado, northeastern New Mexico, western Oklahoma	Grasses, forbs	Sandstone, limestone, shale, granite, gneiss, schist
Rc9-2b	Kl Sm	Z	Saline *	2 550	Boreal, subhumid (boreal, semiarid)	Western and southern North Dakota, northwestern South Dakota	Grasses, forbs; field crops	Sandstone and chalk; alluvium

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Rc10-2bc	Yl	Yh I	Stony	6 320	Mesic, arid; boreal, subarid	Western Colorado, north-eastern Arizona, north-western and central New Mexico, northeastern Utah, northeastern Wyoming	Grasses, forbs and shrubs	Sandstone and shale; alluvium
Rc11-2bc	Yl		Lithic	4 750	Thermic, arid; mesic, arid	Northwestern Arizona, southern Nevada, central and southeastern Utah	Grasses, forbs and shrubs; field crops, irrigated	Sandstone, shale, limestone, granite, gneiss, schist
Rc12-2abc	Xl	Je So		1 790	Mesic, subarid; boreal, humid	Northern and central Wyoming	Grasses, forbs and shrubs	Shale, sandstone, limestone, quartzite
Rc13-2b	Xl	Kl		4 360	Mesic, subarid	Southern Montana	Grasses, forbs; field crops, irrigated	Sandstone and shale; alluvium
Rc14-2ab	Xl Je			1 460	Mesic, subarid; mesic, arid	Southeastern and western Colorado	Grasses, forbs and shrubs	Shale and sandstone; alluvium
Rd1-1a				264	Cryoboreal, sub-humid	Saskatchewan	Nonproductive hardwood forest	Lacustrine sediments
Rd4-1a	La			246	Cryoboreal, humid-subhumid	Manitoba	Productive mixed forest, nonproductive coniferous forest	Glacial till, aeolian sand, lacustrine sediments
Rd5-1a	Ao	G		1 360	Thermic, humid; hyperthermic, humid	Northern Florida, central Georgia, southern South Carolina	Mixed forest; grasses and forbs; horticultural crops	Sandy marine sediments
Rd5-1b	Ao	G		2 550	Hyperthermic, humid; thermic humid	Central Florida, southern Georgia	Horticultural and field crops; grasses and forbs; mixed forest	Marine sands; limestone
Re1-1a				70	Boreal, subarid	Saskatchewan	Field crops	Aeolian sand, lacustrine sediments
Re1-1b				238	Cryoboreal-boreal, semiarid to subarid	Saskatchewan	Field crops	Aeolian sand, lacustrine sediments
Re1-1b				7 360	Mesic, subhumid (mesic, subarid)	North central Nebraska, eastern Colorado, western Kansas	Grasses, forbs; field crops, nonirrigated and irrigated	Aeolian sands
Re1-2b			Lithic	760	Mesic, sub-humid; mesic, subarid	Western Kansas, north-eastern Colorado	Grasses, forbs	Limestone, shale and sandstone
Re9-1ab	Lc			920	Hyperthermic, semiarid; hyperthermic, sub-humid	Southern Texas	Grasses, forbs and shrubs	Aeolian sand
Re14-1b	Be		Stony	5 572	Subarctic, humid	Yukon	Coniferous forest, non-productive, barren or nearly barren	Alluvium, residual materials (local colluvium and solifluctate)
Re15-1ab	Be Tv		Shifting sand	1 410	Subarctic, humid; subarctic, sub-humid	Southern Alaska	Grasses, forbs	Marine sand (beach sand)
Re16-1/2a	Je			145	Boreal, semiarid	Saskatchewan	Field crops	Lacustrine sediments; alluvium
Re16-2a	Je			945	Cryoboreal, sub-humid	Alberta	Field crops; coniferous forest, productive	Alluvium
Re17-1ab	De Ch	O		960	Boreal, humid	North central Minnesota	Coniferous forest; field crops	Sandy glacial outwash

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Re18-1a	Kh			67	Boreal, semi-arid	Saskatchewan	Field crops	Alluvium
Re19-2c	Ch Rc	Cl	Lithic	3 250	Mesic, arid; mesic, subarid; boreal, semiarid	Central and southern Colorado, northwestern New Mexico, north central Montana	Grasses, forbs	Shale, sandstone, siltstone
Re21-1a	Xh			840	Mesic, xeric; mesic, subarid	Southwestern Oregon	Wildlife area	Pumice and volcanic ash
Re21-1ab	Xh			400	Mesic, xeric	Southern Washington, northern Oregon	Grasses, forbs and shrubs; field and horticultural crops, irrigated	Aeolian sand; alluvium
Re23-1a	O			430	Boreal, humid (boreal, aquic)	Eastern Minnesota	Hardwood forest; field crops	Glacial outwash; organic sediments
Re26-2b	Kl Hl Rc			530	Thermic, sub-humid	Southern Kansas, northern Oklahoma	Grasses and forbs; field crops	Sandstone and alluvium
Re27-1a	Yl Rc			600	Thermic, arid	Southern New Mexico	Grasses, forbs and shrubs	Aeolian deposits; alluvium
Re31-2a	Zg Kh		Saline	264	Boreal, semiarid	Saskatchewan	Field crops	Glacial till and outwash
Re61-1ab	Lo Gm			2 080	Mesic, humid; boreal, humid (mesic, aquic)	Central Wisconsin, northwestern Indiana, southwestern Michigan	Hardwood forest; outdoor recreation; field crops	Sandy glacial drift
Rx1-1c				3 800	—	Northwest Territories	Tundra	Glacial till and outwash, marine sediments
Rx1-2a			Stony	31 510	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash, marine sediments
Rx1-2c				22 394	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash
Rx1-3b				4 569	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash, igneous and metamorphic rocks
Rx2-1a	I Gx		Stony	5 113	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash, unspecified igneous and metamorphic rocks
Rx2-1b	I Gx		Stony	107 175	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash, marine sediments, unspecified igneous and metamorphic rocks
Rx3-1a	Bx			3 539	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash
Rx3-2b	Bx			1 354	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash
Rx4-1a	I		Stony	4 323	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash, marine sediments, igneous and metamorphic rocks
Rx4-2a	I		Stony	3 428	Arctic, humid (arctic, aquic)	Northwest Territories	Tundra	Glacial till and outwash, marine sediments, igneous and metamorphic rocks
Rx5-2a	Gx Ox		Stony	18 177	Arctic	Northwest Territories	Tundra	Glacial till, organic sediments

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Sm7-2/3a				658	Cryoboreal, subhumid	Alberta	Field crops	Calcareous glacial till and outwash
Sm7-3a				419	Cryoboreal, subhumid	Alberta	Field crops	Calcareous glacial till, lacustrine sediments
Sm8-3a	La			2 198	Cryoboreal, subhumid	Alberta	Field crops	Lacustrine sediments, calcareous glacial till
Sm10-2a	Kl			780	Boreal, semiarid; mesic, subarid	Northwestern South Dakota, southeastern Montana	Grasses, forbs	Calcareous shale and sandstone; calcareous glacial drift
Sm10-2a	Kl			2 817	Boreal, semiarid; subarid	Saskatchewan, Alberta	Field crops	Calcareous glacial till
Sm11-2a	Cl	Gm		663	Cryoboreal, subhumid	Alberta	Field crops	Calcareous glacial till
Sm11-3a	Cl	Gm		93	Cryoboreal, subhumid	Alberta	Field crops	Calcareous glacial till, lacustrine sediments
So1-3a	Zo			1 370	Mesic, arid	Northern Utah	Grasses, forbs and shrubs; field crops, irrigated	Saline lacustrine deposits and alluvium
So3-2a	Kl			530	Boreal, semiarid	Northern Montana	Grasses, forbs	Alluvium, lacustrine sediments; glacial drift
So4-2a	Gm	Yl		520	Boreal, xeric (boreal, aquic)	Southeastern Oregon	Grasses, forbs and shrubs; field crops, irrigated	Saline lacustrine deposits and alluvium
So5-2a	Gm	Je		700	Thermic, xeric (thermic, aquic)	Central California	Field crops, irrigated	Lacustrine sediments; alluvium
Tv7-2c	Po Bh		Stony	722	Cryoboreal, humid (mountain complex)	British Columbia	Forest, coniferous productive, barren or nearly barren	Calcareous glacial till, residual materials (local colluvium and solifluctate), aeolian ash
Tv7-2c	Po Bh		Stony	3 910	Boreal, perhumid	Western Washington	Coniferous forest; grasses, forbs; field crops, irrigated	Volcanic ash; cinders, tuff, breccia, pumice, andesite
Tv8-2c	Po		Stony	181	Cryoboreal, subhumid (mountain complex)	British Columbia	Forest coniferous productive, barren or nearly barren	Calcareous glacial till, residual materials (local colluvium and solifluctate), aeolian ash
Tv8-2c	Po		Stony	1 220	Boreal, humid	North central Washington	Coniferous forest; field crops, irrigated	Volcanic ash; granite, gneiss, basalt, andesite, sandstone; glacial till and outwash
Tv9-2c	Bd Po		Stony	337	Cryoboreal, humid-subhumid (mountain complex)	British Columbia	Forest coniferous productive, barren or nearly barren	Glacial till, residual materials (local colluvium and solifluctate)
Tv9-2c	Bd Po		Stony	8 150	Boreal, humid	Western Montana, northern Idaho, northeastern Washington	Coniferous forest; grasses, forbs; field crops, irrigated	Volcanic ash; metamorphic and sedimentary rocks
Tv10-2ab	G O	I		2 900	Subarctic, humid (subarctic, aquic)	Southwestern Alaska Aleutian Islands	Grasses, forbs; field crops	Volcanic ash over igneous and metamorphic rocks
Tv10-2abc	G O	I		170	Subarctic, humid (subarctic, aquic)	Aleutian Islands	Grasses, forbs	Volcanic ash over igneous metamorphic rocks

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1000 ha)	Climate	Occurrence	Vegetation	Lithology
Vc17-3a	Lk			1 150	Thermic, subhumid; hyperthermic, subhumid	Southern Texas	Field crops; grasses, forbs and shrubs	Calcareous marine sediments; marl
Vc18-3a	Be	G		660	Thermic, humid	East central Mississippi, west central Alabama	Field crops; mixed forest	Chalk; calcareous shale
Vc19-3a	Vp Gm			80	Mesic, xeric (mesic, aquic)	Southwestern Oregon	Field and horticultural crops, irrigated; grasses and forbs	Alluvium
Vp20-3a	Vc			2 570	Thermic, subhumid	East central Texas	Field crops	Limestone, chalk and marl
Vp21-3a	Yh	Vc		1 840	Hyperthermic, subhumid	Southern Texas	Grasses, forbs and shrubs	Calcareous marine clay and marl
Vp22-3a	E			2 820	Hyperthermic, humid; thermic, humid	Southeastern Texas	Grasses and forbs; field crops	Calcareous clayey marine deposits
We10-2a	Lo			1 620	Mesic, aquic (mesic, humid)	Northeastern Missouri, east central Arkansas	Field crops	Loess over glacial drift
We11-2a	Lg			650	Thermic, aquic	Southern Louisiana	Field crops; grasses, forbs; mixed forest	Alluvium
We12-2a	Wm Hl	G		1 440	Mesic, aquic (mesic, humid)	Southwest Missouri, eastern Kansas	Field crops	Loess
We13-2a	Sg Lo	G		2 790	Thermic, aquic; mesic, aquic (mesic, humid)	Southern Illinois	Field crops; grasses and forbs; hardwood forest	Loess over glacial drift
Xh6-2a	Kk	Je		450	Boreal, xeric	Southeastern Idaho	Field crops, irrigated	Loess; alluvium
Xh7-1/2a	Rc			670	Boreal, xeric	Southern Oregon, northwestern Nevada	Grasses, forbs and shrubs	Alluvium; loess; igneous and sedimentary rocks
Xh8-1b	Kh			750	Mesic, subarid	Northwestern Oregon	Grasses, forbs	Pumice and volcanic ash
Xh9-2a	Kh	Gm Rc	Duric ²	800	Mesic, subarid	Central Washington	Field and horticultural crops, irrigated; grasses, forbs and shrubs	Alluvium; loess
Xk5-2ab	Rc			2 110	Mesic, subarid	Southern Idaho	Grasses, forbs and shrubs; field crops, irrigated	Loess and volcanic ash over basalt
X12-2a	Rc	Kl		1 330	Mesic, subarid	Southeastern Colorado	Grasses, forbs; field crops	Shale and sandstone; alluvium; loess
X13-2ab	Rc	I	Stony	4 220	Mesic, subarid	Northeastern Wyoming	Grasses, forbs; field crops	Sandstone, shale and limestone; alluvium
X14-2ac	Rc I	Zo	Stony	7 470	Boreal, subarid	Southern Wyoming, northwestern Colorado	Grasses, forbs and shrubs; field crops, irrigated	Shale and sandstone; alluvium
X15-2ab	Rc Kl			1 260	Mesic, subarid	Eastern Colorado	Grasses, forbs; field crops	Alluvium; loess
X16-1a	Rc So	Zo	Saline	590	Mesic, arid	Southern Colorado	Grasses, forbs and shrubs; field crops, irrigated	Sandstone and shale; alluvium; loess
X17-2ab	I	Kh	Stony	870	Boreal, xeric	Southern Idaho	Grasses, forbs and shrubs; field crops, irrigated	Loess, volcanic ash; (basalt) igneous rocks
X18-2ab	Kl			650	Mesic, subarid; mesic, semiarid	Northern Wyoming	Grasses, forbs and shrubs; field crops, irrigated	Sandstone and shale; alluvium

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
XI9-2a	Yl	Rc	Duric *	1 520	Mesic, subarid	Southwestern Idaho, eastern Oregon	Grasses, forbs and shrubs; field and horticultural crops, irrigated	Loess; alluvium; igneous and sedimentary rocks
Yh6-2a	Je	Yk		960	Mesic, subarid	Eastern Idaho	Grasses, forbs and shrubs; field crops, irrigated	Alluvium; volcanic ash; loess
Yh7-2ab	Rc	Yk		4 000	Mesic, arid	Northeastern Arizona, southeastern Utah	Grasses, forbs and shrubs; field crops, irrigated; barren	Sedimentary and igneous rocks; alluvium
Yh8-2ac	Rc Yk		Lithic	7 170	Mesic, arid	Western Nevada	Grasses, forbs and shrubs; field crops, irrigated	Igneous and sedimentary rocks; alluvium
Yh9-2ab	Yk Rc I	Je		820	Thermic, arid	Southwestern New Mexico	Grasses, forbs and shrubs; field crops, irrigated; barren	Igneous, metamorphic and sedimentary rocks; alluvium
Yk4-2a	Y	Rc		520	Mesic, subarid	Southern Idaho	Grasses, forbs and shrubs; field crops, irrigated	Alluvium; lacustrine sediments
Yk5-2a	Rc	Yy	Shifting sand	780	Thermic, arid	Southern New Mexico	Grasses, forbs and shrubs; barren	Calcareous alluvium; loess; gypsum dunes
Yk6-2a	I			2 110	Thermic, arid	Western Texas, southern New Mexico	Grasses, forbs and shrubs; barren	Calcareous alluvium; sedimentary rocks
Yk7-2ab	I	Yh	Stony	2 390	Mesic, arid	Southeastern Utah	Grasses, forbs and shrubs; field crops, irrigated	Sedimentary rocks; alluvium
Yk8-2a	I Yh	Je	Duric *	3 560	Thermic, arid	Western Texas, southeastern New Mexico	Grasses, forbs and shrubs; field crops, irrigated	Calcareous alluvium; gypsumiferous materials
YI3-2ac	Yk K		Duric	7 800	Mesic, arid	Eastern Nevada	Grasses, forbs and shrubs; field crops, irrigated	Alluvium; sedimentary and basic igneous rocks
YI4-2ab	Yk	Rc I	Stony	7 210	Mesic, arid; thermic, arid	Southern Nevada, eastern California, northeastern New Mexico	Grasses, forbs and shrubs; barren	Alluvium; shale, sandstone, limestone, quartzite, rhyolite, tuff, basalt, granite
YI5-1/2abc	Yk Rc		Petrocalcic *	20 880	Thermic, arid; hyperthermic, arid; mesic, arid	Southern California, Nevada, southwestern Arizona	Grasses, forbs and shrubs; barren	Alluvium; granite, gneiss, schist, quartzite, limestone
YI6-2ac	Yk I	So Yh	Stony	3 260	Mesic, arid	Western Utah, eastern Nevada	Grasses, forbs and shrubs; field crops, irrigated	Alluvium; lacustrine sediments; calcareous sedimentary rocks
YI7-2a	Yk So	Yh Z	Saline	630	Mesic, arid	Southwestern Utah	Grasses, forbs and shrubs; field crops, irrigated	Limestone, sandstone, shale, quartzite, rhyolite, granite; alluvium
YI8-2abc	Je	Yk	Duric *	300	Thermic, arid	Southern Arizona	Grasses, forbs and shrubs; barren	Schist, granite, sandstone, limestone, basalt; alluvium
YI9-2abc	Re Yk		Duric *	5 150	Thermic, arid; mesic, arid	Central and southwestern New Mexico, southeastern Arizona	Grasses, forbs and shrubs; field crops, irrigated	Undifferentiated basic and acid rocks
YI10-2abc	I	Yk	Stony	480	Thermic, arid	Central Arizona	Grasses, forbs and shrubs; barren	Granite, gneiss, schist, rhyolite, basalt; alluvium
YI10-2b	I	Yk	Stony	600	Thermic, arid	Northwestern Arizona	Grasses, forbs and shrubs; barren	Granite, gneiss, rhyolite, sandstone, limestone, basalt; alluvium

See notes at end of table.

TABLE 6. - SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence	Vegetation	Lithology
Y111-2abc	I Kk		Stony	3 500	Thermic, arid	Southeastern Arizona, southwestern New Mexico	Grasses, forbs and shrubs; barren	Granite, rhyolite, sandstone, limestone, schist; alluvium
Y112-2a	Kl	Rc Kk		2 330	Thermic, arid; mesic, arid; mesic, subarid	Eastern and southeastern Arizona, western and northeastern New Mexico	Grasses, forbs and shrubs; field crops	Limestone, shale and sandstone; alluvium
Y113-2abc	Kl	Yk Kh	Duric ^a	1 880	Mesic, arid; mesic, xeric	Western Nevada, eastern California	Grasses, forbs and shrubs; field crops, irrigated	Granite, rhyolite, tuff, andesite, limestone, shale; alluvium
Y114-2ab	Rc			—	—	Southern California	—	—
Y115-2a	Yk			890	Mesic, arid	Central New Mexico	Grasses, forbs and shrubs	Sandstone, shale; alluvium
Y116-2ab	Yh	Rc I	Stony	5 180	Mesic, arid	Western New Mexico, northwestern Nevada	Grasses, forbs and shrubs; field crops, irrigated	Granite, rhyolite, basalt; alluvium; lacustrine sediments
Zo3-2a	Kh			127	Boreal, subarid	Saskatchewan	Field crops	Lacustrine sediments

^a Field crops include rotational hay and pasture. — ^a The phase applies to only part of the association. — ^a Moisture regime in parentheses is that of associated soil if the soil moisture regime is different from that of the dominant soil.

11. XEROSOLS

Xerosols are inextensive soils occupying plateaus in the Rocky mountains in the western United States. These soils are dry; on the higher plateau, located in Wyoming, the soils have cool temperature regimes, whereas on the lower lying plateau in southern Idaho they have temperate regimes. Principal associated soils are Regosols; Kastanozems, Solonchaks and Lithosols are inextensive. Natural vegetation consists mainly of sagebrush and sparse grass. Some grazing is feasible and cultivated crops are grown where irrigation water is available.

12. YERMOSOLS

Yermosols are the dominant soils of the driest part of the continent — the basin and range area of the southwestern United States. These soils are warm or hot and dry. Principal associated soils are Regosols and Solonetz soils on the more gently sloping areas, Kastanozems on the slopes adjoining the more moist areas to the north and east, and Lithosols. Vegetation is sparse and barren areas are common. Native shrubs and grasses support limited grazing and, where irrigation water is available, cultivated crops are grown.

The region dominated by Yermosols can be divided into two subregions on the basis of distribution of landforms.

12a. Yermosols of desertic mountains and plains. In this subregion mountain ridges and the interspersed plains are of approximately equal extent. Most of the associated Luvisols occur in this subregion.

12b. Yermosols of desertic plains. In this subregion, the plains are extensive; mountain ridges and ranges occupy only one fifth of the landscape. Commonly the soils have developed on long, gently sloping alluvial fans. A large proportion of the associated Regosols occur in this subregion.

13. VERTISOLS

Vertisols occur on limestones, calcareous shales, and marl in the southern part of the United States. They are warm or hot soils that are dry for appreciable periods of the year. In nearly one third of this region underlain by sandstone Luvisols are the dominant soils. Natural vegetation on Vertisols is tall prairie grass; that on the Luvisols is forest. Most of the Vertisols are used for production of cultivated crops, particularly cotton and rice, but a large pro-

portion of these soils support grasses suitable for grazing.

14. GLEYSOLS AND GLEYIC SOILS

These soils, showing characteristics of wetness, are particularly extensive in Alaska and northwestern Canada, the Mississippi valley and along the Gulf and Atlantic coasts of the United States.

In Alaska and northwestern Canada, the soils are cold or very cold and in the northernmost third of this part of the region permafrost is continuous. Associated soils are Cambisols, Regosols and Fluvisols. The vegetation is tundra in northern Alaska

and forest in the remainder of the area. Although the growing season is short, inextensive areas are farmed, particularly on the better drained associated soils.

In the Mississippi delta of the United States, soil temperature regimes are warm or hot. The principal associated soils are Luvisols and, in the delta proper, Histosols. Most of the area has been developed for farmland for the production of cash crops.

Along the Gulf and Atlantic coasts in low-lying, nearly level areas, gleyic soils are dominant, particularly those related to Acrisols and Podisols. Inextensive areas of Histosols and tidal marsh are common; Regosols are the principal associated soils. Most of the area is forested; only a small part of it has been improved for the production of cash crops.

6. DESCRIPTION AND DISTRIBUTION OF SOILS, LAND USE AND SOIL SUITABILITY

LAND USE IN NORTH AMERICA

The continent of North America has a wide range of soils, climate, vegetation and topography, and a corresponding range in suitability of land for economic use. In addition to the effect of the physical environment, many aspects of the economic environment, such as geographic location, population density and transportation facilities, affect land use. These economic and physical factors are interrelated in their overall influence on man's use of land.

Distribution of the principal kinds of land use in North America is shown in Figure 7. A high proportion of the land in the central and eastern United States and in southern Canada is used to produce cultivated crops. Except for localized areas of intensive farming, land in the drier western and southwestern United States is used for livestock grazing or supports no economic use at all. Most of the remainder of the continent is forested. In the far north and on some mountain summits and plateaus the land is blanketed with tundra, suited only for use as wildlife habitat. Swampland and marshland are extensive along the Atlantic and Gulf coasts as well as in a single area at the United States-Canada border.

CROPLAND

Cropland comprises the land used to produce crops and pasture included in a crop rotation system, and land that is temporarily idle. It is found primarily in the central, southern, and southeastern parts of the continent, extending from central Saskatchewan in Canada to southern Texas in the United States and eastward to the Atlantic coast.

Cropland is most extensive in the central lowlands where wheat and maize are grown. Where the climate is cool, with a growing season too short for many crops and a rainfall too low for others, spring wheat grown by dry-farming methods is the principal crop; maize is produced in the milder and more humid climate in the north central United States, and winter wheat and cotton in the areas of

progressively higher temperatures to the south. West of the Mississippi river some irrigated farming is practised; principal crops are forage and grain for livestock, cotton, and some vegetable crops. Small, intensively cropped areas are located in broad intermontane valleys in the United States near the west coast and on part of the Mississippi river flood plain, and in Canada in southern and central British Columbia. A small proportion of these cropland areas is used as grazing or forest land.

The periphery of the extensively cropped plains supports a higher proportion of grazing, generally on rougher and more droughty land. Crops produced in these areas are principally spring wheat and small grains, using dry-farming methods, except in the east central United States where the climate is more humid and winter wheat and maize are the main crops.

In Canada and the northern United States more intensive land use would be limited by cool summers and a short growing season. In the western part of this area, supplementary irrigation would be required for crops other than those produced by dry-farming. Irrigation of these soils is limited to small areas, principally in Kansas and Nebraska.

Extensive areas in southeastern and southwestern Canada and the northeastern United States, for the most part adjacent to the eastern Great Lakes and the St. Lawrence river, are used for the production of specialty crops and for pasture and forest land. The climate in these areas in the eastern part of the continent is temperate and humid. A wide variety of crops is grown, principally hay, feed grains and fodder maize in support of dairy operations. Tree fruits and vegetables are important cash crops. In southwestern Canada, where the climate is somewhat drier, crops are grown by dry-farming methods; supplementary irrigation for some crops is common. On lower lying and more humid areas near the coast specialty crops, mainly tree fruits, are grown.

The remaining dominantly cropland areas include a similar proportion of pasture and forest land, but the crops produced are different. Throughout the southeastern United States cropland is used for cash

crops, the most important of which are cotton and tobacco; maize, sorghum, small grains and hay are also important, and are grown mainly in support of livestock farming. In Canada, forage and small grains are the principal crops. Pasture and forest occupy about half the area of this association of land uses.

RANGELAND

Rangeland is extensive in the western half of the United States. It comprises all the land used for livestock grazing, and includes shrubland, grasslands for forage, and open woodland dominated by low-growing evergreen trees and shrubs, chaparral and brush.

Grasslands used for grazing are extensive on the dry plains east of the Rocky mountains; they are less extensive in the northwestern and southwestern United States. Most is short grass prairie. A small proportion of the area identified as grassland (generally less than 5 percent) is cropland dry-farmed to wheat. Some of this cropland is irrigated for the production of row crops, forage and grains; irrigation water is available on uplands from wells and in valleys from major streams.

Shrubland used for grazing is somewhat more extensive than grassland used for the same purpose. It occupies a broad area in the western and southwestern United States and also in the interior of British Columbia in Canada. It consists mainly of desertic shrubs; sparse short grasses form a ground cover in places. Barren areas are common.

Open woodland used for grazing is located on the steeper hills and low mountain slopes from the Pacific coast of southern California to southern Texas. It comprises low-growing needleleaf and broadleaf trees with an understorey of grass in many places. Brushland is common at lower elevations and there are small areas of irrigated cropland.

As in the grazed grassland and shrubland areas, a severe shortage of moisture and the difficulty of obtaining water for irrigation generally preclude improvement for crop production. Further limitations are imposed by the dissected and hilly to steep topography characteristic of much of the grazed woodland.

FOREST LAND

Forest land is distributed across Canada and Alaska from the Atlantic to the Pacific coast, and is dominant in much of the eastern and southeastern United States, as well as in the mountainous regions in the western part of the country.

In a broad area across central Canada the forest has little value as a source of timber or other wood

products, except for a few sites where timber production is feasible. The greater part of this area, particularly in the north, is mixed open scrub forest and tundra vegetation. It provides some shelter and grazing for wildlife.

Restrictions on improved management or more intensive use of these areas are imposed by the cold to subarctic temperatures of this part of the continent and the consequent very short growing season, the steep slopes common in the western part of the area, the stony soils, and the generally low level of fertility of the Dystric Cambisols and the Orthic Podzols. In addition, drainage problems would be particularly severe in the extensive areas of Dystric Gleysols and Histosols, and the installation of artificial drainage for the purpose of providing additional land for farming would not be feasible in such an environment.

In southern and western Canada, Alaska and the western and eastern United States, the forests generally have commercial value. They are dominantly coniferous in the western United States, Canada and Alaska, but broadleaf species are common in transitional areas near the prairie grasslands in south central Canada; in the eastern United States they are predominantly broadleaf forests with some needle-leaf species included. In general, holdings are relatively large in the western and northern parts of this region, but in the eastern United States much of the forest is in small woodlots on farms. A little forest land is used for grazing, particularly in the areas adjoining land developed for farming; some land in valleys is in farms and used more intensively for the production of cultivated crops.

Climate in the areas of forest with commercial value is milder than in areas of unproductive forest. It ranges from subarctic and moist in Alaska to cool to cold and humid in much of Canada and the northern United States, and is temperate to warm and humid in parts of the southern and southeastern United States; in southwesternmost Canada some areas are cool or cold and somewhat dry, particularly on steeper slopes and those with southern exposures.

Restrictions on improved management or on the more intensive use of the soils supporting forest having commercial value are much the same as those common to soils supporting unproductive forest: predominantly cold temperatures and a short growing season, steep slopes, stony textures, shallowness to bedrock, and low fertility.

OTHER LAND

Desert shrubland is located in the extreme southwestern United States. It consists of sparse desert

vegetation; short grass covers patches of ground and barren zones are common. Irrigated crops are grown in small areas along the Colorado and Gila rivers.

As in the area of grazed shrubland, the Yermosols in this ungrazed area could be made moderately productive by fertilization and irrigation. Principal restrictions on development for more intensive use are very low rainfall and difficulty of obtaining adequate supplies of irrigation water.

Although not accurately identified as a kind of land use, tundra and alpine meadow are closely related vegetative types extensively distributed across the northernmost part of the continent. Because of the unique environment in which they occur they have little if any economic use except as wildlife habitats. Tundra is characteristic of the broad expanses of the very cold, wet, generally low-lying northern part of the continent, and alpine meadow, on drier sites, occurs in the cold high elevation of the mountains and plateaus of the Cordilleran region in the western part of the continent. Lichens, mosses, grasses, sedges, herbaceous plants and dwarf shrubs make up the vegetative cover; the composition of the cover at any particular site depends on the soil conditions. Mountain peaks, lava flows and barren areas are common. Very cold temperatures generally preclude the growth of plants other than those specifically adapted to the climate.

Swampland is extensive along the Atlantic coast of the United States; it also occurs inextensively in southern Florida, along the international border in northern Minnesota, and on the lower Mississippi flood plain. Marshland occurs principally along the coast bordering the Gulf of Mexico. A small proportion of these areas is farmed; their main uses are for recreation and wildlife habitats, and some lumbering.

Because of the low position on the landscape occupied by these wet soils, improvement for farming by drainage would be difficult and in most places economically unfeasible. A high level of management would be required to attain and maintain acceptable yields.

DESCRIPTION, DISTRIBUTION AND SUITABILITY OF SOILS

For easy reference, the discussion of the distribution and suitability of the dominant soils is given here in alphabetical order of symbols. Some soils that are similar from the point of view of agricultural production have been discussed together. More specialized data on properties of the various soils appear in Appendix 1.

LEGEND TO FIGURE 7

LAND-USE REGIONS

CROPLAND

- 1 Mainly cropland
- 2 Cropland and grazing
- 3 Cropland (with specialty crops), pasture, forest
- 4 Cropland, pasture, forest

RANGELAND

- 5 Grassland, grazed
- 6 Shrubland, grazed
- 7 Open woodland, grazed

FOREST LAND

- 8 Forest land with commercial value
- 9 Forest land with no commercial value

OTHER LAND

- 10 Desert shrubland
- 11 Tundra
- 12 Swampland and marshland

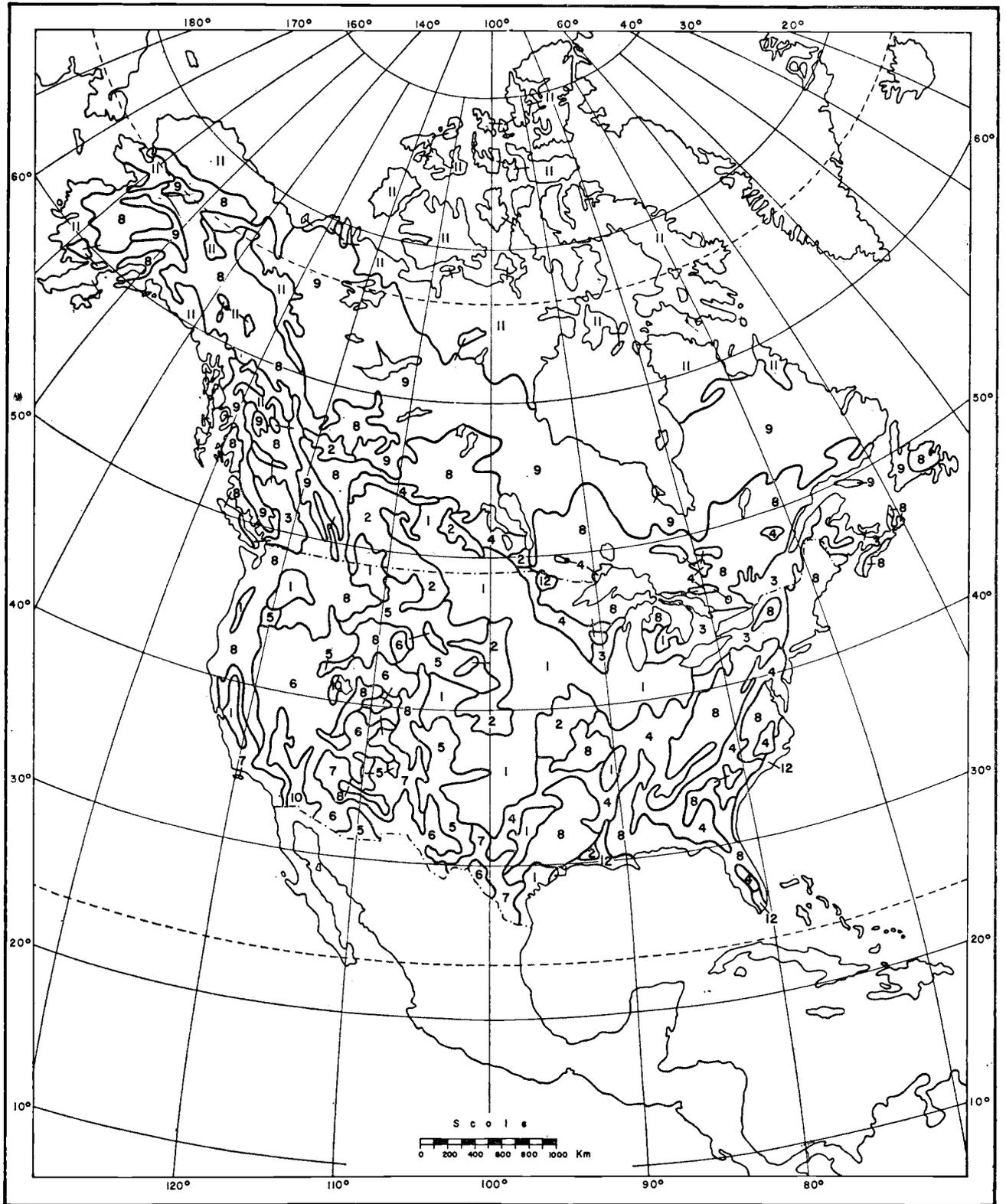


Figure 7. - Land-use regions of North America

A. Acrisols in the United States

Acrisols occur in the United States but not in Canada. They are extensive soils and are distributed on the gentle to steep slopes of much of the southeastern quarter of the country; they also occur on moderate and steep slopes in parts of the coastal mountain ranges in Washington, Oregon and California. Soil temperature regimes range from boreal at the higher elevations in the west to hyperthermic in part of Florida; however, most have mesic and thermic soil temperature regimes. Soil moisture regimes are aquic, perhumid and humid, although in the west some areas of Acrisols have xeric soil moisture regimes. Because of their wide distribution, the nature of the underlying materials varies greatly from place to place. Along the Atlantic and Gulf coasts and in part of the Mississippi river valley, Acrisols are underlain by marine sediments of various textures. Inland from the coastal area, these soils overlie a variety of igneous, metamorphic and sedimentary rocks. In general, Acrisols are inherently unproductive soils but they respond readily to good management, and where properly fertilized many produce good yields of adapted crops.

Af. FERRIC ACRISOLS

Ferric Acrisols are widely distributed in the southeastern United States. They are gently sloping and hilly soils on the middle and upper parts of the coastal plain. Most are on marine sediments of various textures; those in the Mississippi river valley have a thin loess mantle. Soil temperature regimes are thermic and soil moisture regimes are humid. Large areas of Ferric Acrisols are used for field crops — maize, cotton, tobacco, vegetables, small grains, forage crops and, in parts of Florida, citrus fruits. Mixed coniferous and hardwood forest is locally extensive, particularly on the more steeply sloping areas. West of the Mississippi river in southwestern Missouri, northwestern Arkansas and northeastern Oklahoma, the Ferric Acrisols are on sedimentary rocks with a thin mantle of loess. These soils are mostly in hardwood forest although some areas are used for forage crops. Gleyic Acrisols are more commonly associated with the Ferric Acrisols; Dystric Regosols and Orthic Acrisols are less common associates.

Ag. GLEYIC ACRISOLS

Gleyic Acrisols are moderately extensive. Most are located on the nearly level coastal plains and river terraces extending almost continuously from

southern New Jersey to western Florida and from southeastern Texas into southwestern Louisiana. Soil temperature regimes are mesic, thermic and hyperthermic; soil moisture regimes are aquic. The underlying materials are marine and alluvial sediments varying in texture from place to place. Most of the Gleyic Acrisols are in mixed forest but are being rapidly cleared in many places. In the lower lying wetter areas, swamp forest and marsh vegetation occur. Extensive areas have been drained and are used for crops such as maize, cotton, soybeans and a variety of vegetables. Common associated soils are Orthic and Plinthic Acrisols, Dystric Regosols and Haplic Cambisols.

Ah. HUMIC ACRISOLS

Humic Acrisols are inextensive and occur only on moderate to steep slopes in the western parts of California, Oregon and Washington. Underlying materials are mostly basic igneous rocks. Soil temperature regimes are mesic and soil moisture regimes are humid and perhumid. In this moist climate these Acrisols support stands of coniferous forest; in the valleys, these soils are used for forage crops, small grains and vegetables. Associated soils are Humic Cambisols.

Ao. ORTHIC ACRISOLS

Orthic Acrisols are the most extensive of the Acrisols. They are the gently to steeply sloping soils of the piedmont region east of the Appalachian mountains and of the low dissected plateaus west of the mountains. They are also extensive soils west of the Mississippi river on partially loess-mantled dissected plateaus in southern Missouri, northwestern Arkansas, southeastern Oklahoma, and on the rolling upper coastal plain in northern Louisiana and eastern Texas. In California and Oregon, they are steeply sloping soils on a variety of igneous, metamorphic and sedimentary rocks. Soil temperature regimes are mesic and thermic. Soil moisture regimes are predominantly humid except that those Orthic Acrisols occurring in California and Oregon have xeric soil moisture regimes. On steeper slopes the Orthic Acrisols are forested — hardwood forest is dominant in northern Georgia, Tennessee and Missouri; mixed coniferous and hardwood forests dominate elsewhere. On the more gentle slopes the Orthic Acrisols are used for maize, cotton, tobacco, forage crops and some citrus fruits and vegetables. Dystric Cambisols and Gleyic Acrisols are the more common associates of the Orthic Acrisols.

B. Cambisols in Canada

Cambisols are widely distributed in Canada, occurring in all provinces and territories. They are the dominant soils on the landscape of approximately 10 percent of the land area. Cambisols are associated with almost all soils, particularly Lithosols, Podzols and Luvisols; generally they are not associated with Chernozems, Kastanozems and Solonetz soils of the interior plains.

The majority of the Cambisols, approximately 80 percent, have subarctic temperature regimes, including those of the subalpine regions of the Cordilleran highlands. Of the remainder, generally occurring in the St. Lawrence lowland of Ontario and Quebec and the lowlands of Vancouver Island and the Fraser valley of British Columbia, 7 percent have arctic, 9 percent have cryoboreal and boreal and 4 percent have mesic soil temperature regimes. The soil moisture regimes of Cambisols are dominantly humid and perhumid, although some in the interior plateaus of the Cordilleran region have subhumid to semiarid moisture regimes.

Cambisols are developed most frequently on coarse to medium-textured till, outwash and aeolian deposits, but may also be found on fine-textured deposits. Some, in the Cordilleran region of British Columbia, are associated with volcanic ash deposits. They may be found on all topographic phases but the majority occur on rolling or mountainous areas.

It is estimated that less than 1 percent of the Cambisols of Canada are cultivated, mainly in parts of Quebec and Ontario where soil temperature regimes are boreal or mesic, and also in the lower Fraser valley and Vancouver Island in British Columbia where soil temperature regimes are mesic. Cambisols in these areas are used for a variety of field crops in a mixed farm-livestock economy, but with some production of speciality fruit and horticultural crops. Approximately 130 000 sq km of Cambisols are productive forest lands; the remaining 747 700 sq km are nonproductive forest because of severity of climate, rough and steep topography, stoniness or shallowness to bedrock.

Development of farm enterprises on the Cambisols has occurred mainly in areas of relatively favourable climatic, topographic and textural conditions, and where fertility limitations are slight to moderate. Fertility levels of Cambisols vary considerably; Eutric Cambisols are commonly highly productive whereas the Dystric Cambisols usually require sustained fertilization and liming to maintain satisfactory levels of production. Tillage problems are not serious except where conditions of stoniness or shallowness to bedrock occur. Cambisols developed on very coarse-textured materials, particularly in

subhumid or humid areas, may suffer from moisture deficiencies in dry years.

Bd. DYSTRIC CAMBISOLS

Dystric Cambisols occupy about 3 percent of the area of Canada, and make up about one third of the Cambisols. They are most extensive on the Canadian shield in the Northwest Territories, Ontario and Quebec, in the subalpine areas of the southern Cordilleran region and in the coastal lowlands of British Columbia. They are also found on Anticosti Island and in the Chaleur uplands of Quebec. Dystric Cambisols are generally associated with Lithosols, Luvisols and Podzols and commonly occur on rolling and mountainous topography. Parent materials of Dystric Cambisols range from acidic to slightly calcareous, generally sandy to loamy glacial till and outwash, but they can also occur on clayey lacustrine or marine deposits. Most have subarctic, cryoboreal or boreal soil temperature regimes associated with perhumid, humid and subhumid soil moisture regimes; on Vancouver Island and in the lower Fraser valley they have humid to subhumid mesic soil climates. About 2 600 sq km of Dystric Cambisols are in farm units, mainly in Quebec and British Columbia, about 52 000 sq km are in productive forest, and the remaining 226 400 sq km are in nonproductive forest, forest-tundra transitions or under alpine heath.

Be. EUTRIC CAMBISOLS

Eutric Cambisols are the dominant soils on the landscape of about 6 percent of the area of Canada. In western Canada they occur on the Great Slave plain of the interior and the Cordilleran northern plateaus and mountains, in northern British Columbia, northwestern Alberta, the Yukon and Northwest Territories. In eastern Canada they are mainly found near the Great Lakes and in the St. Lawrence lowland area. They occur on undulating, rolling and mountainous topography. Parent materials are usually slightly to moderately calcareous glacial till, lacustrine or local alluvium and aeolian deposits; textures commonly range from sandy loams to clays. About 7 800 sq km of moderately to highly productive Eutric Cambisols are in areas developed for farming, mainly in the St. Lawrence lowland where the soil climate regime is mesic or boreal and humid. About 70 000 sq km of Eutric Cambisols support productive forest sites, but over 416 000 sq km of these soils are in nonproductive forest, either because of severe climate or because of stony and mountainous terrain. Eutric Cambisols are associated with many other soils, including Luvisols,

Gleysols, Fluvisols and Regosols, Dystric Cambisols, Lithosols and Gelic Histosols.

Bx. GELIC CAMBISOLS

Little is known about the Gelic Cambisols, which comprise less than 1 percent of the area of Canada. They occur mostly in those parts of the Canadian shield, northern Manitoba and the Northwest Territories lying within the area of arctic temperature regimes and where permafrost occurs within and below the solum. They are undulating to rolling soils on sandy glacial till, outwash and marine sediments, and are associated with Regosols, Lithosols, and, to a lesser degree, with Gleysols. Because of the short growing season and shallow depth of permafrost the Gelic Cambisols support a tundra or mixed tundra-nonproductive coniferous forest vegetation, which has little potential use except for wildlife grazing. The main management problems are the protection of the sparse native vegetative cover from overgrazing by native animals, prevention of damage from vehicles or other human activity and the preservation of a natural equilibrium between the active unfrozen layer and the underlying permafrost during the short summer season.

B. Cambisols in the United States

In the United States, Cambisols are gently to steeply sloping soils widely distributed, mainly in the eastern half of the country. They are most extensive on the moderate and steep slopes of the Appalachian mountains in the northeastern part of the country and occur much less extensively in other parts of the conterminous United States and in Alaska. Underlying materials vary greatly from place to place — from deep glacial drift to a variety of sedimentary, igneous and metamorphic rocks. Soil temperature regimes are mostly mesic and boreal but in a few places they are thermic, cryoboreal and subarctic. Cambisols vary in productivity. They present a wide variety of management problems affecting use and yields. Many are too steep for farming; a few have temperature regimes too cold and growing seasons too short for all but the most hardy crops; some have fragipans which restrict root development and ultimately crop yields; some have severe shortages of moisture and require irrigation and others are not naturally productive but respond to fertilization.

Bc. CHROMIC CAMBISOLS

Chromic Cambisols are inextensive and occur only in northern New York and along the east side of the

Hudson river valley. They are gently sloping soils on plains underlain by glacial till and outwash and some lacustrine sediments. Soil temperature regimes are mesic and soil moisture regimes humid. Most of these soils are in hardwood or mixed forest, except in some areas along the Hudson river which are used for forage crops in support of dairying. Dystric Cambisols are the principal associated soils.

Bd. DYSTRIC CAMBISOLS

Dystric Cambisols are moderately extensive. They are distributed across ridges, mountains and dissected plateaus from central New York south to central Alabama. Soil temperature regimes are predominantly mesic, but are boreal at the higher elevations in northern Pennsylvania and thermic in Alabama and part of Tennessee. Underlying materials comprise glacial drift in central and eastern New York and sedimentary rocks from southern New York to the south. Inasmuch as most of the Dystric Cambisols are steeply sloping, much of the area they occupy is in hardwood forest, but where slopes are moderate or gentle they are used for grain and forage crops in support of dairying. Many of these have a fragipan. A few areas are used for vegetables, potatoes and fruit.

Be. EUTRIC CAMBISOLS

Eutric Cambisols are inextensive in the United States. They are moderately to steeply sloping soils of valley walls in eastern North Carolina and southern Ohio, of dissected plains in central Oklahoma and southeastern Kansas and of high mountains in western Wyoming and southern and northwestern Montana. In central Alaska they are gently to moderately sloping soils on terraces. Underlying materials are mostly sedimentary rocks, although some are of igneous and metamorphic origin; in Alaska, alluvial sediments and glacial drift are the underlying materials. With such wide distribution, soil climate varies from place to place — from the thermic soil temperature and subhumid soil moisture regimes of Oklahoma and Kansas to the subarctic soil temperature and perhumid soil moisture regimes of Alaska. Most of these soils are forested, and areas of grasses and forbs afford some grazing. Some wheat, sorghum, cotton and forage crops are grown in Oklahoma and Texas. In Alaska, although temperatures are cold, the growing season is short and in some areas permafrost is present, these soils are used to produce grains, forage crops and some hardy vegetables. Luvisols are common associates of the Eutric Cambisols, except in Alaska where Gleysols and Histosols are associated with them.

Bh. HUMIC CAMBISOLS

Humic Cambisols occur on slopes of the mountain ranges in western Washington and Oregon. Underlying materials comprise volcanic ash, cinders, pumice, igneous and sedimentary rocks, glacial till and outwash, and some alluvium. Soil temperature regimes are mostly mesic but are boreal at the higher elevations in western Oregon. Soil moisture regimes are humid, subhumid and xeric. Most of the Humic Cambisols are in coniferous forest; under intensive management they also produce fruits, berries, vegetables, seed crops and grain. Dominant associated soils are Orthic Podzols and Haplic Phaeozems.

Bk. CALCIC CAMBISOLS

Calcic Cambisols are the least extensive of the Cambisols. They are gently sloping soils on a dissected upland of limestone, marl and chalk in central Alabama. The soil temperature regime is thermic and the soil moisture regime humid. Most of these soils are used for forage but cotton, soybeans and maize are grown also. Chromic Vertisols are the principal associated soils.

C. Chernozems in Canada

Chernozems occur as the dominant soils on the landscape of about 2 percent of the land area of Canada. Most are in the interior plains region of western Canada in the provinces of Manitoba, Saskatchewan and Alberta, but a few of these soils are found in small areas within the southern plateau of the Cordilleran region in British Columbia.

Within the interior plains the soil climate regimes of the Chernozems are broadly cryoboreal and boreal subhumid. Within the southern plateau region of British Columbia Chernozems tend to be associated with complexes of warmer and drier boreal to mesic, subhumid to semiarid regimes, influenced by vertical zonation and aspect common to the valleys and plateaus of the intermontane region. They are usually found in cooler sites at elevations above 1 000 m and below the subalpine areas.

The Chernozems are developed mainly on glacial till and glaciofluvial and lacustrine deposits, but occur also on aeolian, alluvial and colluvial materials. Most of these deposits are weakly to strongly calcareous and dominantly loamy in texture, although substantial areas of coarse sandy and fine clayey soils occur. The dominant loamy textured soils

usually occur on undulating to rolling glacial landforms; the less extensive sandy soils are on the undulating alluvial or aeolian plains, and the clayey soils are generally associated with glacial lacustrine deposits in level to undulating lake basins.

The inherent productivity of Chernozems is high but is climatically limited by cool, short growing seasons and by slight but significant moisture limitations during the same period. Moisture limitations are intensified with increasing coarseness of texture and with lower moisture-holding capacities of the soils. Fertility limitations are slight except in the coarser sandy soils.

Management problems of Chernozems in Canada are largely those associated with control of wind and water erosion and good tillage practices for moisture conservation and maintenance of protective soil cover. Summer fallowing for moisture conservation and weed control is practised but is not as essential for the Chernozems as it is for the Kastanozems with semiarid to subarid moisture regimes. Fertility levels can be readily maintained by routine applications of nitrogen and phosphorus. Potassium is not usually a limiting factor.

Ch. HAPLIC CHERNOZEMS

Over half of the area of Chernozems in Canada are Haplic Chernozems. Most are located in the eastern and central portion of the interior plains region of Saskatchewan and Manitoba, extending into Alberta. They also are dominant in the interior plateaus of British Columbia. They occur as a subdominant soil in many areas of Luvic Chernozems. They are most commonly developed on moderately to strongly calcareous parent materials.

The soil climate regimes for Haplic Chernozems are cryoboreal and boreal subhumid.

Haplic Chernozems may have relatively thin A and B horizons with a consequent shallow depth to a calcium carbonate C layer. Consequently, there is greater necessity for protection against soil erosion and to retain topsoil. Fertility limitations are more severe where excess carbonates occur either at the surface or at very shallow depths. They are used mainly for production of field crops and some pasture.

Ck. CALCIC CHERNOZEMS

Calcic Chernozems are the least extensive of the Chernozems; they are the dominant soil mainly in the Manitoba lowland and eastern portions of the Saskatchewan plain. They are mostly medium tex-

tured, moderately to strongly calcareous, locally saline soils on nearly level to gently undulating glacial till and lacustrine deposits. The principal associated soils are Haplic Chernozems and Mollic Gleysols with some Eutric Planosols, the latter two soils occurring in lower slopes, flats or depressional basins. The Calcic Chernozems are commonly A/C soils; if a B horizon is present, it is usually calcareous. The A horizons are usually thicker than those of Haplic Chernozems and may or may not have free carbonates. They are mainly cultivated for field crops and forage. Most Calcic Chernozems are highly productive soils for small grains. Some slight limitations in use and productivity due to excess carbonates and slight salinity may occur in lower slopes and locally in poorly drained positions. Surface drainage is a problem in unusually wet seasons.

Cl. LUVIC CHERNOZEMS

Luvic Chernozems comprise about one third the total area of Chernozems in Canada. They are mostly found in the western portions of the interior plain in Alberta and Saskatchewan on parent materials of lower carbonate content and on older landscapes than Haplic or Calcic groups. They also occur as subdominant soils associated with Haplic Chernozems. Loamy textures predominate over clayey textures, and coarse sandy soils are relatively inextensive. The majority of the Luvic Chernozems are in undulating areas or in rolling areas with long slopes and few knolls and kettles. Where they occur as subdominant soils associated with Haplic Chernozems, they are mostly found in lower slope positions. Some Luvic Chernozems have E or AE horizons underlain by prismatic structured Bt horizons with hard consistence and blocky secondary structures with coatings. These soils are commonly associated with or intergrade to Mollic Solonetz soils. Significant inclusions of Mollic and Eutric Gleysols are found with Luvic Chernozems but areas of these included soils are not as numerous as those associated with Haplic Chernozems.

Luvic Chernozems are moderately to highly productive. Yields are limited by slight moisture deficiencies, by a tendency to puddle and crust in the surface horizons and by slower rates of permeability in the B horizon, particularly in Solonetz intergrades. Management problems include erosion control and maintenance of good tilth. As with other Chernozems, Luvic Chernozems are dominantly used for field crops but a significant percentage are used for rangeland grazing, particularly adjacent to the Rocky mountain foothills of southwestern Alberta.

C. Chernozems in the United States

Chernozems are not widely distributed in the United States. They are most extensive on gentle and moderate slopes in the north central part of the country; they also occur in small areas distributed through the mountainous landscapes between central Colorado and western Montana. Soil temperature regimes are boreal; soil moisture regimes are humid and subhumid. Underlying materials are commonly of glacial origin, but where slopes are steep, the Chernozems overlie a variety of rocks. Although they are highly productive soils, the short growing season restricts the variety of crops that can be grown. Most Chernozems are used for small grains and forage crops; in a few places, where slopes are steep, they are forested.

Ch. HAPLIC CHERNOZEMS

By far the largest proportion of Chernozems are Haplic Chernozems. These are dominant in the north central part of the United States in an area extending from southwestern Minnesota northwest through central North Dakota and north into Canada. The Haplic Chernozems are on the predominantly gentle and moderate slopes of a glacial plain with many poorly drained depressions in morainic areas and glacial outwash and lacustrine sediments in nearly level areas. By far the most common associated soils are Mollic Gleysols in depressions and level areas. The soil temperature regime of the Haplic Chernozems is boreal; however, the soil moisture regime varies from humid in southwestern Minnesota and northeastern South Dakota to subhumid in the area of lower precipitation in North Dakota. Principal crops are cash grains, mostly wheat, and forage crops. Several small isolated areas of Haplic Chernozems occur at higher elevations in Colorado, Utah and Montana on the residuum and colluvium of a variety of rocks. Except for the area in Colorado, which is similar to that in southwestern Minnesota, the Haplic Chernozems have a drier moisture regime and in many places are more steeply sloping; as a consequence, they are farmed less intensively and are used mostly for grazing, and the steeper areas are forested.

Ck. CALCIC CHERNOZEMS

Calcic Chernozems are inextensive soils. They are distributed in eastern North Dakota and western Minnesota, generally east of the Haplic Chernozems. Like most of the more extensive Haplic Chernozems, the Calcic Chernozems overlie glacial till, have bo-

real temperature regimes and subhumid moisture regimes. Wheat and potatoes are the principal cash crops; some forage crops are raised.

C1. LUVIC CHERNOZEMS

Like the Calcic Chernozems, the Luvic Chernozems are also inextensive, occurring only in small areas in the mountainous parts of Wyoming, Idaho and western Montana. Soil temperature regimes are boreal; soil moisture regimes are humid but distribution of rainfall is such that in some places forage crops are irrigated. In addition to the forage crops, most of the Luvic Chernozems are cultivated to small grains or are grazed.

D. Podzoluvisols in the United States

De. EUTRIC PODZOLUVISOLS

Podzoluvisols are very inextensive in the United States and none occur as dominant soils in Canada. All are Eutric. They are gently sloping soils on calcareous glacial till plains in northeastern Michigan. Soil temperature regimes are boreal and soil moisture regimes are humid. They originally supported stands of mixed forest but most have been cleared for farm use. Although the soils are moderately productive and soil moisture is adequate, the short cool growing season imposes some restrictions on the type of farm enterprise and choice of crops. General farm crops, particularly those in support of livestock, are grown.

E. Rendzinas in Canada

Rendzinas are located in the Manitoba lowland of the interior plain and lie adjacent to the east and west sides of Lake Manitoba in the province of that name. They occur in two areas totalling about 0.15 percent of the area of Canada. The soil climate is cryoboreal subhumid. These Rendzinas are developed on glacial and water-worked till of limestone and granitic rock origin and may have sandy overlays. The till is characteristically highly calcareous with over 40 percent of calcium carbonate equivalent, and is generally very stony. Textures vary from fine sandy loam to clay loam. The areas in which the Rendzinas are found are a part of the lowland that was uncovered by the recession and drainage of glacial Lake Agassiz. The topography is nearly level to very gently sloping and undulating, and drainage is imperfect to poor.

These soils lie within the farming area of Manitoba, but they are not intensively developed. They have moderate to low natural fertility because excessive amounts of free calcium carbonate reduce the availability of soil phosphorus. Indeed, livestock pastured on these soils frequently require a phosphate supplement. Shallowness and stoniness are also limiting factors. A mixed farming economy is practised with the major emphasis centred on livestock production. Land use varies from field cropping to improved pasture and rough grazing, depending on degree of stoniness and drainage. The native vegetation of the area, apart from that which is cultivated, is a parkland with fescue prairie and meadow prairie grasses with associated aspen and bur oak; willows, reeds and sedges form the vegetative association in the more poorly drained portions of the area.

The principal associated soils are Humic and Calcic Gleysols, some of which are slightly saline, and are mainly used for rough grazing or production of native hay.

G. Gleysols in Canada

Gleysols occur throughout all regions of Canada; they are relatively inextensive as the dominant soils of the landscape but commonly occur as poorly drained subdominant associates of other soils. Because of their pattern of distribution and widespread occurrence in much of the undeveloped regions of Canada, accurate estimates of their extent are difficult to obtain, but it is believed that they comprise in total about 8.5 percent of the land area of the country. They are the dominant soil in approximately 2.5 percent, but it is estimated that the remaining 6 percent occur as subdominant associates of other soil units.

Climatically, Gleysols have peraquic, aquic or subaquic soil moisture regimes and soil temperature regimes ranging from arctic to mesic. Thus, they are found associated with most regionally well-drained soils.

The general distribution of Gleysols within the aquic soil moisture regimes varies with local microclimate, topography and land pattern. Most Gleysols in the undeveloped areas beyond the limits of settlement are associated with peraquic or aquic moisture regimes in which saturation occurs for moderate to long periods within the growing season. Absolute length of the growing season varies with temperature regimes, thus these saturation periods are expressed in relative rather than absolute terms. Within settled areas the development of roads, sur-

face drainage ditches and, in many cultivated areas, subsurface tiling has resulted in partial drainage of many formerly very poorly drained areas. Under such conditions, many Gleysols have acquired sub-aquic moisture regimes in which saturation occurs for relatively short periods. In some areas where drainage has been in effect for long periods, Gleysols are developing characteristics and properties intergrading to those of soils having moisture regimes drier than those characteristic of Gleysols.

Gleysols occur on a wide range of parent materials — glacial tills and outwash and lacustrine, marine and alluvial deposits. Extensive areas of Gleysols are found on slowly permeable clay deposits of lacustrine or marine origin, particularly on flats or slightly depressional basins in level to undulating topography. In areas of glacial tills they occur on loamy to clayey resorted materials of lower slopes and enclosed basins, or within kettle depressions occurring on moderately undulating to strongly rolling glacially developed landforms. They are also found locally within pitted outwash and in ice-scoured depressions within the lithosolic complexes of the Canadian shield.

In undisturbed areas within the boreal forest, Gleysols support a hydrophytic vegetation of trees, shrubs, grasses, sedges, reeds and mosses. Forest growth is generally unproductive due to length of freeze period, shortness of growing period, lack of aeration and shallowness to ground water. Their main uses are those associated with wildlife.

In regions with boreal soil temperature regimes, other than those which are forested, the vegetative cover of Gleysols is mostly grasses, sedges and reeds. The more extensive areas are usually drained and then cultivated for forage and coarse grains; locally, Gleysols in depressional areas are used for production of native hay or are maintained as wildfowl habitats.

Where the soil temperature regime is mesic, the utilization of Gleysols for the production of a variety of special crops, including vegetables, has been successfully developed in the St. Lawrence lowlands of Ontario and Quebec and the lower Fraser valley of British Columbia.

The productivity of most Gleysols is moderately high, particularly when desirable conditions of surface and subsurface drainage are maintained. Limitations due to mineral nutrient fertility is generally slight with the exception of a few areas of Dystric Gleysols developed on acidic materials or those of low base saturation. Problems of nitrification under conditions of partial saturation and lack of aeration, together with loss of nitrates through leaching, are moderately severe on all Gleysols, particularly with Eutric and Dystric Gleysols, and to a lesser extent with Mollic and Humic Gleysols.

Management problems common to all Gleysols include control of surface and subsurface drainage, protection against flooding and maintenance of fertility levels. Where Gleysols have a significantly deep cover of peat, adequate packing and surface tillage is necessary where maintenance of peat cover is desired. If it is considered desirable to incorporate the peat layer into the underlying mineral horizons, deeper tillage practices may be necessary. Within the boreal forest, better growth rates could be obtained through controlled drainage in order to lower subsurface water levels. Maintenance of adequate levels of nitrogen is necessary for high productivity.

Gd. DYSTRIC GLEYSOLS

Dystric Gleysols comprise only a very small area. They border Yukon and Alaska, forming part of the undulating to mountainous complex of Gleysols, Cambisols and Gelic Histosols occurring in that area. Information on the distribution of soils is scanty and based on schematic and exploratory studies. The soil temperature regime is subarctic. Underlying materials are generally loamy and derived from glacial till, fluvial deposits, weathered residuum from bedrock, and local alluvium.

Additional areas of Dystric Gleysols occur as subdominant associates of other soils, mostly Podzols but to a lesser extent Albic Luvisols.

Dystric Gleysols are found on acidic or slightly calcareous parent materials. They support a non-productive forest or forest-marsh vegetation and their main use has been for wildlife habitat, except in a few places where they occur in cultivated areas as poorly drained associates of Podzols and Luvisols.

Ge. EUTRIC GLEYSOLS

Eutric Gleysols comprise most of the Gleysol units mapped in Canada; only a relatively small area of these soils occur as subdominant associates of other soils, mainly Luvisols, Cambisols, Histosols, Fluvisols and Lithosols. Extensive areas occur within the Great Slave plain and Slave river lowlands of Alberta and the Northwest Territories and in the Hudson Bay lowland of Ontario, where soil temperature regimes range from subarctic to cryoboreal. Underlying materials are generally loamy to clayey and comprise calcareous lacustrine, alluvial and marine clays or glacial till deposits. The Eutric Gleysols support a relatively unproductive forest or mixed forest-marshland vegetation, and are largely undeveloped and unused except for rough grazing and wildlife activities.

Other areas of Eutric Gleysols occur on calcareous lacustrine and glacial till deposits within and adjacent to the Canadian shield regions of Ontario and Quebec. In these areas of less severe climate, some development of agriculture and commercial forestry has taken place with the agricultural emphasis on coarse grains, forage and pasture. Smaller areas of Eutric Gleysols occur in the river valleys and Rocky mountain trench of the southern plateau regions of British Columbia and have been utilized to a limited extent for forage production and grazing.

Most of the Eutric Gleysols occur on nearly level to undulating topography, particularly where associated with lacustrine or marine deposits, with lesser areas of rolling topography associated with shallow glacial till or clay deposits overlying rolling bedrock surfaces.

Gh. HUMIC GLEYSOLS

Humic Gleysols are of minor extent in Canada. They are the dominant components of associations covering parts of the lower Fraser valley of British Columbia. Others occur as subdominant components of Luvisolic map units within the Canadian shield regions of Ontario and Quebec.

In British Columbia the Humic Gleysols are developed on nearly level to undulating glacial and marine sediments. In many places they have a peaty surface. The soil climate is mesic, humid to subhumid and is modified by maritime influence from the Pacific. The soils of the lower Fraser valley and delta have been extensively developed for a variety of crops; many areas have been improved by drainage, fertility limitations are generally slight and productivity is high. Urban encroachment from greater Vancouver and other towns in the heavily populated Fraser valley is severely limiting the acreage available for efficient crop production. Areas in Ontario and Quebec in which Humic Gleysols are subdominant have been developed to a limited degree for field cropping, forage production and pasture.

Gm. MOLLIC GLEYSOLS

Mollic Gleysols are dominant in soil units covering about 0.4 percent of Canada, with a nearly equal area of them occurring as subdominant associates of a wide range of other soils, including Kastanozems, Chernozems, Greyzems, Luvisols and Eutric Cambisols. They extend across all provinces from Ontario and Quebec westward to British Columbia and the Northwest Territories but are of minor occurrence in the eastern Maritime Provinces. Mollic Gley-

sols have soil temperature regimes varying from subarctic to mesic. Where they are the dominant soils on the landscape, Mollic Gleysols are usually found on nearly level to gently undulating topography on calcareous alluvial, lacustrine or sorted glacial sediments. Where they are the subdominant soils on the landscape they commonly occur in local depression areas or undrained potholes in moderately undulating to rolling topography.

Uncultivated Mollic Gleysols support a vegetation of meadow grasses and sedges and within settled areas these are used for hay production, rough grazing or wildfowl habitat. Where extensive acreages of these soils occur, particularly in mesic or relatively mild boreal soil climates, they are commonly drained and cultivated. Productivity for annual crops and forages is usually high.

Gx. GELIC GLEYSOLS

Gelic Gleysols occur throughout the entire arctic region of northern Canada, including the arctic islands, extending from the Labrador coast to the Yukon-Alaskan border. They are the dominant soils of about 0.4 percent of Canada. They are found in the Northwest Territories and Yukon within the Mackenzie river delta and arctic coastal plains, and also in the Eagle and Old Crow plains in the Porcupine mountains and plateau region. A much greater area of Gelic Gleysols is believed to occur as subdominant associates of the very extensive areas of Gelic Regosols occurring within the Arctic.

These areas support at best a sparse and limited tundra vegetation, and that for a very limited growing season. Such areas are used for wildlife habitat, and for some rough grazing.

Maintenance of vegetative cover for wildlife sustenance and preservation of equilibrium between active and permafrost layers poses important problems in management. The effects of destroying protective surface cover, with consequent deepening of the saturated active layer by thawing of the underlying permafrost, has been shown to have drastic and permanent effects on the natural ecological balance.

G. Gleysols in the United States

In the United States, Gleysols are distributed mostly in the eastern, more humid half of the country from the United States-Canada border south to the Gulf of Mexico and throughout most of Alaska. With the wide range in latitude in which Gleysols

occur, soil temperature regimes vary greatly — from arctic in parts of Alaska to hyperthermic in the southernmost part of Florida. Soil moisture regimes are aquic. Commonly, the Gleysols are level soils except in Alaska where they range from level to steep. Land use varies greatly from region to region, and is determined mainly by climate. For example, the very cold Gleysols of the extreme north support tundra vegetation whereas those in the warm south are in cropland. The management problem common to all Gleysols when used as cropland is water control. Not only does the installation of artificial drainage systems afford a more suitable soil climate for production of a wider spectrum of crops, but in many areas of Gleysols it also lengthens a growing season normally too short for many cash crops. They respond to good fertilization and liming and can produce good yields of adapted crops. In the western United States they must also be irrigated.

Gd and Ge. DYSTRIC AND EUTRIC GLEYSOLS

Dystric Gleysols are the most extensive and widely distributed Gleysols in the United States. They are nearly level and moderately sloping soils on deep alluvial, lacustrine and marine sediments and glacial drift. Because of the wide range of latitude over which these soils occur, soil temperature regimes vary greatly — from the hyperthermic regime of southern Florida to the subarctic regime of the southern half of Alaska. For the same reason, present and potential land use and related management problems also vary greatly from one area to another.

The Dystric Gleysols are most extensive in Alaska, occurring on gently and moderately sloping glacial drift plains and stream valleys throughout most of the central and southwestern parts of the state. Soil temperature regimes are subarctic. In the areas occupied by Dystric Gleysols, permafrost is discontinuous yet relatively extensive in contrast to the areas of Gelic Gleysols farther north in which permafrost is continuous. Most of these Dystric Gleysols are in spruce and birch forest but, despite the low temperatures and very short growing season, some small areas are used for pasture, hay, small grains and hardy vegetables. In northern and eastern Michigan, soil temperature regimes are warmer (boreal), but the Dystric Gleysols are mostly forested although small areas are used for truck crops. In eastern Michigan, adjoining Lake Huron on lacustrine plains, Dystric Gleysols have mesic soil temperature regimes. Because of the warmer temperatures and longer growing season, these soils are farmed more intensively. They are used for cash crops, such as sugar beets and beans. Farther south, in

Missouri and northeastern Arkansas, the Dystric Gleysols are on alluvial sediments. Eutric Gleysols are dominant in the lower Mississippi flood plain. Soil temperature regimes are thermic. The soils in southern Missouri and Arkansas are somewhat more productive and are farmed more intensively. Principal crops are maize, soybeans, cotton and rice. Those in Alabama and Mississippi are mostly forested and small areas are used for grazing. In southern Florida the Dystric Gleysols are on marine sands. These are among the less productive of the Dystric Gleysols. The groundwater table is high and much of the area is swamp forest and marshland. Only a small area has been drained for use as cropland for production of vegetables.

Gh. HUMIC GLEYSOLS

Humic Gleysols occur only on the seaward edge of the coastal plain of Georgia and South Carolina. They are nearly level soils on sandy marine sediments. Soil temperature regimes are thermic. These soils support a mixed forest although small areas are in grass and afford some grazing. Because they are low-lying and in many places have high water tables and are therefore difficult to drain, these soils have little present potential for farm use. Principal associated soils are Dystric Gleysols on the slightly higher lying areas. Thionic Fluvisols and Histosols are inclusions.

Gm. MOLLIC GLEYSOLS

Mollic Gleysols are not widely distributed in the United States. They are most extensive on nearly level lacustrine and glacial till plains in western Minnesota and eastern North Dakota. Soil temperature regimes are boreal. Water management would be required to remove excess water as early as possible in spring (March through June) to permit farming operations to begin as soon as temperatures permit. Much of the area of the Mollic Gleysols is used for cultivated cash crops, such as spring wheat, potatoes and sugar beets. Principal associated soils are Histosols in lower lying wetter areas and Chernozems on the higher lying drier areas.

The Mollic Gleysols also occur in small areas in southern Oregon. In most respects they are like those in Minnesota and North Dakota; however, they occur on alluvial sediments as well as on lacustrine sediments, and some have mesic rather than boreal soil temperature regimes. Good management would include irrigation, as well as drainage, to compensate for the low rainfall during the grow-

ing season. Most of these Mollic Gleysols are used to support raising of livestock. Small grains, hay, and forage and seed crops are grown.

Gx. GELIC GLEYSOLS

The Gelic Gleysols are extensive in the northern half of Alaska on the coastal plains and deltas bordering the Arctic Ocean and the Bering Sea, on interior lowlands and on hills and mountain footslopes. Most are gently and moderately sloping soils on glacial drift, although some are on the weathered residuum of a variety of rocks. Cambisols, Regosols and Histosols, all Gelic, are common associated soils. Soil temperature regimes are arctic and subarctic and permafrost is nearly continuous. Most of the Gelic Gleysols are in tundra; those south of the Brooks range are in unproductive forest.

H. Phaeozems in the United States

Phaeozems are moderately extensive in the United States but do not occur in Canada. They are distributed over dissected loess and glacial drift plains in the upper part of the Mississippi valley southwest of the Great Lakes, on the broad flood plain of the Mississippi river, the coastal plains of Texas and Louisiana and on the perimeter of the broad intermontane basin west of the Rocky mountains. Soil temperature regimes are mostly mesic and thermic although at higher elevations some are boreal; soil moisture regimes are mainly humid although xeric regimes occur in the northwestern part of the country. Phaeozems are highly productive soils with moisture adequate for crops in most years. For the majority, good management involves the maintenance of productive capacity with fertilization and prevention of erosion. Where these soils are somewhat poorly drained water management is required, and where moisture is seasonally deficient dry-land agriculture and irrigation are practised.

Hg. GLEYIC PHAEOZEMS

Gleyic Phaeozems are the wet soils of the flood plain along the upper reaches of the Mississippi river and the coastal plain of eastern Texas and southwestern Louisiana. Most are in slack water areas some distance from the rivers. Soil temperature regimes are thermic along the coast of the Gulf of Mexico, but are mesic elsewhere. Soil moisture regimes are aquic. Water management is a problem on these soils; drainage is difficult because of the

fine texture of the soils and their low position on the flood plain. Flooding is common during periods of high stream levels. The soils are used for cash crops such as maize and soybeans and for feed grains and hay for livestock. Along the Texas and Louisiana coasts, the Gleyic Phaeozems are not as intensively managed for crops, although in some places these soils are being used to produce rice and sugarcane; most are used for grazing. Common associates of the Gleyic Phaeozems are better drained, somewhat higher lying soils such as Haplic Phaeozems, Fluvisols, Luvisols, and Regosols.

Hh. HAPLIC PHAEOZEMS

Haplic Phaeozems are somewhat less extensive than the Luvic Phaeozems. Most are on nearly level and gently sloping loess or till plains, although in central Kansas, northwestern Louisiana and southwestern Arkansas they are on nearly level alluvial deposits; in eastern Kansas and Oklahoma and in western California they occur on sedimentary and igneous rocks. Soil temperature regimes are mostly mesic but in Louisiana, Arkansas and California they are thermic; soil moisture regimes are humid or subhumid except in western California where they are xeric. Most of the Haplic Phaeozems are used for production of maize, soybeans, small grains, forage crops and, in the southern part of the country, cotton and sugarcane. Where the underlying materials are sedimentary and igneous rocks, the slopes moderate or steep and the soils less deep, the Haplic Phaeozems mainly support native grasses which afford some grazing. Common associated soils are Luvic Phaeozems.

Hi. LUVIC PHAEOZEMS

Of the Phaeozems, the Luvic Phaeozems are by far the most extensive. They occur most extensively on the gentle and moderate slopes of the predominantly loess-covered glacial till plains in Illinois, Missouri, Iowa and the eastern parts of Kansas and Nebraska. Except in south central Kansas where they are thermic, soil temperature regimes are mesic; soil moisture regimes are humid or subhumid. The Luvic Phaeozems are among the more highly productive grain-producing soils in the United States. Maize, soybeans and other feed grains are grown extensively on these soils. Luvic Phaeozems of similar productive potential also occur on dissected shale and sandstone hills in southeastern Kansas and southeastern Oklahoma. Poorly drained soils — many with mollic surface horizons, mainly Mollic Gleysols and Mollic Planosols — and Gleyic Phaeozems are common associates of Luvic Phaeozems in this part of the country.

In areas of Utah, Oregon and Washington, Luvic Phaeozems occur on gentle to steep slopes of a dissected plateau comprising igneous and some metamorphic and sedimentary rocks. In this part of the country most of these soils have mesic soil temperature regimes, although at the higher elevations some have boreal soil temperature regimes. Soil moisture regimes are xeric, much drier than for similar soils farther east. With the drier and somewhat cooler soil climate, most of these Luvic Phaeozems are used for grazing of the native grasses, forbs and shrubs they support. However, in valleys, where water is available for irrigation for summer crops, they are used for production of cash crops, such as small grains, peas, tree fruits and vegetables.

I. Lithosols in Canada

Lithosols range from very thin regosolic soils overlying smooth, fissured or fractured bedrock to bedrock surfaces almost devoid of any soil cover whatsoever. Nearly 40 percent of the land area of Canada is significantly affected by proximity of bedrock to the surface of the ground. Lithosols are the dominant soils on the landscape in slightly more than one third of this large portion of the country; they are subdominant associates of other soils in the remaining two thirds. These very shallow soils are significant in all provinces and territories except Prince Edward Island.

Lithosols commonly have as their associates Podzols, Regosols and Cambisols and, to a lesser extent, Luvisols, Gleysols and Histosols. The characteristics of the associated soils are generally determined by the type and depth of unconsolidated material overlying the bedrock formations. Where depth of surficial materials is greater than 10 cm but bedrock contact lies within 50 cm of the surface, the associated soils are considered to be lithic phases.

Significant areas of icefields and mountain glaciers are common to areas of Lithosols occurring within the subalpine regions of the Cordilleran mountains, and are very extensive in the arctic highlands of Baffin and Ellesmere islands.

Geographically, Lithosols are most extensive in the vast expanse of the Precambrian shield dominated by granites and gneisses. They also occur in large areas of the younger stratified rocks forming the discontinuous ring of mountains and plateaus composing the borderland region surrounding the shield. These borderland rock areas include: (1) to the west, the three great belts of folded sedimentary, volcanic and plutonic rocks of the Cordilleran system, (2) to the north, the flat-lying sedimentary rocks of

the arctic lowlands, and (3) in the extreme northeast, the deformed and folded sedimentary rocks forming the mountains and plains of the islands in the Innuitian region. Lithosols are less commonly found in the uplands of the Appalachian region, and in the St. Lawrence lowland region they are uncommon except for narrow tracts of nearly bare limestone bordering the Canadian shield and along the ridge of the Niagara escarpment. In the interior plains region, where sedimentary rocks have been extensively modified and mantled by incorporation and deposition of glacial drift, very few areas of Lithosols or rock outcrops occur except in the Manitoba lowland where local limestone bedrock is exposed or is thinly mantled by glacial drift and lacustrine sediments.

Climatically, the major areas of Lithosols have arctic and subarctic temperature regimes with less extensive areas having cryoboreal and boreal temperature regimes. Soil moisture regimes are dominantly humid or perhumid on upland slopes. But because of shallowness of soil over bedrock and disruption of regional drainage patterns by glaciation, many lakes, ponds and swamp areas occur in lower slopes or basin positions, giving rise locally to aquatic moisture regimes. Complexes of soil climates of this nature are particularly common in the Canadian shield.

The nature of the parent materials of the Lithosols is largely determined by the characteristics of the bedrock. Much of the shallow regolith is coarse textured and of either local or glacial origin. The remainder is finer textured and is the result of sedimentation in postglacial lakes and areas of marine submergence.

Lithosols are largely unproductive for forestry and unsuitable for agriculture because of their shallowness to consolidated bedrock. The large majority of these soils in Canada have arctic and subarctic temperature regimes which impose an additional and compelling limitation on these uses. Most areas are therefore used for wildlife activities, including hunting, trapping and fishing; summer and winter recreational activities are becoming increasingly important in specific areas. Recreational activities are well developed in the mountains of the southern and western Cordilleran region in Alberta and British Columbia and within the borders of the Canadian shield in Saskatchewan, Manitoba, Ontario and Quebec, where ready access is available from urban centres. A number of national and provincial parks have been established within these areas.

Where Lithosols are the subdominant associates of other soils, they usually occur as local outcroppings in the general landscape, and the associated soils are commonly thin, stony or strewn with boulders. Such lithic and stony phases are severely limited in

potential for agricultural development, productive tree growth and commercial forestry operations.

In a few areas, associated arable soils with boreal or cryoboreal temperature regimes have been developed to a limited extent for farming but productivity is generally low and farm operations marginal.

Management problems over much of the lithosolic areas are largely those involved with protection and maintenance of the native vegetation and ecological balance. Fire protection is essential, but frequently difficult to maintain over large areas of relatively inaccessible terrain.

I. Lithosols in the United States

In the United States, Lithosols are dominant soils only on mountains and steep slopes in Alaska. They are distributed throughout the state, from the northern slopes of the Brooks range in the north to the western part of the Canadian Cordilleran region in the southeast. Soil temperature regimes are arctic and subarctic; soil moisture regimes are humid and subhumid. Vegetation on these very thin soils is mostly sedge tundra in the northern part of the state and at the higher elevations toward the south; it is tundra and alpine meadow in the remainder of the area of Lithosols. Barren areas, bedrock devoid of any soil cover, glaciers and permanent snowfields are common on the mountains of southern and southeastern Alaska.

Associated with the Lithosols on less steeply sloping areas and at lower elevations are Regosols and Cambisols. These deeper soils support a vegetative cover of spruce and birch forests, as well as some tundra and alpine meadow. Inasmuch as mean annual soil temperatures are lower than 0°C throughout the area of this soil association, permafrost is common. In northern Alaska on the slopes of the Brooks range and the plains north of the mountains, permafrost is nearly continuous. Elsewhere in Alaska among the Lithosols and associated Regosols and Cambisols, permafrost is discontinuous. Its presence or absence is dependent upon the depth of soil, amount of insulating vegetation or organic cover, aspect and elevation. The extreme shallowness of the Lithosols, their common occurrence on steep slopes, and in many places the cold soil temperature regime, all preclude their use for any purpose other than the poor grazing afforded in places by tundra vegetation and grasses of alpine meadows.

Elsewhere in the United States, Lithosols are subdominant soils. They are associated with Luvisols in the mountainous parts of Wyoming, Colorado and New Mexico, commonly occurring on the steepest slopes and mountain peaks. Lithosols are also widely distributed in small areas among the ridges and

valleys of the mountains in other parts of the western United States and in the low mountains and steep hills in the eastern part of the country.

J. Fluvisols in Canada

Fluvisols occur within the alluvial flood plains of a large number of rivers in Canada. Their extent is difficult to estimate as many are confined to narrow strips adjacent to river channels, many occur in areas where only fragmentary information is available and very few are extensive enough to be shown at the scale of the soil map. Eutric Fluvisols comprise three of the larger flood plain areas within the Slave and Mackenzie river systems. Dystric Fluvisols occur inextensively in the tidal marshlands adjacent to the Bay of Fundy in the Maritime Provinces. The remaining Fluvisols, slightly less than half of those occurring in Canada, occur as associates of other soils, mainly Cambisols, Gleysols, Regosols and Histosols.

Fluvisols have soil temperature regimes ranging from the arctic regime in the Mackenzie delta and the subarctic regime in the Mackenzie and Yukon valleys, to the cryoboreal and boreal regimes in the Peace and Saskatchewan river valleys. Soil moisture regimes range from perhumid to semiarid. Many Fluvisols are subject to periodic flooding for limited periods.

Parent materials are typical of alluvial deposits. They are noncalcareous to moderately calcareous and vary in texture from fine sandy loams to clays depending on local river conditions. The tidal marshland deposits along the Bay of Fundy are mostly clayey and acid in reaction. Topography is generally level to very gently undulating in all Fluvisol areas.

Land use varies with local climate and with flooding conditions. In the Mackenzie delta, the combination of arctic soil temperatures and frequency of spring flooding tends to limit land use to wildlife habitat. Fluvisols with subarctic soil temperatures are similarly used except for some grazing, although, locally, timber is cut commercially.

Where Fluvisols are being used for agriculture, management problems involve protection against flooding and maintenance of adequate drainage. Fertility is rarely a significant limitation on the Eutric Fluvisols, but more intensive use of Dystric Fluvisols is limited by high acidity and relatively low levels of fertility. On the deltas of the Saskatchewan and Slave rivers, the potential exists for development of an agricultural economy based on improved pasture and grazing with supplemental cropping, but these areas are mainly being preserved as wildlife habitats. Extensive drainage and pro-

tection from flooding of Dystric Fluvisols of the tidal marshlands of New Brunswick have been undertaken for many years, but the area has been only partially developed for farm use. Schemes for multipurpose use, including protection of wildfowl areas, are being organized.

Within the Saskatchewan and Qu'Appelle valleys in Saskatchewan where soil moisture regimes are semiarid to subhumid, Fluvisols are used for cultivated crops, improved pasture and grazing; where possible, irrigation from the rivers has been used to supplement soil moisture deficits and increase production. Similar development has taken place in some areas of the Peace river valley in northern Alberta and British Columbia.

J. Fluvisols in the United States

In the United States, Fluvisols are not extensive as dominant soils on the landscape and are distributed in a few discrete areas in Utah, Nevada and California. However, Fluvisols are widely distributed throughout the country in areas too small to show at the scale of the accompanying map. They are associates of many soils and are an important part of the landscape of virtually every delineation on the soil map. They are situated on the level and very gently sloping floors of valleys and basins among intervening mountain ridges. Underlying materials consist of alluvial deposits on flood plains, alluvial fans and terraces, and lacustrine sediments in old lake beds. Soil temperature regimes are mesic, thermic and hyperthermic; soil moisture regimes are arid and xeric. Productivity of these Fluvisols is limited by lack of moisture; it is greatly enhanced by irrigation but the possible effect of accumulation of salts requires careful management. Where a fluctuating groundwater table is present, salts accumulate in large quantities and Solonchaks are the principal associated soils.

Jc. CALCARIC FLUVISOLS

Slightly more than half of the total area of Fluvisols in the United States are Calcaric Fluvisols distributed in small areas in eastern Utah, western Nevada and southern California. Those in Utah and Nevada are mostly in broad basins bounded by north-south oriented mountain ridges. Elevations are generally above 670 m in Nevada and 1 675 m in Utah, and consequently soil temperature regimes are mesic. The Calcaric Fluvisols support desert shrubs and grass, much of which is grazed; near streams affording an adequate supply of water, hay, small grains and pasture grasses are grown under irrigation,

as well as cash crops such as sugar beets. In contrast to the Calcaric Fluvisols in Nevada and Utah, those in southern California are at elevations near sea level; consequently they have hyperthermic soil temperature regimes. They are intensively managed for production of irrigated cash crops such as cotton, truck crops, citrus, hay and small grains, with only a small proportion of the land being used for grazing.

Je. EUTRIC FLUVISOLS

Eutric Fluvisols are the dominant soils in the lower lying part of the Central valley of California. Elevations are less than 165 m and soil temperature regimes are thermic. Like the Calcaric Fluvisols of southern California, the Eutric Fluvisols in the central part of the state are intensively managed for production of irrigated cash crops such as citrus fruits, nuts, truck crops, cotton, maize and rice as well as hay and forage crops. On the higher lying terraces and inextensive gentle foot slopes, Chromic Luvisols are the principal associated soils.

K. Kastanozems in Canada

In Canada, Kastanozems are the dominant soil in approximately 2.4 percent of the land area. In addition, small areas of these soils occur as subdominant associates of other soils, particularly Solonetz and Chernozems, and to a lesser degree of Gleysols, Regosols and Solonchaks.

The majority of the Kastanozems occur in the southern portion of the provinces of Saskatchewan and Alberta, extending in a broad arc from the international boundary bordering the states of North Dakota and Montana to an apex about 432 km northward on the Saskatchewan-Alberta border. This broad area corresponds very closely to the areas of boreal and cryoboreal semiarid to subarid soil climate regimes and ecologically to the short grass and mixed prairie grasslands of the interior plains. Smaller areas of Kastanozems occur in the southern plateau regions of the British Columbia interior, specifically in the dry valleys and on unshaded slopes adjacent to the Thompson, Fraser and Okanagan river systems.

The Kastanozems are developed mainly on glacial till, glaciofluvial, and lacustrine deposits but also occur on aeolian, alluvial and colluvial materials. Most deposits are weakly to moderately calcareous and dominantly loamy in texture, but with significant occurrences of sandy and clayey areas. The clayey soils are generally associated with glacial lacustrine deposits and level to moderately undulating lake

basins. Medium-textured soils occur on undulating or rolling glacial deposits, with some areas thinly mantled by alluvial, lacustrine or loessial deposits. Sandy-textured Kastanozems are generally associated with alluvial, lacustrine, glaciofluvial or aeolian undulating to rolling plains.

Nearly half the Kastanozems have boreal sub-arid climate regimes. Under virgin conditions they support a somewhat sparse growth of xerophytic to mesophytic grasses and forbs, commonly referred to as the short grass section of the mixed prairie. They have a somewhat thinner A horizon containing slightly less organic matter and are lighter in colour than the Kastanozems, which have more moist soil moisture regimes. These are highly fertile soils but under cultivation productivity is limited by severe moisture deficits during the growing season and the probability of occurrence of severe droughts in some years. Less than half of these lighter coloured soils are cultivated; generally they are the finer textured loams.

The remainder of the Kastanozems have boreal and cryoboreal semiarid soil climate regimes. These are darker soils in which the A horizons are usually thicker, have lower dry colour values (less than 4.5 Munsell) and higher percentages of organic matter than the Kastanozems of the drier areas. They support a moderate growth of mesophytic grasses and forbs. The probability of droughts or serious moisture deficits occurring during the growing season is less for these darker Kastanozems; this is reflected in somewhat more intensive land use and higher yields. About 70 percent of these darker brown soils are cultivated; most have loam, clay or fine sandy loam texture.

Kastanozem soils in Canada are used almost exclusively for farm enterprises, ranging from field cropping, mainly for wheat and other small grains, to livestock economy based on utilization of improved pasture or grazing of native rangeland. Availability of moisture for plant growth is a dominant consideration, and the proportion of cropland to pasture varies with the soil moisture regimes, the moisture-holding capacity of the various textural types and the effects of local topography.

Within the provinces of Saskatchewan and Alberta, grain production is the dominant land use, accounting for 60 percent of the cultivated area. Much of this is farmed under a two- or three-year rotation of grain and summer fallow except where irrigation has made possible a greater diversification of crops. The remainder of these soils are used for cattle production on improved pasture or range.

In British Columbia, the major use of Kastanozems is for cattle grazing, except for about 100 000 ha of fine- and medium-textured terraces and lacustrine

bottom lands adjacent to river valleys, which are used for irrigated fruit growing and mixed farming.

The inherent productivity of Kastanozems is relatively high, but is significantly limited by the availability of moisture for plant growth. Where moisture is adequate, the soils respond to moderate applications of phosphorus and nitrogen. Under irrigation and intensive cropping heavier applications of fertilizers are usually required for maximum yields. Potassium is rarely a limiting factor. Sandy soils may be more limited than loamy or clayey soils in available nutrients. Very few coarse-textured soils of lower moisture-holding capacities are cropped on a sustained basis and yields are erratic. A large amount of marginally arable land brought under cultivation during the early days of agricultural settlement has been abandoned progressively following successive periods of disastrous droughts, which are frequently accompanied by severe wind erosion. Most of these areas have either reverted to natural rangeland or have been sown to permanent pasture. Many such areas are now successfully utilized and managed as community pastures.

Management problems involve careful and timely tillage to conserve moisture and prevent wind erosion, particularly following early autumn or spring cultivation and during summer fallow periods. Control of weed growth and maintenance of trash cover are important factors in such operations. Problems of adequate drainage and control of salinity are specific management problems on irrigated lands.

Kh and Kl. HAPLIC AND LUVIC KASTANOZEMS

Approximately 65 percent of the Kastanozem map units in Canada are dominantly Haplic, and the remainder are Luvic. Association of these types within many map units is common, and the differences between them is seldom distinct. Although there are no dominantly Calcic soil units, all three kinds of Kastanozems can be found in catenary association, particularly in moderately undulating to rolling glacial topography. Where such patterns occur, the Haplic soils usually occupy mid- and upper slope positions with Luvic soils on lower slopes. Minor inclusions of Calcic Kastanozems occur in upper slope or knoll positions. The proportion of Luvic to Haplic Kastanozems increases where the parent materials are low in carbonates, or are moderately alkaline. Under such conditions the dominant Luvic Kastanozems intergrade to, or are associated with, solonetzic or solodic soils. Where associated with solonetzic soils, the Luvic Kastanozems exhibit compactness or poor permeability resulting from the structural characteristics of the B horizons.

In contrast, the Haplic Kastanozems characterized by cloddy or granular structures are somewhat limited in capability by thin A or B horizons and shallowness to subsoil horizons with excessive amounts of carbonates, gypsum or soluble salts. Most Kastanozems developed on fine-textured calcareous clays are Haplic, frequently lacking well developed B horizons and often showing properties of shrinking, swelling and surface granulation characteristic of soils intergrading in properties to Vertisols. Because of their relatively high moisture-holding capacity these clay soils are frequently the most productive of the Kastanozems for the growth of small grains.

K. Kastanozems in the United States

In the United States, Kastanozems are among the most extensive soils. They are distributed from the international border south to southernmost Texas and from approximately the 95° meridian west to central Washington and Oregon. With such broad distribution over wide ranges in latitude as well as in elevation, soil climate varies greatly. Soil temperature regimes are boreal, mesic, thermic and hyperthermic, and soil moisture regimes are subhumid, semiarid, subarid and xeric. Underlying materials are also variable; however, calcareous sedimentary rocks, limestone, sandstone and shale underlie most of the Kastanozems. Metamorphic and igneous rocks are not uncommon, particularly in the mountainous and more severely dissected landscapes in the western half of the area in which the Kastanozems occur. In places the Kastanozems are underlain by deep unconsolidated materials — calcareous glacial drift in parts of Montana, North and South Dakota, Nebraska and Kansas; loess in Nebraska, Kansas, northern Texas and southwest Oklahoma; and by alluvial sediments throughout the area of Kastanozems. Kastanozems commonly have severe shortages of moisture affecting crop production to varying degrees. Most are used for small grains under a system of dry-land farming; the remainder are irrigated or are used for grazing. The Kastanozems generally are potentially highly productive soils, but require good management to maintain nitrogen levels and to take advantage of periods when moisture levels are high.

Kh. HAPLIC KASTANOZEMS

Like the Luvic Kastanozems, the Haplic Kastanozems are widely distributed throughout the western half of the United States but are much less extensive. East of the Rocky mountains they are on the gentle slopes of interfluves on dissected plains underlain

by calcareous sedimentary rocks, mostly limestone and shale; on the western periphery of the Rocky mountains they are on the gentle and moderate slopes of intermontane basins. Soil temperature regimes range from boreal in the northern and northwestern part of the country to hyperthermic in southern Texas. Soil moisture regimes are mostly subhumid and semiarid east of the Rocky mountains and xeric on the western periphery and intermontane basins. Most of the Haplic Kastanozems support native grasses, forbs and shrubs which afford some grazing for livestock. They are used in many places for production of winter wheat. In the intermontane valleys and basins where water is available for irrigation, forage crops, small grains and truck crops are grown; in southern Texas, cotton and citrus fruits are grown under irrigation. Luvic Kastanozems and Eutric Regosols are common associates of the Haplic Kastanozems.

Kk. CALCIC KASTANOZEMS

Calcic Kastanozems are of very limited distribution and extent. They occur mostly on deposits of loess in northern Texas, western Oklahoma and southern Kansas, and on calcareous sedimentary rocks, including marl, in northeastern and southeastern New Mexico and southern Texas. Soil temperature regimes are thermic and soil moisture regimes are subhumid, except in northeastern New Mexico where soil temperature regimes are mesic and soil moisture regimes are semiarid. In New Mexico and southern Texas, the soils are shallow. The potential of these soils for crop production is limited not only by shallowness but also by a seasonal shortage of moisture. They are used mainly for grazing and only where the soils are deeper are they used for production of wheat and sorghum. Associated soils are mostly Luvic and Haplic Kastanozems, although Vertisols are associated with the Calcic Kastanozems in southern Texas.

Kl. LUVIC KASTANOZEMS

Luvic Kastanozems are by far the most extensive of the Kastanozems in the United States. Distribution of these soils is essentially the same as that of the entire group of Kastanozems. Soil temperature and moisture regimes are the same except that there are no Luvic Kastanozems with a hyperthermic soil temperature regime. On the plains and hills east of the Rocky mountains, Luvic Kastanozems have developed on predominantly calcareous sedimentary rocks; in parts of Montana, North and South Dakota, Nebraska, Kansas and Oklahoma on calcareous glacial drift; and throughout the general area on

alluvial sediments from these materials. Most of these soils are used for production of wheat and other small grains. In north central Kansas, south central Nebraska, eastern South Dakota, northern Montana and eastern Colorado water is available for irrigating crops such as maize, sorghum and hay. The remainder of the Luvic Kastanozems east of the Rocky mountains support native grasses, forbs and shrubs and are used for grazing.

In intermontane valleys and basins of the Rocky mountains, Luvic Kastanozems have boreal and mesic soil temperature regimes. Soil moisture regimes are xeric except in the mountainous regions of Arizona and New Mexico where they are semi-arid. Some produce wheat, but because of the scarcity of rainfall other Luvic Kastanozems support a relatively sparse cover of native grasses, forbs and shrubs which afford limited grazing. In some valleys where water is available from larger streams, small grains, sorghum, hay and some vegetables and fruit crops are grown. Regosols, Chernozems and, in the drier climates, Solonetz and Yermosols are common associates of the Luvic Kastanozems.

L. Luvisols in Canada

Luvisols are distributed through the forested areas of Canada and are the dominant components of soil units in about 8.6 percent of the country. Additional small areas of Luvisols occur as subdominant components of other soil units. Most common associates are other forest soils, Histosols, Cambisols and Podzols, but in areas of forest-grassland transition Greyzems and Gleysols are common associates of the Luvisols.

La. ALBIC LUVISOLS

All Luvisols in Canada have been broadly identified as Albic Luvisols; however, variations in luvisolic profiles in Canada suggest that, in the future, identification and mapping of other luvisolic groups will be feasible, including the probability of the occurrence of Podzoluvisols in some areas.

The Albic Luvisols have soil climate regimes ranging from the mesic humid regime of those occupying part of the St. Lawrence lowland of Ontario and Quebec, to the cooler boreal, cryoboreal and subarctic regimes of extensive areas of Albic Luvisols extending from coast to coast across Canada. Approximately 75 percent of these soils occur under relatively cold cryoboreal predominantly humid regimes, although the range in moisture regimes is perhumid to subhumid; nearly 20 percent occur in areas with very cold subarctic temperature regimes;

the remainder have developed under a cool boreal humid regime.

In Canada the Albic Luvisols are developed mainly on glacial till, glaciofluvial or glaciolacustrine deposits, with some occurring on a variety of post-glacial sediments. Most are weakly to moderately calcareous and have a high base status, although some are on weakly acidic or noncalcareous materials with a more moderate degree of base saturation. Loam textures dominate but significant areas of clayey and sandy loam Luvisols occur. The striking morphological characteristics of eluviated E and argillic B horizons are usually most strongly expressed in the medium-textured soils and to a lesser extent in clayey soils. They are weakly expressed in the coarser sandy soils which tend to intergrade in characteristics to Cambisols or Podzols.

The Albic Luvisols are found mainly on undulating and rolling topography with a few areas occurring on mountain slopes. In rolling and sloping phases they are usually developed on upper and midslope positions with gleyic phases occurring in lower slopes and associated Histosols or Histic Gleysols occupying the undrained low-lying wet positions.

Major land uses of Luvisols in Canada are determined primarily by soil climate and by local characteristics of topography and parent material tempered by economic considerations and geographic location.

Under subarctic soil temperature regimes, the natural forest growth on Albic Luvisols is unproductive except in locally protected sites, and climatic conditions are not considered suitable for major agricultural development. The principal use of such soils is therefore largely associated with maintenance of wildlife activities.

Under mesic, boreal or cryoboreal soil temperature regimes, most Albic Luvisols are naturally suited to the sustained growth of productive forest vegetation. Commercial forestry is a prime land use in many areas, particularly where soil temperature regimes are cryoboreal and boreal. Where topography and parent materials are favourable, agricultural development of Albic Luvisols provides a viable alternative to forestry. Under these conditions, farm enterprises vary from the production of a wide variety of annual crops, where soil temperature regimes are mesic, to limited production of coarse grains and forage crops or to the development of improved or bush pasture in the areas of cryoboreal temperature regimes.

In the St. Lawrence lowlands, where the Luvisols have mesic temperature regimes, these soils originally supported extensive stands of productive hardwood but they are now largely cleared and are intensively cultivated. Fertility limitations are slight to moderate with most soils responding to moderate appli-

cations of phosphates and in some areas of potassium; sustained liming is not usually a necessary practice. Limitations are generally greater on sandy soils and annual applications of nitrogen are usually required for maintenance of yields. Management problems involve prevention of erosion on sloping lands and maintenance of adequate surface drainage on finer textured soils. Stoniness or shallowness to bedrock are handicaps in local areas. Minor areas of the less productive soils and areas with rough rolling topography remain in natural wood lots or are being reforested. Urban encroachment in that portion of the St. Lawrence lowland bordering Lake Erie and Lake Ontario imposes a serious limitation on the efficient use of the soils for farming.

In the areas with boreal and cryoboreal temperature regimes the greater proportion of the Albic Luvisols supports stands of mixed or coniferous forest and a variable intensity of commercial forest development, including lumbering and pulpwood enterprises. Despite limitations of increasingly cool temperature and short seasons, development for farming has been extended significantly into these forested areas wherever topographic and physical conditions are favourable to crop production, and where accessibility to transportation and markets can be economically maintained. This development has been largely oriented toward production of coarse grains, forage and pasture, and has been most pronounced in the maritime provinces of New Brunswick and Nova Scotia, the clay belt areas of the Canadian shield in Ontario and Quebec and, to the greatest extent, in the interior plains region of Manitoba, Saskatchewan, Alberta and northeastern British Columbia. Smaller areas of Albic Luvisols have been developed for farming in the Fraser basin and interior plateau division of the interior Cordilleran region of British Columbia.

These cooler Albic Luvisols have greater limitations with respect to physical and fertility characteristics than their counterparts in the St. Lawrence lowlands. The more pronounced development of eluviated E horizons of these soils has resulted in cultivated surface horizons with less organic matter, poorer physical structure, lower initial fertility levels and usually greater acidity. Heavier applications of nitrogen and phosphorus are required for satisfactory yields and are invariably reflected in increased production for most crops. Applications of sulfur have been shown to be beneficial on many of these soils in western Canada. Significant responses have been obtained from application of lime on soils with highly acidic surface horizons. Potassium is not generally a limiting factor except on specific local types.

Physically, many of these Albic Luvisols have surface horizons with cultivated clods of low porosity

lacking a well-developed granular structure. On wetting they tend to become unstable, and to puddle and flow, thus accentuating problems of water erosion. On drying, the surface tends to cake and form a crust with low porosity. Such conditions hinder emergence of seedlings, increase runoff and reduce aeration. The surface horizons are also subject to poor drainage above the argillic B horizons, which are frequently characterized by slow permeability.

L. Luvisols in the United States

Luvisols are extensive in the United States and comprise large areas widely distributed across the country. Most are gently and moderately sloping soils on unconsolidated materials. South and southwest of the Great Lakes and along the Mississippi river, the underlying materials are glacial drift and loess. In Texas and California, and in small basins and valleys, mainly in Kentucky, Tennessee, Maryland and Pennsylvania, they are on alluvial sediments and some sedimentary rocks. In the mountainous areas extending from northern New Mexico to northern Idaho, Luvisols commonly are steeply sloping soils on a variety of sedimentary, igneous and metamorphic rocks. A wide range of soil climate results from such broad distribution. Soil temperature regimes range from boreal in the northern latitudes and at high elevations to hyperthermic at the more southern latitudes and at lower elevations. Soil moisture regimes are dominantly humid but subarid, xeric and aquic regimes occur in some places. Luvisols are inherently productive soils when under good management. Short, cool growing seasons in the north and at high elevations, steep slopes in mountainous areas, and a shortage of moisture in the dry climate in the western and southwestern parts of the country impose restrictions on land use and choice of crops to be grown.

La. ALBIC LUVISOLS

Albic Luvisols are widely distributed from northern New Mexico to the Canadian border. They are the steeply sloping soils of much of the Rocky mountains. Underlying materials are a variety of sedimentary, igneous and metamorphic rocks, although some of these soils are on glacial drift. Albic Luvisols are also gently and moderately sloping soils on glacial drift plains on the periphery of Lake Superior. At the relatively high elevations and more northerly latitudes at which Albic Luvisols occur, soil temperature regimes are boreal; soil moisture regimes are humid except at lower elevations in western South Dakota and eastern Wyoming where they are sub-

humid, and at lower elevations on the west of the mountains adjoining the flanking plateaus where some are subarid. Most of the Albic Luvisols support coniferous forest and a variety of grasses, forbs and shrubs. On the gentle and moderate slopes of valleys, small grains and forage crops are grown, commonly under irrigation. The Albic Luvisols in the vicinity of Lake Superior are also forested, but some general farm crops are produced, mostly in support of livestock. Common associated soils are Podzols, Lithosols, and in the vicinity of Lake Superior, Gleysols and Histosols.

Lc. CHROMIC LUVISOLS

Chromic Luvisols occur in widely separated parts of the United States. In California they are level to steeply sloping soils on coalescing alluvial fans and adjoining mountain footslopes in the broad valleys of the Sacramento and San Joaquin rivers. They are extensive on the nearly level to moderate slopes of the gently dissected plains of central and southern Texas. They also occur inextensively in the widely distributed basins and valleys in Kentucky, Tennessee, Virginia, Maryland and Pennsylvania. Soil climate ranges from area to area: in California thermic soil temperature and xeric soil moisture regimes are dominant; in Texas thermic and hyperthermic soil temperature and subhumid soil moisture regimes prevail and in the northeast basins mesic (thermic in Tennessee) soil temperature and humid soil moisture regimes are dominant. Most of the Chromic Luvisols support grasses and shrubs which afford grazing. In California some of these soils are irrigated and are used for small grains, forage crops, fruit and nut orchards, and truck crops; in Texas irrigated cotton and sorghum are grown; in the northeast the steeper slopes are forested and the remainder used for grain and forage crops in support of livestock and for cash crops such as tobacco, fruit, maize and vegetables. In California common associated soils are Eutric Regosols; in Texas there are Luvic and Haplic Kastanozems, and in the widely distributed basins and valleys in the northeastern part of the country Orthic Acrisols and Eutric Cambisols are found.

Lg. GLEYIC LUVISOLS

Gleyic Luvisols are the least extensive of the Luvisols. They are nearly level soils on lacustrine sediments in northern Ohio and southeastern Michigan, on sandy marine sediments in Florida and on alluvium and loess in northwestern Mississippi. Soil temperature regimes are thermic except in southern Florida where they are hyperthermic; soil moisture

regimes are aquic. Water management is critical for farming on Gleyic Luvisols. Those used for the production of crops have been artificially drained. Those in northwestern Ohio, southeastern Michigan and northwestern Mississippi are used for crops such as maize, small grains, soybeans, forage crops and some vegetables. Those in Florida are mostly in forest, but some areas are used for grazing and others are drained for the production of citrus fruits and vegetables. Common associated soils are Eutric Gleysols and Orthic Luvisols.

Lk. CALCIC LUVISOLS

Calcic Luvisols occur in western and northwestern Texas, eastern New Mexico, western Oklahoma and southwestern Kansas. They are gently sloping soils on rolling loess-mantled uplands and alluvial sediments. Soil temperature regimes are dominantly thermic although in the northwestern part of the area of occurrence the temperature regimes are mesic. Soil moisture regimes are subhumid. Most of the Calcic Luvisols support grasses and forbs which are grazed. Crops such as sorghum, maize and cotton are raised, although irrigation is required to compensate for the seasonal shortage of moisture. Eutric Regosols are the dominant associates in the remainder of the area.

Lo. ORTHIC LUVISOLS

Orthic Luvisols are distributed from the Great Lakes south to the delta of the Mississippi river. Nearly all are on the gentle and moderate slopes of glacial drift and loess-covered plains. However, on the breaks between the upland plains and the flood plains of the Mississippi river and its tributaries, the Orthic Luvisols occur on severely dissected slopes extending through the loess and glacial drift cover and into the underlying sedimentary rocks. Several small areas of Orthic Luvisols occur in Washington and Oregon on moderate and steep slopes underlain by igneous and sedimentary rocks, in places mantled by volcanic ash and loess. Soil temperature regimes are dominantly mesic; however, in much of Minnesota and northern Wisconsin soil temperature regimes are boreal and along the Mississippi river south of Illinois they are thermic. Soil moisture regimes are humid. Orthic Luvisols are used mostly for maize, small grains and forage crops; small areas are used for the production of fruits and vegetables and, in Maryland, Virginia, Kentucky and Tennessee, for tobacco. Common associated soils are those having restricted drainage — Gleyic Luvisols, Mollic Gleysols and Gleyic Phaeozems — partly due to their occurrence on level or nearly level areas

of the terrain and partly because of the restriction to drainage caused by the argillic B horizon. Other associated soils occurring in better drained sites are Regosols, Phaeozems and Podzoluvisols.

M. Greyzems in Canada

In Canada, Greyzems are the dominant component of map units in less than 1 percent of the land area and usually have Albic Luvisols, Chernozems or Gleysols associated with them. Additional small areas of these soils are subdominant associates of Albic Luvisols and Chernozems. Greyzems occur in the provinces of Manitoba, Saskatchewan and British Columbia and subdominantly, or as inclusions, in Alberta. Most areas of Greyzems are found within the transitional areas lying between the Chernozems of the parkland-fescue prairies and the Albic Luvisols of the true boreal forest. Many occur in areas where extensive tree growth has become established on former grassland and meadow vegetation.

Mo. ORTHIC GREYZEMS

All Greyzems in Canada are Orthic Greyzems. In the interior plains they have cryoboreal and boreal subhumid to humid soil climates, about 75 percent having cryoboreal temperature regimes. In the mountains and plateaus of the interior of British Columbia, they are found in cooler, subhumid locations at higher elevations or with shaded aspects within the timberline. Associated with these soils are Chernozems and Kastanozems occupying warmer and drier, subhumid to semiarid grassland sites at lower elevations or with unshaded aspects.

Parent materials are dominantly glacial in origin, ranging from tills to lacustrine sediments, most of which are calcareous. Textures are mostly loamy, although some of these soils occur on clayey deposits. Topographically the majority are on undulating landscapes, with less than one fifth occurring on rolling topography.

In Manitoba, Saskatchewan and Alberta most areas of Orthic Greyzems are being developed for farming and now support a mixed farming economy with emphasis on small grains and oilseeds, although in some zones a significant amount of forage is grown. A few areas of original woodland are still used for commercial forestry. In the interior of British Columbia the Greyzems are at moderately high elevations bordering the timberline and are mostly used as part of the summer grazing range.

Under cultivation Orthic Greyzems are highly productive, comparable to Chernozems in fertility

status, responding to moderate applications of nitrogen and phosphorus. Potassium is not usually a limiting factor. Under good tillage practices they will retain a reasonably stable cloddy to granular structure within the cultivated layer. In those Orthic Greyzems intergrading toward Albic Luvisols, the incorporation of E horizon material into the cultivated layer results in some tendency for clods to flow and puddle when wet, and crust and cake when drying. Such physical conditions increase the susceptibility of the soil to water erosion on sloping lands and hinder seedling emergence.

Where Greyzems are developed on clayey materials, or where they are associated with Mollic Solonetz, Gleysols or Luvisols, the textural B horizons tend to restrict root growth and penetration.

M. Greyzems in the United States

In the United States, Greyzems are virtually nonexistent as dominant soils. They only occur in one small area in north central North Dakota along the United States-Canada border, and are the southern extremity of the Orthic Greyzems in southern Manitoba. The description for Canada is generally applicable.

O. Histosols in Canada

Histosols occur in all provinces and territories of Canada, mostly within regions having humid and perhumid cryoboreal and boreal soil climate regimes, but also in some with warmer mesic soil temperature regimes. Their occurrence is less common in areas with subhumid to subarid soil moisture regimes and in the arctic regions. Because of their widespread distribution in underdeveloped areas, where soil information has been mainly obtained by exploratory traverse or schematic interpretation, only general estimates of their total extent and distribution can be made.

Histosols are believed to comprise about 11 percent of Canada. They are the dominant soil on the landscape in approximately 10 percent of the country, the remaining 1 percent occurring as subdominant associates of other soils. In addition, many smaller areas of Histosols occupying poorly drained segments of soil landscape patterns are known to occur.

More than 50 percent of the Histosols in Canada are Gelic Histosols with frozen layers within 200 cm of the surface for two months or more following the summer solstice. Virtually all of the remaining Histosols are Dystric Histosols; only a very few are Eutric Histosols. The Gelic Histosols usually occur in

areas having subarctic or transitional cryoboreal to subarctic soil temperature regimes. In some places Gelic Histosols are associated with continuous or intermittent permafrost, usually indicated by the development of pronounced microrelief in the form of peat plateaus, domes, ridges and low mounds.

Most common associates of Histosols are Podzols, Cambisols, Luvisols and Gleysols and, to a lesser extent, Regosols and Lithosols.

Climatically the Histosols, unless drained, have aquic soil moisture regimes but soil temperature regimes range from mesic to subarctic.

Because of their unique physical properties, the soil temperature relationships of Histosols are usually modified in degree from those of adjoining mineral soils. Because of the insulating effect of hydrophytic vegetative cover and fibrous surface horizons, many Histosols warm and cool more slowly than the better drained mineral soils with which they are associated. These effects are particularly accentuated with soils having a high water content subject to freezing because of the additional latent heat involved in the freezing and thawing processes. Thus, many of the Histosols having aquic moisture regimes and cryoboreal and boreal temperature regimes retain frozen subsoil layers through the spring and early summer periods, long after their better drained associates have thawed and warmed. Where soil temperature regimes are mesic, or where Histosols in colder areas have been cleared of vegetative cover, drained and cultivated, soil temperature relationships are less modified and more nearly approximate those of the associated better drained soils.

Within areas having arctic soil temperature regimes associated with permafrost, the growing season is generally too short to enable any substantial accumulation of organic surface layers thicker than that which would be classified as histic phases of Gelic Gleysols. Consequently, there are few occurrences of Histosols within the arctic regions.

The organic deposits forming the parent material of Histosols overlie a wide range of mineral materials ranging from glacial tills and outwash to alluvial and lacustrine sediments. In places, they overlie bedrock. Where organic surface layers are shallow, the nature of the underlying mineral layers occurring within the control section is highly significant in determining the classification and properties of Histosols, as well as influencing land use, productivity and management problems associated with these soils.

The topography of most areas of Histosols in Canada is level to gently undulating, but the surface of the soil may be hummocky. The latter situation is most commonly found in areas of Gelic Histosols. Few areas of blanket bog — Histosols on steeply sloping land — have been identified in Canada.

The more extensive areas of Histosols lie within undeveloped regions of the country and support a natural vegetation of hydrophytic species, ranging from that characteristic of swamp bogs and wet forest to meso-hydrophytic species associated with very moist forest sites. With minor exceptions forest development on Histosols is restricted by poor drainage and cool or frozen subsoil conditions; tree growth is mostly unproductive or stagnant. Such areas are used mainly for wildlife habitats with the growth of shrubs, herbs and mosses usually sufficient to provide a limited grazing capacity. Areas of Histosols supporting a relatively nonforested or open fen type of vegetation are also mostly used for wildlife grazing, but if adjacent to agricultural settlements may be used for rough pasture. Their suitability for such use may be significantly bettered by improvement of drainage conditions.

Other areas of Histosols have been drained, cleared and successfully managed for the production of improved pasture or cultivated crops, and although the total area involved is relatively small, they form a significant part of the agricultural economy in local areas. Development of Histosols has occurred in areas of mesic or moderately cool boreal soil climates, where growing season temperatures are not a severely limiting factor.

Where controlled drainage, satisfactory tillage methods and adequate fertilization are practised, the productivity of Histosols is usually high. Dystric Histosols generally require periodic or in some instances sustained liming to counteract acidity and maintain a nutrient balance. Under cultivation many Histosols, both Eutric and Dystric, show deficiencies in mineral nutrients, and most require applications of phosphorus and potassium to obtain maximum productivity.

O. Histosols in the United States

Histosols do not occur extensively as the dominant soil on the landscape of the United States. They are the level organic soils found in shallow depressions in glaciated areas of the north, on flat plains along the Atlantic coast, in southern Florida in the Central valley of California and on the outer part of the delta of the Mississippi river. Soil temperature regimes are boreal, thermic and hyperthermic; soil moisture regimes are aquic and peraquic. Although they have productive potential if drained and intensively managed, most of the Histosols are in swamp forest or marsh grasses; only a small proportion is farmed.

Most extensive of the Histosols are those in northern parts of Minnesota and Michigan. These have

boreal soil temperature regimes and aquic soil moisture regimes. Most are in needleleaf forest, but small areas have been drained and are used for subsistence farming — cash crops, pasture and hay. Frost is a serious hazard to production of cultivated crops. Of the less extensive areas of Histosols, those in central California, southeastern Georgia and eastern North Carolina have thermic temperature regimes and aquic moisture regimes, whereas those in southern Florida and Louisiana have hyperthermic temperature and peraquic moisture regimes. The Histosols in California and Florida are drained and managed for cash crops. Those in Louisiana and those on the flat coastal plain of North Carolina are mostly marshland and their productive potential has not been exploited.

As mentioned above, Histosols also occur in small areas throughout much of the glaciated northern part of the United States. They are associated with Podzols and Luvisols and are in small depressions and level areas widely distributed across the landscape.

P. Podzols in Canada

Podzols are widely distributed in Canada, occurring in all provinces from Newfoundland to British Columbia and extending northward into the Northwest Territories and Yukon. The most extensive areas are found within the Canadian shield, the Appalachian region and the western coastal zones of the Cordilleran region.

Podzols are the dominant soil in approximately 23 percent of Canada's landscape, and are subdominant associates of other soils in an additional 7 percent of the country. Podzols are commonly found in association with Lithosols, Luvisols, Cambisols, Gleysols and Histosols; more than 15 percent of Canada is mapped as complexes of Podzols and Lithosols.

Podzols have mainly boreal and cryoboreal, humid to perhumid climatic regimes under coniferous to mixed forest vegetation, but may have perhumid moisture regimes under heath vegetation. They have cryoboreal to subarctic regimes in the more northern areas and milder mesic perhumid to humid regimes in southern Ontario, Quebec and Nova Scotia.

Podzols in Canada are most commonly found on coarse-textured, stony glacial till or outwash deposits, but also are extensive on loamy-textured deposits. Parent materials are dominantly acidic, but may also be slightly calcareous. They occur on a wide range of slope, from undulating to mountainous, but over 70 percent are found on rolling landscapes.

As the vast majority of Podzols in Canada are either forested or support heath vegetation it is natural that the major land uses are forestry, wildlife activities, such as hunting and trapping, and recreation.

Development of Podzols for farming has occurred mainly in eastern Canada, more particularly in the sections having milder boreal and mesic temperature regimes. It is estimated that about 26 000 sq km are in improved farming areas, although not all of these are under cultivated crops. Of the areas used for cultivated crops nearly three fourths occur within the province of Quebec, and most of the remainder are approximately equally distributed among Ontario, Prince Edward Island, New Brunswick and Nova Scotia. Less than 80 sq km of these soils have been improved in Newfoundland. No significant areas of Podzols have been used for farming in western Canada; most are in forest. Nearly half are considered to be in commercially productive forest, and the remainder are in noncommercial forest, mainly because of stoniness, proximity to bedrock, severe climatic limitations or inaccessibility.

The inherent productivity of Podzols in Canada is generally not high. They are limited regionally by relatively unfavourable climate, and locally by stoniness or shallowness to bedrock or because of imperfect drainage and limitation to root development associated with fragipans or topographic position. With adequate fertilization and proper management, including sustained liming, the better Podzols are moderately productive. Annual applications of nitrogen, phosphorus and potassium are usually required for maintenance of yields, with rates varying for particular crops and conditions.

Other management problems include control of water erosion, particularly with intensively tilled crops on sloping land, and the maintenance of adequate drainage on gleyed soils in lower slope position. In contrast, some Podzols on coarse-textured or shallow materials may exhibit moisture deficits in the dry years. They are used mainly for small grains, forage and pasture production with associated livestock, but significant areas of special crops, tobacco, potatoes, blueberries, orchard fruits and vegetables are produced in regionally suitable areas.

PO. ORTHIC PODZOLS

All Podzol map units are dominantly Orthic Podzols and the foregoing description applies to them.

P. Podzols in the United States

Podzols are distributed mostly in the northern part of the United States near the Great Lakes and in the extreme northeast. They are also widely distributed

in Florida and along the southeast coast, but are found inextensively in Alaska. As a consequence of their occurrence over a wide range of latitude as well as elevation, the soil temperature and soil moisture regimes of Podzols range widely; the former include subarctic, cryoboreal, boreal, thermic and hyperthermic regimes and the latter include perhumid, humid and aquic regimes. Podzols are predominantly gently and moderately sloping soils on materials of glacial origin, although those in the southeastern part of the country are on marine sediments. The Podzols in Alaska range more widely in slope and in the nature of the underlying materials. Where Podzols are farmed, most are used for crops associated with dairy enterprises, although in some areas adapted cash crops are grown. Productivity is generally low, although these soils respond to good management and can be made moderately productive. Many areas are forested.

Pg. GLEYIC PODZOLS

Gleyic Podzols are level and gently sloping soils on sandy marine sediments on the Atlantic and Gulf coasts of Florida and in several small widely separated areas along the coasts of North and South Carolina. Soil temperature regimes are thermic in the Carolinas and northern Florida and hyperthermic in the southern part of Florida. Soil moisture regimes are aquic, and locally peraquic. Most of the Gleyic Podzols are forested, but in south central Florida, with good management, they are used for growing citrus fruits. Principal associated soils are Dystric Regosols, mostly on marine sands, with little farming potential.

Pl. LEPTIC PODZOLS

Leptic Podzols are distributed in the southern parts of Maine, New Hampshire and Vermont, and across most of Connecticut, Massachusetts and Rhode Island. They are gently and moderately sloping soils on thick deposits of glacial drift and marine sediments. In contrast to the boreal soil temperature regime of the Orthic Podzols farther inland and at somewhat higher elevations, the Leptic Podzols have mesic soil temperature regimes. Soil moisture regimes are humid. As a consequence of the milder climate in the area of the Leptic Podzols they are cropped more intensively than the Orthic Podzols. In addition to crops in support of dairy farming, they are also used for production of adapted fruits and tobacco. Principal associated soils are Orthic Podzols and associated Gleysols, which are widely distributed as dominant soils to the west and north.

Po. ORTHIC PODZOLS

In the United States, Orthic Podzols are by far the most extensive Podzols. They are widely distributed on nearly level to hilly glacial till plains as well as on till-mantled hilly uplands and low rounded mountains of the northern parts of Minnesota, Wisconsin, Michigan and New York, and most of Vermont, New Hampshire and Maine. They also occur in south central Alaska, on a gently sloping loess-mantled glacial till plain, in southeastern Alaska on moderately to steeply sloping volcanic ash mantled mountains and in southern New Jersey on sandy marine sediments. Some of the Orthic Podzols have fragipans. On steeper slopes the soils are shallow; in many places they are stony.

Soil temperature regimes are boreal except in Alaska, where they are subarctic and cryoboreal, and in New Jersey, where they are mesic. Moisture regimes are humid or perhumid. The generally short, cool growing season limits the crops that can be grown. In places stoniness also limits cropping practices. Most crops grown are those associated with dairy farming. However, potatoes are an important cash crop in Maine and tree fruits are grown in some places where winters are less severe. Common associated soils are Dystric Gleysols and Histosols; these soils with aquic moisture regimes are located in depressions and on level to gently sloping parts of the landscape. In northern Michigan and southern New Jersey, where the Orthic Podzols are more sandy and soils with aquic moisture regimes less common, the principal associated soils are Dystric Regosols, Eutric Podzoluvisols and Orthic Acrisols. Much of the area of these soils is forested.

R. Regosols in Canada

Regosols are the dominant soils in approximately 25 percent of the land area of Canada. They also occur as subdominant associates of soils in an additional 1 percent of the country.

Rd and Re. DYSTRIC AND EUTRIC REGOSOLS

Of the remaining Regosols in Canada, most are Eutric Regosols occurring on neutral or basic parent materials; a few are Dystric Regosols usually occurring on noncalcareous or acidic materials. These Eutric and Dystric Regosols have boreal and cryoboreal soil temperature regimes and, although widely distributed as minor inclusions among other soils, occur as dominant soil on the landscape only within the interior plains of Manitoba, Saskatchewan and Alberta. Their location and lack of profile develop-

ment are mainly the result of the nature of the parent material or topographic position, with broad climatic factors playing an important but less significant role in their development. Most are on coarse, gravelly or sandy glaciofluvial and aeolian deposits, including areas of dunes, or in sandy to loamy alluvial deposits, some of which are strongly calcareous or saline. In alluvial flood plains, Regosols are frequently associated with Fluvisols. Other Eutric and Dystric Regosols are found on coarse or loamy, stony or eroded glacial deposits associated with old eroded glacial channels, on upper slope and knoll positions in rolling morainic areas and on colluvial or talus materials associated with steep valley or mountain slopes.

The land use and productivity of Eutric and Dystric Regosols are influenced by parent materials, topography and the limitations imposed by temperature and moisture regimes under which they occur. Most of the Dystric and some of the Eutric Regosols with cryoboreal and boreal subhumid to humid soil climates support forest vegetation. Many of these soils are associated with Cambisols and Luvisols. Their productivity for forestry is dependent on parent material and slope characteristics. The coarser textured Regosols and those on the drier slopes usually support a sparse or relatively unproductive growth. These are mainly used as wildlife habitats, and their management problems involve the protection and conservation of vegetative cover. Limited areas of less coarse-textured materials with a deeper regolith and more favourable moisture conditions sustain productive forest growth and are used to a limited extent for commercial forestry. Within areas of semiarid to subarid soil moisture regimes, Eutric and Dystric Regosols support native grass or shrub vegetation and are commonly associated with Kastanozem soils; in these associations the Regosols are usually characterized by a weakly developed A horizon. The coarse-textured Regosols with low moisture-holding capacity are not considered suitable for dry-land crop production or improved pasture. Due to their limited productive capacity their utilization is mainly limited to rangeland grazing.

Eutric Regosols on parent materials with fine sandy, loamy or clayey textures have better moisture-holding capacities than the coarse-textured Regosols but shallow soil depth, low levels of fertility and low organic matter content limit their productive capacity. Many of these soils are used for rangeland with improved pasture and supplemental crop production on locally favourable sites. Eutric Regosols associated with saline or highly calcareous materials are usually limited in their ability to sustain economic growth of crops and are also largely used for grazing purposes.

Management problems on sandy-textured Regosols

involve protection of native vegetation against overgrazing and wind erosion, particularly in dune areas. On sloping Regosols water erosion is commonly a major hazard.

Rx. GELIC REGOSOLS

Nearly all the Regosols are Gelic Regosols. They are distributed across the arctic region of Canada, from Labrador and Baffin Island on the east to the Mackenzie delta in the west. They comprise a wide variety of textures and parent materials ranging from coarse glacial till and outwash to a variety of marine sediments, and occur on undulating, rolling and mountainous topography. The thin solum and weak profile development of these soils is mainly the result of the severity of the arctic climate and the related cryopedologic processes and the presence of permafrost. In the formation of these soils environmental conditions tend to override the effect of differences in parent materials.

Although profile development of these Gelic Regosols is too weak for them to be considered other than regosolic, a number of variations in profile characteristics have been described by various workers in the limited studies undertaken in this vast area. These range from Gelic Regosols lacking any horizon development other than a very thin humus layer to those with distinctive brownish horizons, grading toward Cambisols. Other Gelic Regosols exhibit mottling indicative of gradation to Gelic Gleysols. However, the main characteristics dominating all these variations are the weak profile development and the shallow solum overlying permafrost layers.

Gelic Regosols are generally unproductive for forestry or agriculture because of climatic limitations. Most support a sparse tundra vegetation within a very limited growing season, but some areas are barren or are almost devoid of any vegetative cover. The use of these areas is largely limited to wildlife grazing during the short snow-free season. Management of such areas involves protection and conservation of the limited vegetative cover and maintenance of the natural equilibrium between active and permafrost layers within the soil.

R. Regosols in the United States

Regosols are widely distributed in the United States, but are most extensive in a broad area extending from North Dakota to southwestern Florida. Soil temperature regimes are boreal, mesic, thermic and hyperthermic; soil moisture regimes are humid, sub-humid, subarid, arid and xeric. Although the Rego-

sols occur on gentle to steep slopes, they are most extensive on moderate and steep slopes. Regosols are on a variety of underlying materials, but most are on soft sedimentary rocks or sand dunes. Because of the slopes on which they occur, the relative shallowness of most of the soils and the dry soil moisture regimes, most of the Regosols in the United States are not productive soils. Most support a cover of native grasses and forbs but some are in forest and several are used for irrigated cultivated crops.

Rc. CALCARIC REGOSOLS

Calcaric Regosols are moderately to steeply sloping soils on dissected plains, badlands, mesas and mountain slopes. Many are shallow to rock, although they are not shallow enough to be Lithosols. Common underlying materials are sandstone, shale, limestone, siltstone and alluvium from these and some other rocks. In the northern part of the country, soil temperature regimes are mesic and boreal, the former prevailing in Montana and northern Wyoming and the latter in western North Dakota and northwestern South Dakota. Soil moisture regimes are mostly semiarid and subarid, the moister regimes in western North Dakota becoming progressively drier toward west central Montana. The predominance of relatively cool and dry soil climate, moderate and steep slopes and, in places, shallowness to bedrock limit productivity of these Calcaric Regosols. Most support native grasses and forbs and are used for grazing. Some spring wheat is grown on moderately sloping soils in the more humid parts of North Dakota. Small grains, forage crops and pasture are grown under irrigation along some of the larger streams in southern Montana. Luvic Kastanozems and Luvic Xerosols are the principal soils associated with the Calcaric Regosols.

Most of the remainder of the Calcaric Regosols, distributed from northeastern Wyoming south to western Texas and west to the Pacific coast of southern California are shallow, moderately to steeply sloping soils. Many comprise the steep side slopes of valleys, including the Grand Canyon of the Colorado river. Soil temperature regimes are boreal, mesic and thermic; soil moisture regimes are mostly subarid and arid. The soils support some native grasses, forbs and shrubs, which afford some limited grazing. Where water is available for irrigation, mainly in the valleys along the larger streams, small grains, forage crops, pasture and, in several widely scattered areas in the south, truck crops and cotton are grown. Luvic Yermosols and Luvic Xerosols are the principal associated soils in these dry regions.

Rd. DYSTRIC REGOSOLS

In the United States, Dystric Regosols are the least extensive of the Regosols. They are gently sloping soils on sandy marine sediments in northern Florida, central Georgia and southeastern South Carolina, and are moderately sloping soils on predominantly marine sands in central Florida, southwestern Georgia and southeastern Alabama. Soil temperature regimes are thermic and hyperthermic and soil moisture regimes are humid. Although these are inherently unproductive soils having a sand fraction that is 95 percent quartz or other normally insoluble material and low water-holding capacities, most of these Dystric Regosols are intensively cropped. Good management for sustained production of cash crops requires addition of plant nutrients and supplemental irrigation. In Florida they are used for production of citrus fruit and vegetables, and in Alabama, Georgia and South Carolina for cotton, maize and groundnuts as well. Some small areas are used for grazing or are forested. Principal associated soils are sandy Acrisols.

Re. EUTRIC REGOSOLS

Like the Calcaric Regosols, the Eutric Regosols are widely distributed across the United States from the sandy outwash plains south and west of the Great Lakes south to the aeolian sands in southern Texas and west to the coarse volcanic ash deposits of southern Oregon. In Minnesota, Wisconsin and Indiana, they are gently and moderately sloping soils on glacial drift, outwash and alluvium. Soil temperature regimes are mostly boreal but mesic in southern Wisconsin and Indiana; soil moisture regimes are humid. Most of these Eutric Regosols are in needleleaf forest. Although the growing season is short in the cooler climate, crops in support of dairy farming are raised, and in the warmer temperatures of Indiana the Eutric Regosols are more intensively used. Associated with the Eutric Regosols in this northern glaciated area are the Gleysols and Histosols in wet level areas and depressions and Luvisols and Chernozems on higher lying areas.

Most extensive of the Eutric Regosols are those comprising the sand hills of Nebraska as well as less extensive areas in Kansas, eastern Colorado, southern Texas, southern New Mexico, southern Washington and northern Oregon. These are gently and moderately sloping soils mostly on low and high dunes of fine aeolian sand. Soil temperature regimes are mesic and hyperthermic; soil moisture regimes are subhumid, semiarid, xeric and arid. The soils support a cover of native grasses, forbs and, in the extreme south, desertic shrubs. They are used for grazing but careful

management is required to preclude overgrazing with the resultant destruction of vegetation and creation of blowouts. In southern Texas and parts of western Kansas some of these soils are irrigated for production of small grains, sorghum and forage crops, and in southern Washington and northern Oregon for horticultural crops as well. The Eutric Regosols of southwestern Oregon are gently sloping on deposits of gravel and sand-size volcanic ash and pumice. These soils have little potential for farming but support needleleaf forest. Eutric Regosols also occur on the southern coast of Alaska where they are gently and moderately sloping soils on marine sands. Soil temperature regimes are subarctic and soil moisture regimes are humid. They support some native grasses which afford limited grazing and, although temperatures are cold and the growing season short, they produce locally some hardy vegetables.

The remainder of the Eutric Regosols — those in north central Montana, western and southern Kansas, central and southern Colorado and northwestern New Mexico — are shallow soils on sandstone, siltstone, shale and limestone, or on the colluvium from these. Soil temperature regimes are mesic except in north central Montana where they are boreal, and soil moisture regimes are subhumid and semiarid. They support native grasses, forbs and shrubs which afford limited grazing; in southern Kansas, some small grains and sorghum are grown.

S. Solonetz in Canada

Solonetz soils occur as the dominant component of approximately 1 percent of the land area of Canada. In addition, small areas of these soils occur as subdominant components of other soil units. They have as their more common associates Kastanozems and Chernozems, but Greyzems and Luvisols are associated with them in some units. Geographically, the main areas of Solonetz soils are in the interior plains region, particularly in the provinces of Alberta and Saskatchewan and to a lesser extent in the Peace river area of northeastern British Columbia and in Manitoba.

Sm. MOLLIC SOLONETZ

All solonetzic map units in Canada have Mollic Solonetz as the dominant soil. They have cryoboreal and boreal temperature regimes, and subhumid, semiarid and subarid moisture regimes. They support a grass and forb vegetation, ranging from mixed prairie in the more arid sites to fescue parkland and areas of transition from parkland to forest

in the subhumid areas. A significant percentage of alkali-tolerant vegetation is usually found in the Solonetz areas.

Colour, organic matter content and thickness of surface horizons tend to be similar to those of geographically associated soils. Thus, under subarid and semiarid soil moisture regimes, the Mollic Solonetz soils have surface A horizons comparable to those of Kastanozems, and under subhumid conditions comparable to those of Chernozems or Greyzems. Eroded phases and pitted areas frequently support a relatively sparse xerophytic vegetation of forbs and grasses, and have little, if any, development of an A horizon; under forest vegetation, the A horizons tend to be non-Mollic, grey in colour and similar to those described for Albic Luvisols.

The Mollic Solonetz are usually distinctly less productive than the soils with which they are associated. In Canada most areas of Mollic Solonetz are either cultivated for the production of grains or forage or are utilized as native pasture. Limitations in productivity and use imposed by moisture deficits of subhumid to subarid soil climate regimes are compounded for Solonetz soils by physical and chemical characteristics. The compact and coated B horizons, which tend to become plastic when wet and very hard when dry, restrict moisture and root penetration. The proximity to the surface of saline and alkaline subsoils and periodic salinization of surface horizons further limit healthy plant growth and water availability.

Crop production on these soils is generally a marginal operation, and there has been a considerable fluctuation in the percentage of land cropped and pastured since settlement was first attempted. It is estimated that about 45 percent of all Solonetz soils in Canada are cultivated, the remainder being used as grazing land. The proportion of cultivated land varies from less than 25 percent in the subarid areas to over 60 percent in some of the subhumid areas where Mollic Solonetz are associated with Chernozems. Locally, excessive salinity, degree of erosion or stoniness are also significant factors in determining the feasibility of cultivation or grazing.

The Mollic Solonetz generally give moderate responses to applications of phosphorus and nitrogen, particularly the latter. Management problems in cultivation involve the timely use of tillage equipment to conserve moisture and to prevent caking of surface clods and desiccation of the underlying B horizons. Experimental studies have shown beneficial effects of gypsum brought up from the C horizon by deep ploughing, and by heavy applications of nitrogen in the form of ammonia. However, these practices have not yet been established as feasible from an economic standpoint.

S. Solonetz in the United States

Solonetz soils are very inextensive in the United States as dominant units. They are level soils on lacustrine and alluvial sediments in basins and broad valleys in central California, southeastern Oregon, northern Utah, northwestern South Dakota and northern Montana. Soil temperature regimes are boreal at the higher latitudes of Montana and South Dakota and the higher altitudes in Oregon, mesic in Utah and thermic at the low elevations in central California. Soil moisture regimes are semiarid in the north, arid in Utah and xeric in Oregon and California. Solonetz also occur as moderately extensive associates of Kastanozems in the western and northern parts of Montana and in western North and South Dakota.

Sm. MOLLIC SOLONETZ

The Mollic Solonetz are by far the least extensive of the Solonetz in the United States. They occur in northwestern South Dakota and southeastern Montana on calcareous shale, sandstone and glacial drift. They support salt-tolerant grasses and forbs and are used only for grazing.

So. ORTHIC SOLONETZ

The Orthic Solonetz are the more extensive of the Solonetz in the United States. The most extensive area occurs in the vicinity of Great Salt lake in northern Utah. Soil temperature regimes are mesic; soil moisture regimes are arid. In addition to halophytic grasses, forbs and shrubs which afford limited grazing, these Solonetz are irrigated for production of small grains, forage crops and pasture. In areas where salt accumulations are most severe, Solonchaks are the principal associated soils. In Oregon the Orthic Solonetz are similar in most respects to those in Utah, except that soil temperature regimes are boreal rather than mesic and soil moisture regimes are xeric.

Orthic Solonetz also occur in northern Montana. Except that they lack a mollic A horizon, they are similar in most respects to the Mollic Solonetz in the southeastern part of the state.

In central California, the Orthic Solonetz have thermic soil temperature regimes and xeric soil moisture regimes. These soils are intensively managed, including drainage and irrigation, for production of cash crops such as cotton, rice and truck crops, as well as for small grains and forage crops.

Except in the arid basin surrounding Great Salt lake, the principal associated soils have mollic A horizons, those in Montana being Kastanozems and those in Oregon being Gleysols. Gleyic Solonetz are local inclusions.

T. Andosols in Canada

In Canada the presence of thin layers of volcanic ash has been noted within the solum of a number of soils in the Cordilleran region of the country and also to the east in the interior plains. Most of these layers are discontinuous and of local occurrence, but in the southern part of British Columbia adjacent to the United States border they are more widely distributed. Commonly the volcanic ash occurs as a layer 1 to 5 cm thick beneath the organic litter of undisturbed forest soils or buried as much as 10 cm deep in grassland soils. In the Canadian system of classification, soils having these layers have been recognized at the series and family level, but not at the higher taxonomic categories. For purposes of this report, soils with these thin layers of volcanic ash have been classified Vitric Andosols.

The areas of Andosols in Canada are a northward extension of these soils in the states of Washington, Idaho and Montana into portions of the mountainous areas of British Columbia. They occupy a total area of slightly more than 12 300 sq km. Common associated soils are Dystric and Humic Cambisols and Orthic Podzols. Minor inclusions of Regosols, Kastanozems and Chernozems also occur.

Andosols have developed under moderately cool to cool cryoboreal to boreal subhumid to humid soil climates, modified by vertical zonation and aspect that are characteristic of mountainous terrain. Subalpine conditions are found at the higher elevations, usually over 2 000 m. Underlying materials are mostly loamy, very slightly calcareous to noncalcareous, stony till with local colluvium extending into the valleys; thin layers of volcanic ash occur in most areas except on eroded slopes.

The topography is dominantly steeply sloping with some lesser slopes characteristic of mountainous terrain. Elevations range generally from 1 000 to over 2 335 m, but higher peaks extend above 2 670 m. Most of the noneroded slopes support a productive growth of coniferous forest. Small areas of land suitable for pasturing and cropping are found in valley bottoms and lower slopes.

T. Andosols in the United States

In the United States, the Andosols comprise large areas on steep slopes in Washington, Idaho, and Montana, as well as small areas in Alaska and the Aleutian islands. Soil temperature regimes are humid. They are formed in volcanic ash, pumice or other pyroclastic materials, and commonly are rich in glass. Andosols are not productive soils because of one or more features characteristic of these soils

— cold temperatures, inherently low fertility and steep slopes. Management problems would include control of erosion on sloping areas and intensive fertilization.

Tv. VITRIC ANDOSOLS

Andosols in the United States are Vitric Andosols. They are on volcanic ash overlying a variety of rocks. Soil temperature regimes are boreal and soil moisture regimes are humid. Most of the Vitric Andosols are in needleleaf forest, but in the valleys on alluvium, which is high in volcanic materials, irrigated forage crops and small grains are grown. Principal associated soils are Podzols and Cambisols.

The Vitric Andosols in southwestern Alaska and the Aleutian islands have subarctic soil temperature regimes. Here the soils are on thinner deposits of volcanic ash over igneous and metamorphic rocks and range more widely in slope than those in Washington, Idaho and Montana. These soils are not forested but support some grasses and forbs; small areas on the mainland are used for raising hardy vegetables. In the cold northern climate, principal associated soils are Gleysols and Histosols.

V. Vertisols in the United States

Vertisols occur as dominant soils in the United States, mainly in Texas, but also in small areas in Mississippi, Alabama and Oregon. They do not occur in Canada. Soil temperature regimes are mesic, thermic and hyperthermic; soil moisture regimes are humid, subhumid and xeric. Vertisols are level or nearly level clay soils mostly on calcareous marine sediments or soft calcareous sedimentary rocks. Management is difficult because of the high content of slowly permeable montmorillonitic clays that crack deeply when dry. Most of the Vertisols are suited for mechanized farming if rainfall is adequate; irrigation would be feasible but difficult. Commonly these soils are used for production of field crops, particularly cotton and rice, and for grazing.

Vc. CHROMIC VERTISOLS

Chromic Vertisols are the less extensive of the Vertisols and are distributed inextensively in southern Texas, eastern Mississippi, western Alabama and southern Oregon. Being very gently sloping soils, Chromic Vertisols are not subject to ponding. Aeration is sufficiently good and they are commonly brownish in colour. Soil moisture is usually sufficient for production of cultivated crops such as cotton, small grains, maize and, in the cooler and drier soil climate

regimes in Oregon, some tree fruits. Grazing is also practised. Management practices in Oregon often include irrigation to compensate for seasonal moisture deficits.

Vp. PELLIC VERTISOLS

Pellic Vertisols are the more extensive of the Vertisols but they are distributed only in east central and southern Texas. These are the Vertisols of depressions and level areas. They are subject to surface ponding, aeration is generally poor and they have thicker and darker surface horizons than the Chromic Vertisols. Although part of the area of Pellic Vertisols is used for grazing, a large part is used for cultivated crops such as cotton, maize, sorghum and small grains. Along the southwestern border of Texas, Pellic Vertisols are irrigated, but to the north and east crops are raised without irrigation or with supplemental irrigation. On the nearly level, low-lying plain along the coast of Texas, water is abundantly available and some of the Pellic Vertisols are used for growing rice.

W. Planosols in the United States

We. EUTRIC PLANOSOLS

Planosols are of relatively minor extent in the United States, but do not occur in Canada. Most are Eutric. They are distributed generally in areas adjacent to the Mississippi river valley in southern Illinois, northeastern and southwestern Missouri, eastern Kansas, east central Arkansas and southern Louisiana. The more extensive areas of Planosols occurring in Illinois, Missouri and Arkansas are on nearly level and gentle slopes of dissected plains of loess of variable thickness, in most places overlying glacial drift. Soil temperature regimes are mesic in Missouri and Illinois and thermic in Arkansas; soil moisture regimes are aquic. Management of these Eutric Planosols involves control of the ground water which is seasonally perched above the slowly permeable argillic B horizon. Even when drained, they are only moderately productive. They are used mostly for raising maize, soybeans, small grains and forage crops, but some areas are forested. In Louisiana the Eutric Planosols are on calcareous deltaic sediments. Soil temperature regimes are thermic. They are used for rice production and, where drained, for forage. Luvisols are commonly associated with the Eutric Planosols, and in southwestern Missouri and eastern Kansas, soils with mollic A horizons, Mollic Planosols and Luvic Kastanozems, are common associated soils.

X. Xerosols in the United States

Xerosols are neither extensive nor widely distributed. They occur only in the United States, and are most extensive in Wyoming and Colorado and less extensive in Idaho, Oregon and Washington. Soil temperature regimes are boreal and mesic; soil moisture regimes are subarid. In Idaho, loess and volcanic ash are the dominant underlying materials, whereas in the remaining areas alluvium and sedimentary rocks are dominant. Soils are gently to moderately sloping except in parts of southern Wyoming and northernmost Colorado where they are steep. The Xerosols are potentially productive soils, but because of severe shortages of moisture and in some places relatively low temperatures, they are used mostly for grazing. Under irrigation, they produce a variety of cultivated and forage crops.

Xh. HAPLIC XEROSOLS

Haplic Xerosols are even less extensive than the Calcic Xerosols. They occur in small areas in southeastern Idaho, parts of Oregon and in central Washington, mainly in basins and on the lower footslopes of adjacent mountain ranges. Underlying materials are mostly unconsolidated — loess, alluvium and volcanic ash. Like the Luvic and Calcic Xerosols, the Haplic Xerosols in southern Idaho and central Washington are intensively farmed where irrigation water is available; they are used for producing crops such as small grains, forage crops, potatoes, sugar beets, a variety of vegetables and fruits. The remaining area is used for the grazing afforded by native grasses and shrubs. Haplic and Calcic Kastanozems and Calcaric Regosols are common associates of the Haplic Xerosols.

Xk. CALCIC XEROSOLS

Calcic Xerosols are very inextensive as dominant soils, occurring only in southern Idaho. They are nearly level and sloping soils in loess and volcanic ash overlying basalt. They support native grasses and shrubs which afford some grazing. Much of the farming is dry, but where irrigation water is available the soils are intensively used for small grains, forage crops and potatoes. Calcaric Regosols are common associated soils.

Xl. LUVIC XEROSOLS

Luvic Xerosols are the most extensive of the Xerosols. They are the nearly level and sloping soils of the high plains and intermontane basins of nearly two thirds of Wyoming as well as parts of eastern

and southern Colorado and southern Idaho and Oregon. Soil temperature regimes are dominantly mesic, but in southern Wyoming and southern Oregon, where elevations are generally above 1 500 m, soil temperature regimes are boreal. Soil moisture regimes are mostly subarid except in a few basins in southern Oregon where they are xeric. In Wyoming and Colorado, underlying materials are predominantly sedimentary rocks — shale, sandstone and limestone — as well as alluvial deposits and some small areas of loess. The Xerosols in these areas support a variety of native grasses and shrubs which afford some grazing. Along the larger streams, where water is available for irrigation, the Luvic Xerosols are used for raising small grains and forage crops and, where soil temperature regimes are mesic, for sugar beets, maize, potatoes and beans. In many places stoniness limits the use of these soils for farming. In southern Idaho and Oregon the Luvic Xerosols are nearly level and sloping soils on loess and volcanic ash. Soil temperature regimes are mostly mesic and soil moisture regimes are subarid except in several small basins in Oregon where the temperature regimes are boreal and the moisture regimes are xeric. Use of these Luvic Xerosols in southern Idaho is slightly more intensive than in the east, and the crops grown include a greater variety of vegetables and fruits; otherwise, land use and specific crops grown are essentially the same. Calcaric Regosols are common associated soils.

Y. Yermosols in the United States

Yermosols are extensive soils occurring west of the 101° meridian in the United States. They do not occur in Canada. Although they are found on gentle to steep slopes, they are most extensive on gentle slopes. Soil temperature regimes are mesic, thermic and hyperthermic, and soil moisture regimes are aridic, with the exception of a single area of Yermosols in southeastern Idaho on elevations above 2 600 m, where the soil temperature regime is boreal and the soil moisture regime is xeric. Underlying materials comprise a variety of rocks in ridges and mountain ranges and alluvial and lacustrine sediments in the broad intervening valleys and basins. Commonly vegetation is sparse, consisting mainly of xerophytic shrubs and grasses; some areas are barren. Those Yermosols suited for any economic use afford only a limited amount of grazing, but where irrigation water is available crops are grown. Management for production of crops is difficult; many of the Yermosols are stony, some have petrocalcic layers or duripans, and some are saline or are potentially saline if irrigation is not carefully controlled.

Yh. HAPLIC YERMOSOLS

Haplic Yermosols are about equal in extent to the Calcic Yermosols. Most occur in western Nevada and northeastern Arizona, and small areas of these soils are found in southern New Mexico and eastern Idaho. They have mesic soil temperature regimes and arid soil moisture regimes except that those in eastern Idaho have subarid soil moisture regimes. Like most of the Yermosols, the Haplic Yermosols are on a variety of igneous, metamorphic and sedimentary rocks comprising moderately to steeply sloping ridges and mountain ranges and alluvial deposits on fans and terraces in the intervening valleys and basins. Also, like the other Yermosols, the Haplic Yermosols support a sparse growth of xerophytic shrubs and grasses which afford only a limited amount of grazing; many areas are barren. Surface and groundwater suitable for irrigation is scarce, but where it is available the Haplic Yermosols are used for small grains, forage crops, for potatoes in Idaho and for cotton, sorghum and truck crops in New Mexico. Dominant associated soils are Calcaric Regosols, Calcic Yermosols and Eutric Fluvisols.

Yk. CALCIC YERMOSOLS

Calcic Yermosols, occurring mainly in western Texas, eastern New Mexico, southeastern Utah and southwestern Idaho, comprise a little more than 10 percent of the Yermosols. They have mesic and thermic soil temperature regimes and like most other Yermosols have aridic soil moisture regimes. Unconsolidated sediments — alluvial and lacustrine sediments and some areas of loess — and some sedimentary rocks comprise most of the underlying material. The Calcic Yermosols support only a sparse growth of xerophytic shrubs and grass which afford a little grazing; some areas are barren. In those locations where irrigation water is available, small grains and forage crops are grown; cotton and sorghum are raised in parts of New Mexico and Texas, and potatoes, beans and sugar beets in Utah and Idaho. Associated soils are Lithosols, Regosols and, locally, Gypsic Yermosols in New Mexico.

Yl. LUVIC YERMOSOLS

Luvic Yermosols are by far the most extensive of the Yermosols. They are distributed through the southwestern part of the country, from western Texas west to southern California and north to northern Nevada. Soil temperature and soil moisture regimes do not differ from those of Yermosols in general. The soils support a sparse growth of xerophytic shrubs and grasses, some of which afford a little grazing;

in southern Nevada and southeastern California where vegetative growth is especially sparse or lacking, the Yermosols generally are ungrazed. Water for irrigation is in very short supply, but where it is available forage crops and small grains are raised. Associated soils are Calcic Yermosols, Luvic Kastanozems and some areas of Solonetz and Calcaric Regosols.

Z. Solonchaks in Canada

Solonchaks are widely distributed throughout the glaciated interior plains of Canada, commonly occurring in small undrained potholes and depressions and in intermittently dry lake basins. Very few areas of Solonchaks are extensive enough to be mapped as the dominant soil on the landscape, or to be subdominant associates of other soils. Only two areas, one of Orthic Solonchaks with associated Kastanozems and a second with Mollic Solonchaks as the associated soil in a Regosol-Solonchak complex, have been mapped on the soil map. Both these areas are within the province of Saskatchewan.

Zg. GLEYIC SOLONCHAKS

The other relatively extensive occurrence of Solonchaks in Canada are Gleyic, in a complex of Regosols and associated Kastanozems. These occur on the Saskatchewan plain between Last Mountain and Manitou and Quill lakes. This area is another remnant glacial lake basin with negligible or intermittent external drainage. The soil climate regime of these soils is boreal and semiarid. Parent materials are generally loamy, calcareous and saline. Sodium and magnesium sulfates are the dominant salts, but there is also a significant inclusion of chlorides. Most of these Solonchak soils are in native grass and are used for grazing. The associated Kastanozems are generally used for grain production. Generally, salinity of these Gleyic Solonchaks is less severe and the grazing capacity is proportionally higher than on the soils in the Old Wives lake basin.

Zo. ORTHIC SOLONCHAKS

An area of Orthic Solonchaks about 1 300 sq km in extent includes and surrounds Old Wives lake, an intermittently wet and dry saline lake basin in southwestern Saskatchewan. The soil climate is boreal subarid. A significant proportion of Orthic Kastanozems is also found in the area. The parent materials range from sandy to loamy lacustrine sediments and are calcareous and saline. Salts are

dominantly sodium and magnesium sulfates derived from the cretaceous shales which underlie and are incorporated in the glacial deposits of the area. The topography of the lake basin is gently undulating to flat and depressional; the lake itself, fed by the Wood river and its tributaries, has no external drainage except in periods of exceptionally high rainfall. Evaporation in this part of the country is high and in many years the edge of the lake recedes and the exposed parts of the lake bed become dry and form salt flats.

The Solonchak areas support sparse vegetative growth consisting mainly of salt-tolerant grasses and shrubs used for rough pasture even though the grazing capacity is very low; many areas are bare of vegetation. Associated Kastanozems are commonly slightly saline, and although cropped are of relatively low productivity. Many smaller areas of Solonchak soils are found within the same region, particularly along the alluvial flats of the Big Muddy valley, an old glacial channel leading to the Missouri valley in Montana.

Many other areas of Solonchak soils occur; most are found in relatively small basins or in narrow margins surrounding lakes. Generally they are considered nonarable but have a limited capacity for rough grazing.

Z. Solonchaks in the United States

Solonchaks occur in the United States only as associates of soils much more extensively distributed on the landscape, mainly the Calcaric Fluvisols of southern California and western Nevada and the Orthic Solonetz of northwestern Utah.

Presence of salts generally precludes use of these soils for any crops.

Conclusions

North America has a wide range of soils extending from subtropical and arid to polar regions. Most of the soil units of the soil map are present on the continent, but soils of the humid tropical climates such as Ferralsols are absent.

The major types of land use are closely related to soil and climatic conditions. Intensive agricultural land uses are concentrated in the eastern and central United States and locally along the western coast. Low-intensity types of land use with local irrigation schemes coincide with the semiarid climate of the

west. In Canada, permanent agriculture is confined to the southern part of the country, leaving large mountainous and arctic areas covered with the natural forest or tundra vegetation. By and large, special crop, fruit and vegetable production are located in areas with high density of population.

General farming including cash crops and feed grains, together with grazing, forage production and woodlands, are dominant in the eastern part of the United States. Sizable areas of forest cover the Appalachian and Allegheny mountains. The main soil units in the area are Orthic Acrisols, Chromic Luvisols and Dystric Cambisols on the mountain slopes.

Forage, livestock production and forests on steeper land cover extensive areas of the northeastern United States, the northern lake states and southeastern Quebec, where Podzols and locally Dystric Cambisols are dominant. The use of forest land for recreation is important in this densely populated area.

Fruit and vegetable crops and dairy production are the main land uses in the lake states and southern Ontario on Albic and Orthic Luvisols.

Feed grain and livestock production are dominant in the cornbelt, on Orthic Luvisols in the east and Luvic and Haplic Phaeozems in the west.

Spring and winter wheat are the principal agricultural products in the central and northern great plain, which extends far beyond the Canadian border in Saskatchewan. The dominant soils are Luvic and Haplic Kastanozems with Haplic Chernozems in the north and Calcic Luvisols in the south.

The western semiarid and arid regions of plain plateaus and isolated mountains are rangeland, with irrigation agriculture where water is available and soils favourable. The leading soil units are Xerosols, Yermosols and locally Vertisols.

In the Rocky mountain range, forest is dominant on slopes and crests but there are some broad valleys and high plateaus where grazing is the leading land use and the main soils are Luvic Kastanozems, Luvic Chernozems and Eutric Cambisols.

Wheat production and rangeland grazing are the main land use in the northwestern United States, on Haplic and Luvic Kastanozems.

The steep areas along the northwestern coast of the United States and the Vancouver area are covered with forests, with some general farming, fruit and special crops in the valleys. The dominant soils are Humic Cambisols and Humic Acrisols.

The region of hills and broad valleys in California is well known for its climate favourable for fruit, vegetable and specialty crop production. The main soils are Chromic Luvisols and Orthic Acrisols.

**MORPHOLOGICAL, CHEMICAL AND PHYSICAL PROPERTIES OF NORTH AMERICAN SOILS:
DATA FROM SELECTED PROFILES**

In this appendix data are presented on typical profiles representing the major soil units that occur as dominant or associated soils on the Soil Map of North America.

The purpose of including these descriptions and tables is to help define more clearly the nature of the soil units used in the map. Naturally, the description and analyses of one profile will not show the range of soil characteristics and climatic conditions within such broad units, but combined with the definitions in Volume I and with the descriptions and analyses in the other volumes they should at least help in understanding the concepts on which the legend is based.

The data have been set out systematically to include most of the items generally available in survey reports. The profile descriptions were written over a period of more than 20 years and there is, of course, considerable diversity in the amount and kind of information they contain. However, an attempt has been made to present it as uniformly as possible so that valid comparisons can be made.

Presentation of data

Whenever possible the data have been taken from the original documents without alteration. However, some changes have been made for the sake of brevity or uniformity of presentation in the site descriptions.

SITE DESCRIPTION

The information used to describe the site is as follows:

Location: An attempt was made to locate the site of each profile, either in a country and state or by the distance and direction from a main town, or by latitude and longitude.

Classification: USDA (U.S. Department of Agriculture) or Canada (Department of Agriculture) classification.

Altitude: The altitude, where available, is given in metres above mean sea level.

Physiography: Where possible, the nature of the landscape as well as the slope at the profile site are given. Because of differences in definition of terms such as undulating, moderately steep, etc., figures are used if they are available.

Drainage: The natural drainage of the soil is commonly described in terms of the *drainage classes* of the U.S. Soil Conservation Service *Soil survey manual*, and is a synthesis of runoff, permeability and internal soil drainage.

Parent material: The origin and nature of the material and the bedrock, if near the surface, are given under this heading.

Vegetation: The potential natural vegetation, or primitive vegetation outside human influence, is described or inferred from that remaining in relict areas, or from study of other environmental factors.

Climate: The soil climate is given and usually includes the temperature and moisture regimes.

PROFILE DESCRIPTION

The profile descriptions are made in accordance with the specifications of the U.S. Soil Conservation Service *Soil survey manual*. The information is given in the order: colour, mottling, texture, structure, consistency, other items. Horizon designations have been altered to conform with the definitions given in Volume I. Where they were not included in the original description, they have been added on the basis of the descriptive and analytical information available.

ANALYSES

The methods of analysis are described in the Soil Survey Investigations Report No. 1, *Soil survey laboratory methods and procedures for collecting soil samples*, issued in 1967 by the U.S. Soil Conservation Service.

In the tables of soil analyses, most headings for columns of laboratory data include a symbol that refers to a method described in the above report.

The main methods of analysis are listed below for easy reference:

Particle size analysis (3A1): Pipette method with sodium metaphosphate as dispersing agent. Results are sometimes given for both U.S. Department of Agriculture and International Society of Soil Science silt fractions.

Organic Carbon (6A1a): Walkley-Black method.

Organic Nitrogen (6B2a): Semi-micro Kjeldahl method.

pH H₂O and KCl (8C1a-8C1c): Dilution 1 : 1.

Extractable or exchange acidity (6H1a): Barium chloride - triethanolamine pH 8.2 displacement method.

CEC and extractable cations (5A1): Displacement by ammonium acetate, 1N, pH 7 method.

LIST OF SOIL PROFILES

<i>Symbol and unit</i>			<i>Country</i>	<i>Page</i>	<i>Symbol and unit</i>			<i>Country</i>	<i>Page</i>
Af	ACRISOL	Ferric	United States	118	La	LUVISOL	Albic	Canada	162
Ag		Gleyic	United States	120	Lc		Chromic	United States	164
Ah		Humic	United States	122	Lg		Gleyic	United States	166
Ao		Orthic	United States	124	Lo		Orthic	United States	168
Bd	CAMBISOL	Dystric	Canada	126	Mo	GREYZEM	Orthic	Canada	170
Be		Eutric	Canada	126	Od	HISTOSOL	Dystric	Canada	172
Bx		Gelic	Canada	128	Oe		Eutric	Canada	174
Ch	CHERNOZEM	Haplic	Canada	130	Ox		Gelic	Canada	174
Ck		Calcic	Canada	132	Pg	PODZOL	Gleyic	United States	176
Cl		Luvic	Canada	132	Pl		Leptic	United States	178
De	PODZOLUVISOL	Eutric	United States	134	Po		Orthic	United States	180
E	RENDZINA		Canada	136			Canada	182	
Ge	GLEYSOL	Eutric	Canada	138	Rc	REGOSOL	Calcaric	United States	184
Gh		Humic	United States	140	Rd		Dystric	United States	186
Gm		Mollic	Canada	142	Re		Eutric	Canada	186
Gx		Gelic	Canada	142	Rx		Gelic	Canada	188
Hg	PHAEZEM	Gleyic	United States	144	Sm	SOLONETZ	Mollic	Canada	188
Hh		Haplic	United States	146	So		Orthic	United States	190
Hi		Luvic	United States	150	Vc	VERTISOL	Chromic	United States	192
Jc	FLUVISOL	Calcaric	United States	152	Vp		Pellic	United States	194
Jd		Dystric	Canada	154	Xk	XEROSOL	Calcic	United States	198
Je		Eutric	Canada	154	Xl		Luvic	United States	200
Kh	KASTANOZEM	Haplic	Canada	156	Yk	YERMOSOL	Calcic	United States	202
Kk		Calcic	United States	156	Yl		Luvic	United States	204
Kl		Luvic	Canada	160	Zo	SOLONCHAK	Orthic	Canada	206

FERRIC ACRISOL Af

Classification (USDA)	Typic Hapludult, clayey, mixed (?), thermic
Location	Johnston County, North Carolina
Altitude	60 m (approximately)
Physiography	Valley slope erosion surface; slope 4%
Drainage	Moderately well drained
Parent material	Coastal plain sediments
Vegetation	Cultivated
Climate	Thermic; humid

Profile description

Ap	0-9 inch	Brown (10YR 5/3) medium loamy sand with few to common fine to medium (0.25-0.50 inch) quartz pebbles; single grain; loose; side-valley alluvium; abrupt boundary.
2Bt1	9-18 inch	Strong brown (7.5YR 5/6) medium to coarse sandy clay; moderate medium sub-angular blocky; common thin discontinuous clayskins; friable to firm; many coarse distinct yellowish brown (10YR 5/4) and common medium prominent yellowish red mottles; few to common fine pebbles; few fine mica; noncalcareous Tuscaloosa formation; gradual wavy boundary.
2Bt2	18-24 inch	Variegated yellowish brown, and yellowish red (10YR 5/4, 5/8 and 5YR 4/8) medium to coarse sandy clay; weak medium to coarse subangular blocky; thin continuous clayskins on coarser peds; friable, common fine to coarse mica; abrupt irregular (contact across 4 feet of the pit is from 23 to 34 inches below surface) boundary.
3BC	24-28 inch	Light grey (10YR 6/1) smooth clay with few fine sand grains; moderate medium to coarse angular blocky; thin discontinuous clayskins in pores and larger aggregates; firm; common medium faint light grey (10YR 7/1) and common coarse red (2.5YR 4/6) mottles; common very fine and fine mica; clear irregular boundary with a relief of 8 inches.
3C1	28-40 inch	Light grey (10YR 6/1) smooth clay with few very fine sand grains or silt; weak coarse angular blocky; firm; common coarse prominent red (2.5YR 4/6) mottles; few very fine and fine mica; abrupt smooth boundary.
4C2	40-48 inch	Light grey (10YR 6/1) loamy very fine sand; massive to very weak platy; slightly brittle when moist, very hard when dry; common faint light grey (10YR 7/1) and common coarse distinct yellowish brown (10YR 5/6) streaks and mottles; few horizontally oriented hard to very hard sesquioxide tubes and nodules 0.5 inch in diameter are associated with the yellowish brown colours; gradually smooth boundary.
4C3	48-60 inch	Greyish brown (10YR 5/2) sandy loam with common light grey (10YR 7/1) horizontal clay lenses less than 1 inch thick; friable sandy loam with few slightly brittle areas; clay is very firm; common very coarse prominent strong brown (7.5YR 5/8) and common fine prominent yellowish red (5YR 5/8) mottles; few fine micas; base of observation 66 inches; the clay lenses are discontinuous across the face of the pit and were not sampled.

Horizon	Depth inches	1B1b Size class and particle diameter (mm) 3A1														
		Total			Sand					Silt			Coarse fragments 3B1			
		Sand (2-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	0.05-0.02	Int. III (0.02-0.002)	Int. II (0.2-0.02)	(2-0.1)	2A2 > 2 < 76	2-19	19-76
		% of < 2 mm													%	% of < 76 mm
Ap	0-9	88.6	7.0	4.4	7.1	17.5	18.8	31.8	13.4	4.9	2.1	33.2	75.2	7		
2Bt1	9-18	48.0	17.2	34.8	3.7	10.8	11.7	10.8	11.0	11.0	6.2	27.0	37.0	1		
2Bt2	18-24	44.8	20.0	35.2	1.5	10.7	11.2	8.9	12.5	22.0	9.0	27.6	32.3	tr		
3BC	24-28	30.6	28.5	40.9	0.4	4.8	5.5	4.8	15.1	15.7	12.8	33.3	15.5	tr		
3C1	28-40	33.0	28.1	38.9	0.2	0.8	1.2	4.9	25.9	17.0	11.1	46.8	7.1	tr		
4C2	40-48	79.9	4.8	15.3	3.5	33.6	25.5	14.1	3.2	1.4	3.4	8.0	76.6	tr		
4C3	48-60	77.3	3.0	19.7	1.9	20.1	25.0	27.2	3.1	0.5	2.5	11.4	74.2	tr		

Horizon	Organic matter			Carbonate as CaCO ₃ %	6C1a Ext. iron as Fe %	Bulk density			Water content			pH	
	6A1a OC %	6B2a N %	C/N			g/cm ³	4A1e 1/3-bar g/cm ³	4A1h Oven dry g/cm ³	%	4B1c 1/3-bar %	4B2 15-bar %	8C1c (1:1) KCl	8C1a (1:1) H ₂ O
Ap	0.24	0.026	9		0.1								4.7
2Bt1	0.14				1.3								4.7
2Bt2	0.08				1.0								4.7
3BC	0.04				0.6								4.6
3C1	0.04				0.3								4.4
4C2	0.02				0.6								4.4
4C3	0.02				0.5								4.5

Horizon	Extractable bases 5B1a					6H2a Ext. acidity	5A3a CEC Sum cations	6G1d Ext. Al	Ratios to clay 8D1			8D3 Ca/Mg	Base saturation	
	6N2d Ca	6O2b Mg	6P2a Na	6Q2a K	Sum				CEC Sum	Ext. iron	15-bar water		5C3 Sum cations %	5C1 NH ₄ OAc %
Ap	0.3	0.1	tr	0.1	0.5	1.6	2.1	0.5	0.48	0.02		3	16	
2Bt1	2.3	0.5	tr	0.2	3.0	8.4	11.4	4.5	0.33	0.04		5	26	
2Bt2	1.4	0.3	tr	0.1	1.8	8.4	10.2	6.7	0.29	0.03		5	18	
3BC	1.3	0.6	0.1	0.1	2.1	12.0	14.1	9.8	0.34	0.01		2	15	
3C1	0.6	0.5	0.1	0.1	1.3	12.5	13.8	12.2	0.35	0.01		1	9	
4C2	tr	0.3	tr	tr	0.3	4.7	5.0	4.3	0.33	0.04		—	6	
4C3	0.1	0.2	0.1	tr	0.4	6.6	7.0	5.8	0.36	0.02		—	6	

Horizon	Clay fraction analysis ¹ 7A1b-d								X-ray spectrographic analysis of 0.25-0.05 mm sand fraction			
	Montmorillonite	Chlorite	Vermiculite	Mica	Int. layer Al-Vm.	Quartz	Kaolinite	Gibbsite	ZrO ₂	TiO ₂	K ₂ O	CaO
	7A2 X-ray							DTA 7A3		%	%	%
Ap	—	—	xx	x	x	x	38	2	0.10	0.65	0.66	0.018
2Bt1	xxx	—	—	—	xx	tr	42	tr	0.04	0.40	0.62	0.012
2Bt2	xx	—	—	—	xx	—	40	—	0.04	0.42	0.52	0.013
3BC	xxx	—	—	—	xx	—	48	—	0.05	0.41	0.25	0.013
3C1	xxx	—	—	—	xx	—	46	—	0.03	0.42	0.80	0.012
4C2	xxx	—	—	—	xx	—	43	—	0.05	0.45	0.89	0.010
4C3	xxx	—	—	—	xx	—	40	—	0.04	0.41	0.84	0.010

¹ Relative amounts: blank = not determined, dash = not detected, tr = trace, x = small, xx = moderate, xxx = abundant, xxxx = dominant.

GLEYIC ACRISOL Ag

Classification (USDA)	Aeric Paleaquult, clayey, mixed, thermic
Location	McIntosh County, Georgia
Altitude	10 m (approximately)
Physiography	Nearly level (0 to 2%) marine terrace
Drainage	Somewhat poorly drained
Parent material	Coastal plain sediments
Vegetation	Cut-over wooded area - slash pine (<i>Pinus caribaea</i>), sweet gum (<i>Liquidambar styraciflua</i>), red oak (<i>Quercus borealis</i>), post oak (<i>Q. stellata</i>), gallberry (<i>Ilex glabra</i>)
Climate	Humid; thermic

Profile description ¹

Ah	0-3 inch	Black (N 2/0) fine sandy loam; weak fine granular structure; very friable when moist, sticky when wet; boundary abrupt.
ABg	3-9 inch	Greyish brown (10YR 5/2) fine sandy loam with common medium faint mottlings of yellowish brown (10YR 5/4); weak fine granular structure; very friable when moist, slightly sticky when wet; boundary clear and smooth.
BAg	9-16 inch	Yellowish brown (10YR 5/6) fine sandy clay loam with many coarse mottlings of greyish brown (2.5Y 5/2) and a few fine to medium mottlings of strong brown (7.5YR 5/6); subangular blocky structure; friable when moist, sticky when wet; boundary gradual and smooth.
Btg1	16-21 inch	Grey (10YR 6/1) fine sandy clay with many medium prominent mottlings of yellowish brown (10YR 5/6) and common medium mottles of red (2.5YR 4/8); moderate medium angular blocky structure; slightly firm when moist, very sticky when wet; boundary gradual and smooth.
Btg2	21-31 inch	Grey (N 5/0) clay with many medium prominent mottlings of dark red (2.5YR 3/6) and common medium mottles of yellowish brown (10YR 5/6); strong medium angular blocky structure; firm when moist, very sticky when wet; boundary gradual and smooth.
Btg3	31-47 inch (60 inch plus)	Grey (10YR 5/1) fine sandy clay with many medium prominent mottlings of dark red (2.5YR 3/6) and common medium distinct mottles of yellowish brown (10YR 5/6); moderate medium angular blocky structure; firm when moist, very sticky when wet.

NOTE: Colour of soil moist unless otherwise stated.
¹ See Volume 1 for definition of horizons.

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
Ah	0-3	0.9	2.0	2.3	30.6	29.3	29.2	5.7	68.0	15.7	tr	fs1
ABg	3-9	0.3	1.3	1.7	30.1	26.4	29.5	10.7	65.3	16.5	tr	fs1
BAG	9-16	0.3	1.1	1.4	20.9	24.4	28.5	23.4	52.8	17.6	tr	f
Btg1	16-21	0.1	0.8	1.2	18.0	20.7	27.1	32.1	45.5	17.5	tr	cl
Btg2	21-31	0.2	0.4	0.7	12.6	15.1	20.9	50.1	33.6	13.2	tr	c
Btg3	31-47	0.2	0.5	0.8	13.6	13.1	22.1	49.7	33.0	18.8	—	c

Horizon	pH			Organic matter			6C1a	CaCO ₃ equiv. %	Moisture tensions		
	8C1a (1:1) H ₂ O	(1:5)	(1:10)	6A1a OC %	6B1a N %	C/N	Free iron Fe ₂ O ₃ %		4B1a $\frac{1}{10}$ atm. %	4B1a $\frac{1}{3}$ atm. %	4B2 15 atm. %
Ah	5.1			2.50	0.104	24	0.4		28.0	15.9	3.6
ABg	5.2			0.52	0.028	18	0.4		19.7	12.2	3.7
BAG	4.9			0.20	0.030		1.0				8.5
Btg1	4.7			0.17	0.030		1.3				10.7
Btg2	4.7			0.17	0.042		2.0				16.8
Btg3	4.6			0.16			2.3				16.7

Horizon	5A1a	Extractable cations 5B1a					5C1	5C3	5B1a	5A3a	Ca/Mg	Bulk density
	Cation exchange capacity NH ₄ OAc	6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	BS % NH ₄ OAc exch.	BS % on sum cations	Sum bases	Sum cations		
		me/100 g							me/100 g			
Ah	7.1	1.3	0.7	5.4	<0.1	0.1	30	28	2.1	7.5		
ABg	4.8	0.8	0.6	8.6	<0.1	<0.1	29	14	1.4	10.0		
BAG	8.2	0.5	1.0	9.6	0.1	<0.1	20	14	1.6	11.2		
Btg1	10.4	<0.1	1.0	12.4	0.1	0.1	12	9	1.2	13.6		
Btg2	18.2	<0.1	1.8	21.9	0.2	0.1	12	9	2.1	24.0		
Btg3	18.8	<0.1	1.6	22.4	0.2	0.1	10	8	1.9	24.3		

¹ Common smooth and irregular light brown concretions (Fe-Mn?).

HUMIC ACRISOL Ah

Classification (USDA)	Ultic Tropudalf; very fine, mixed, isohyperthermic
Location	Cibuco Soil Conservation District, Puerto Rico. Barranquitas Soil Study Area
Altitude	610 to 615 m
Physiography	Dissected mountain footslopes
Drainage	Well drained
Parent material	Weathering of basaltic-andesite flow breccia
Vegetation	Idle road bank; previously cultivated
Climate	Isohyperthermic; humid

Profile description

Ap	0-6 inch	Dark reddish brown (5YR 3.5/2 moist) and brown (7.5YR 5/4 dry) clay; massive and moderate coarse granular; massive parts break down to coarse granules; hard; many coarse pores; much worm activity; a few smooth macrosurfaces perhaps from pressure orientation by worms; abrupt boundary.
BA	6-17 inch	Red (2.5YR 4/6) ped interiors and reddish brown (2.5YR 4/4) ped surfaces with few fine distinct reddish yellow mottles that show some association with the macrosurfaces and pore walls; clay; where moist, moderate to strong medium coarse blocky, and where dry along surface of cut, strong medium and fine blocky; very firm; distinct broken clay films and numerous pressure surfaces; sand-size black aggregates common; some light-coloured, sand-size grains; few interped pores; roots common; gradual boundary.
Bt	17-34 inch	Red (2.5YR 4/6) clay with reddish brown (2.5YR 4/4) macrosurfaces and with few fine distinct yellowish brown mottles; moderate to weak coarse blocky; firm; few distinct clay films; common pressure surfaces; occasional slickenside; few black sand-size aggregates; few fine pores; 5 to 10 percent saprolitic material ranging from sand-size to 0.5-inch diameter; clear wavy boundary.
C1	34-60 inch	Red (2.5YR 4/6) and reddish yellow (5YR and 7.5YR 6/6 to 6/8) about equal with many reddish brown (2.5YR 4/5) vertical surfaces; silty clay; moderate coarse prismatic with prisms at about 30 degrees to vertical; clay films on vertical surfaces; cleavage planes appear largely controlled by original rock structure.
C2	60-90 inch	Saprolite. Reddish yellow (5YR and 7.5YR 6/6 to 6/8) with 30 percent reddish brown (2.5YR 4/4) along macrosurfaces and as parts about 0.5 inch in diameter; silty clay; firm; slickenside surfaces at 30 degrees to vertical; clay films common on vertical surfaces but sparse considering the whole soil mass; clay films commonly have pustular surface.
C3	90-114 inch	Transition from C2 to C4.
C4	114-138 inch	Saprolite. Reddish yellow (5YR and 7.5YR 6/6 to 6/8) with about 20 percent reddish brown (2.5YR 4/4) as apparently disconnected parts about 0.5 inch in diameter and as coatings on macrosurfaces; silty clay loam; very firm; many soft white bodies about 1 mm across; black (N 2/0) Fe-Mn (?) concentrations common on macrosurfaces; few clay films on macrosurfaces; presence of the small white bodies and the black coatings are the principal differences from the C2.
C5	150-174 inch	Similar to C4 with a more greenish cast; veins of light olive grey (5Y 6/2); obtained a sample of the veins as well as the bulk sample.
R1	204 inch	Saprolitic rock that when saturated can be broken in the hands only with difficulty; numerous black coatings on macrosurfaces; interiors of saprolitic rock fragments have numerous whitish bodies as described in the C4 horizon; some reddish brown (2.5YR 4/4) clay on fracture surfaces.
R2	222 inch	Weathered lava with prominent rock structure; much greenish material; surfaces of fractures black; several epidote-rich veins and light-coloured quartz veins.
R3	222 inch	Unweathered rock.

Horizon	Depth inches	Size class and particle diameter ¹ (mm) 3A1															
		Total			Sand					Silt			3Alc Water-disp. clay < 0.002	Coarse fragments			
		Sand (2-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	0.05-0.02	Int. III (0.02-0.002)	Int. II (0.2-0.02)		(2-0.1)	2A2 > 2 (< 19)	2-19	19-76
		% of < 2 mm													%	% of < 76 mm	
Ap	0-6	18.1	26.5	55.4	2.4	2.8	2.2	5.7	5.0	6.6	19.9	14.8	13.1		tr		
BA	6-17	6.8	23.5	69.7	0.4	0.6	0.7	2.5	2.6	4.3	19.2	8.4	4.2	36	tr		
Bt	17-34	10.3	28.6	61.1	0.1	0.5	1.0	4.6	4.1	6.3	22.3	13.2	6.2	14	tr		
C1	34-60	22.5	34.4	43.1	1.8	2.7	2.5	7.5	8.0	9.0	25.4	21.4	14.5		tr		
C2	60-90	42.4	33.4	24.2	1.5	6.9	7.1	16.1	10.8	9.8	23.6	29.2	31.6				
C4	114-138	44.2	39.0	16.8	1.6	5.5	5.9	16.9	14.3	13.4	25.6	37.4	29.9		5		
C5	150-174	44.9	35.9	19.2	7.5	10.6	5.0	11.0	10.8	11.8	24.1	29.0	34.1		tr		

Horizon	Organic matter			Carbonate as CaCO ₃	6C2a Ext. iron as Fe	Bulk density			4D1 COLE	Water content			pH	
	6A1a	6B1a	C/N			4A1a	4A1c	4A1b		4B4	4B3	4B2	8C1c	8C1a
	OC*	N				Field state	30 cm	Air dry		Field state	30 cm	15-bar	(1:1)	(1:1)
	%	%				g/cm ³	g/cm ³	g/cm ³		%	%	%	N KCl	H ₂ O
Ap	3.19	0.291	11		7.8	1.31	1.23	1.37	0.014	27.2	29.1	24.9	4.2	4.9
BA	1.36	0.134	10		8.8	1.16		1.44	0.073	43.7		34.6	3.7	4.6
Bt	0.82	0.090	9		8.3	1.06		1.38	0.092	49.4		33.7	3.0	4.6
C1	0.29	0.037	8		6.3	1.07		1.22	0.044	42.6		31.4	3.5	4.4
C2	0.11				5.5	1.08		1.20	0.036	41.8		25.7	3.7	4.9
C4	0.04				4.3	1.23		1.31	0.020	27.2		20.1	3.7	5.3
C5	0.04				2.5	1.55		1.62		16.7		18.9	3.7	5.6

Horizon	Extractable bases 5B1a					6H1a Ext. acidity	CEC		6G1d KCl-ext. Al	5A3b Bases plus al me/100 g clay	8D3 Ca/Mg	Base saturation		Ratios to clay ¹ 8D1		
	6N2b	6O2b	6P2a	6Q2a	Sum		5A3a	5A1a				5C3	5C1	NH ₄ OAc	Ext. iron	15-bar water
	Ca	Mg	Na	K			Sum cations	NH ₄ OAc				Sum cations	NH ₄ OAc	CEC		
	me/100 g											%	%			
Ap	10.3	8.4	0.1	1.0	19.8	21.5	41.3	28.4	0.6	36.8	1.2	48	70	0.51	0.14	0.45
BA	3.7	5.4	0.2	0.2	9.5	29.2	38.7	27.6	11.6	30.3	0.7	24	34	0.40	0.13	0.50
Bt	1.7	6.5	0.2	0.2	8.6	29.3	37.9	27.1	13.0	35.4	0.3	23	32	0.44	0.14	0.55
C1	1.6	16.5	0.2	0.4	18.7	26.8	45.5	35.1	15.0	^a 43	0.1	41	53	0.81	0.15	0.73
C2	3.5	24.4	0.3	0.4	28.6	15.1	43.7	35.8	4.5	^a 52	0.1	65	80	1.48	0.23	1.06
C4	10.2	27.4	0.4	0.5	38.5	12.9	51.4	42.3	1.5	^a 80	0.4	75	91	2.52	0.26	1.20
C5	19.9	26.3	0.6	0.4	47.2	8.3	55.5	47.7	0.6	^a 102	0.8	85	99	2.48	0.13	0.98

¹ Figures in italics indicate that the nonclay probably has strong clay-like properties. - ^a 17 kg/m³ to 60 inches (Method 6A). - ^b Clay percentage is estimated (15-bar water percentage × 2.5).

ORTHIC ACRISOL Ao

Classification (USDA)	Typic Fragiudult; fine-loamy, mixed, thermic
Location	Covington County, Mississippi
Altitude	90 m (approximately)
Physiography	Gently sloping (3%) ridge with northwest exposure
Drainage	Moderately well to well drained. Permeability is moderate in the horizons above the fragipan and slow in that layer
Parent material	Coastal plain material
Vegetation	Mixed pine (<i>Pinus</i> spp.) and hardwood (mostly oaks, <i>Quercus</i> spp.) with under-story of dogwood (<i>Cornus</i> spp.), persimmon (<i>Diospyros</i> spp.), sumac (<i>Rhus</i> spp.), blackgum (<i>Nyssa sylvatica</i>), huckleberry (<i>Gaylussacia</i> spp.) and maple (<i>Acer</i> spp.) saplings
Climate	Thermic; humid

Profile description

O	1-0 inch	Thin litter of leaves, principally oaks and pine needles.
Ah	0-3 inch	Very dark greyish brown (10YR 3/2 moist) fine sandy loam; medium to coarse and fine crumb structure; very friable; many coarse roots and many fibrous roots; smooth abrupt boundary.
E	3-5 inch	Yellowish brown to light olive brown (10YR 5/4 and 2.5Y 5/4 moist) fine sandy loam; medium and fine platy structure with some weak fine subangular blocky peds; friable; root bleaching along fine pores; clear smooth boundary.
EB	5-10 inch	Brown to yellowish brown (10YR 5/3 and 5/4 moist) fine sandy loam; weak medium to fine granular structure; friable; few fine roots; many worm casts and pores filled with Ah material; clear smooth boundary.
BE	10-13 inch	Brown (10YR 4/3 moist) to yellowish brown (10YR 5/4 moist) or strong brown (7.5YR 5/6 moist) very fine sandy clay loam; weak medium to fine subangular blocky structure; friable; clear smooth boundary.
Bt1	13-24 inch	Yellowish red (5YR 4/8 moist) very fine sandy clay loam; weak to moderate medium to fine subangular blocky structure; friable; plastic and sticky when wet; clayskins prominent and continuous in pores but faint to patchy around peds; clear smooth boundary.
Bt2	24-32 inch	Yellowish red to strong brown (5YR 4/8 and 7.5YR 5/6 wet) sandy clay loam; weak to moderate medium and fine subangular blocky structure; slightly sticky, slightly plastic; clayskins continuous along root channels; clear smooth boundary.
BCx1	32-41 inch	Yellowish red to strong brown (5YR 5/6 and 7.5YR 5/6 wet) sandy loam; soil is very firm and massive in place but is friable when removed; breaks to moderate medium and coarse platy and subangular blocky peds; few roots occur mainly in the grey streaks along ped faces; abrupt wavy boundary.
BCx2	41-56 inch	Strong brown (7.5YR 5/6 wet) and very pale brown (10YR 7/4 wet) sandy loam; coarse prismatic peds; in place soil is very firm and appears massive but when displaced is friable; peds are vesicular; few roots along grey streaks.

ORTHIC ACRISOL

United States

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay < 0.002	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
Ah	0-3	0.6	3.8	16.6	24.4	2.4	46.6	5.6	27.4	27.8	—	fs1
E	3-5	0.1	3.5	16.7	26.3	2.5	45.5	5.4	28.1	26.9	—	fs1
EB	5-10	0.2	3.6	17.6	25.8	2.2	44.7	5.9	27.8	25.5	—	fs1
BE	10-13	0.1	¹ 2.6	¹ 13.8	¹ 22.2	² 2.0	47.4	11.9	25.5	29.5	—	1
Bt1	13-24	0.1	¹ 3.2	¹ 13.9	¹ 21.0	¹ 1.8	37.0	23.0	20.5	23.5	—	1
Bt2	24-32	0.1	¹ 4.1	¹ 21.2	¹ 34.0	² 2.9	27.9	9.8	22.4	17.3	—	fs1
BCx1	32-41	0.3	¹ 4.6	¹ 24.4	¹ 39.2	³ 3.2	20.8	7.5	21.4	12.6	—	fs1
BCx2	41-56	0.1	4.3	26.2	28.4	2.7	19.8	18.5	19.3	11.7	—	s1

Horizon	pH			Organic matter			6C1a Free iron Fe ₂ O ₃ %	CaCO ₃ equiv. %	Moisture tensions		
	8C1a 1:1 H ₂ O	1:5	1:10	6A1a OC %	6B1a N %	C/N			4B1a ¹ / ₁₀ atm. %	4B1a ¹ / ₃ atm. %	4B2 15 atm. %
Ah	4.9			2.92	0.107	27	0.4		35.0	19.9	3.8
E	5.2			0.82	0.033	25	0.5		24.6	16.9	2.5
EB	5.2			0.22	0.018		0.5		19.4	15.5	2.0
BE	5.1			0.17	0.026		1.0		22.1	17.9	4.1
Bt1	5.0			0.18	0.031		2.3		28.8	20.4	8.8
Bt2	5.0			0.08			1.0		17.6	12.7	3.6
BCx1	5.0			0.04			0.7		15.0	10.3	2.9
BCx2	5.0			0.06			1.8		18.7	13.4	6.6

Horizon	5A1a	Extractable cations 5B1a					5C1 BS NH ₄ OAc exch. %	5C3 BS on sum cations %	5B1a Sum bases me/100 g	5A3a Sum cations me/100 g	Ca/Mg
	CEC NH ₄ OAc	6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K					
Ah	9.2	1.4	0.4	11.9	0.1	0.2	23	15	2.1	14.0	
E	3.8	0.6	0.4	3.6	<0.1	0.1	29	23	1.1	4.7	
EB	2.0	0.2	0.1	2.2	<0.1	0.1	20	15	0.4	2.6	
BE	3.4	0.3	0.8	3.2	<0.1	0.2	38	29	1.3	4.5	
Bt1	8.3	0.3	2.2	6.4	0.1	0.3	35	31	2.9	9.3	
Bt2	3.0	<0.1	0.4	3.2	<0.1	0.1	17	14	0.5	3.7	
BCx1	2.3	<0.1	0.3	2.3	<0.1	0.1	17	15	0.4	2.7	
BCx2	4.1	0.8	0.4	4.1	<0.1	0.2	34	25	1.4	5.5	

¹ Many irregular dark brown to black concretions (Fe-Mn?). - ² Few irregular dark brown to black concretions (Fe-Mn?).

DYSTRIC CAMBISOL Bd

Classification (Canada)	Orthic Dystric Brunisol, Rayston Series, British Columbia
Location	3.2 km south of Union Bay, Vancouver Island, British Columbia
Altitude	35 m
Physiography	Irregularly sloping till plain, slightly modified by marine environment during postglacial uplift
Drainage	Well drained
Vegetation	Red cedar (<i>Thuja plicata</i>), red alder (<i>Alnus rubra</i>), red maple (<i>Acer rubrum</i>), ferns; very productive coastal forest
Climate	Mild mesic; subhumid; modified by maritime influence

Profile description

O	3-0 cm	Thin moderately well to well decomposed litter.
AB	0-25 cm	Dark brown (8.0YR 4/4 moist, 5/6 dry) loam; weak, fine subangular blocky and weak, medium granular with many coarse to fine concretions; soft with very firm or very hard concretions; clear smooth boundary; pH 5.0.
Bw	25-88 cm	Dark yellowish brown (10YR 4/4 moist, 5/6 dry) loam; weak, fine subangular blocky and weak, medium granular and few fine concretions; soft, with very firm or very hard concretions; the number of concretions diminishes with depth; clear smooth boundary; pH 5.1.
C	88-100 cm	Brown (10YR 3.5/2 moist, 5.5/3 dry) loam; amorphous; firm, hard; about 10 per cent stone; pH 5.3.

EUTRIC CAMBISOL Be

Classification (Canada)	Eutric Brunisol, Mackenzie Series, Northwest Territories
Location	61°21'N 118°34'W, west of Fort Providence, Northwest Territories
Altitude	185 m
Physiography	Alluvial terrace of Mackenzie river
Drainage	Well drained
Parent material	Moderately fine textured, moderately calcareous alluvium
Vegetation	Mixed wood forest. White spruce (<i>Picea glauca</i>), aspen (<i>Populus tremuloides</i>), white birch (<i>Betula papyrifera</i>), shrubs
Climate	Subarctic to cold cryoboreal; humid to subhumid

Profile description

O	1-0 inch	Litter of leaves and twigs.
Ah	0-0.5 inch	Light grey (10YR 7/2 dry) clay loam; weak, fine, granular; soft; abrupt smooth boundary.
Bw	0.5-10 inch	Brown and yellowish brown (10YR 5/3 and 5/4 moist, 6/3 dry) clay loam; weak, fine granular; plastic, slightly sticky; noncalcareous; abrupt smooth boundary.
BC	10-17 inch	Brown (19YR 5/3 moist, 6/3 dry) clay loam; weak, fine, granular; plastic, slightly sticky; moderately calcareous; clear smooth boundary.
C	17-36 inch	Stratified silt loam; each lamina about 3 mm thick with yellowish brown (10YR 5/4 moist) upper surface and dark grey (10YR 4/1 moist) below; upper surface slightly sandier than the grey layer; plastic, slightly sticky; moderately calcareous.

DYSTRIC CAMBISOL

Canada

Horizon	Depth cm	pH		Exchangeable cations			6A2c	Fe + Al				Amorphous Al in NaF
		8C1a H ₂ O	8C1e CaCl ₂	CEC NH ₄ OAc	Ca + Mg	CEC Ca(OAc) ₂	OC	Oxalate 6C6		Na pyrophosphate ext. 6C5		
		mc/100 g					%	Fe %	Al %	Fe %	Al %	
O	3—0											
AB	0—25	5.0	4.5	3.7	3.4	11.3	1.63	0.72	0.41	0.33	0.35	10.3
Bw	25—88	5.1	4.6	3.3	3.1	10.7	1.04	0.64	0.55	0.29	0.20	10.8
C	88—100	5.3	4.5	8.5	8.2	13.5	0.36	0.58	0.16	0.12	0.10	9.1

EUTRIC CAMBISOL

Canada

Horizon	Depth inches	pH		6A1a	Dithionite extractable 6C4		Oxalate extractable 6C6		Textural class
		8C1a H ₂ O	8C1e CaCl ₂	Organic matter %	Fe %	Al %	Fe %	Al %	
Ah	0—0.5								
Bw	0.5—10	6.1	5.9	1.3	1.36	0.19	0.30	0.15	cl
BC	10—17	8.1	7.9	1.2	1.00	0.09	0.28	0.09	cl
C	17—36	8.1	7.8	1.0	1.01	0.11	0.36	0.10	sil

Horizon	6B1a	6TI	CEC		Moisture equivalent %	Permanent wilting %	Estimated bulk density g/cm ³	
	N %	Soluble P ppm	CaCl ₂	Ca(OAc) ₂				
					mc/100 g			
Ah	—	—						
Bw	0.06	0.8	21.6	25.2	23.4	11.9	1.2	
BC	0.06	0.5			23.3	8.0	1.2	
C	0.04	0.8			27.6	11.4	1.2	

GELIC CAMBISOL Bx

Classification (Canada)	Cryic Eutric Brunisol
Location	68°20'N-133°20'W. 2.4 km east of Inuvik, Northwest Territories
Altitude	70 m (approximately)
Physiography	Gently to moderately sloping upland plains
Drainage	Well drained
Parent material	Moderately fine textured, weakly calcareous glacial till
Vegetation	Forest-tundra transition, including <i>Picea mariana</i> , <i>Betula primula</i> , <i>Alnus crispa</i> , <i>Salix glauca</i>
Climate	Arctic; humid with significant aquatic inclusions

Profile description

O	1-0 inch	Litter of leaves and twigs, slightly decomposed at the lower limit.
Ah		Very dark brown (10YR 2.5/2) mineral horizon high in organic matter; ranges from a trace to 0.5 inches thick; field pH 4.5.
BA	0-6 inch	Yellowish brown (10YR 5/4) silty clay loam; moderate, fine to medium granular; friable; boundary clear and smooth; pH 4.5.
Bw	6-10 inch	Dark greyish brown (10YR 4/2) clay loam; moderate, fine granular; slightly plastic; a few black pebbles; boundary gradual and smooth; pH 5.8.
BC	10-27 inch	Very dark greyish brown (2.5Y 3/2) silty clay; a few pebbles; very weak, fine granular to amorphous; moderately plastic; boundary diffuse, smooth; pH 6.8.
C	27-38.5 inch	Very dark greyish brown (2.5Y 3/2) amorphous clay loam; frozen, many small disseminated ice crystals; very plastic and sticky when thawed; pH 7.7.

Horizon	Depth inches	Particle size distribution % 3A1b						8C1a pH H ₂ O	Organic matter		
		Sand		Silt		Clay			6A1a OM %	6B1a N %	C/N
		> 50 μ	50-20 μ	20-5 μ	5-2 μ	2.0-0.2 μ	< 0.2 μ				
BA	0-6	19.4	12.2	17.9	11.1	20.5	18.8	4.5	2.9	0.12	14
Bw	6-10	21.6	12.4	19.6	13.1	24.8	8.5	5.8	2.1	0.10	12
BC	10-27	18.8	13.9	15.7	13.9	28.9	13.2	6.8	2.4	0.11	13
C	27-37	31.1	11.0	15.0	9.0	23.4	11.6	7.7	1.9	0.08	14
C	37-38.5	27.5	13.5	15.0	10.8	19.5	13.7	7.7	7.7	0.08	12

Horizon	61 CaCO ₃ equiv.	5A1b CEC me/100 g	Exchangeable cations 5B1b me/100 g				Sat. %	Fe + Al oxalate ext.	
			Ca	Mg	K	Na		Fe %	Al %
BA		24.5	11.0	4.5	0.3	0.1	65	0.66	0.19
Bw		25.9	16.5	5.8	0.2	0.1	87	0.63	0.21
BC		27.9	19.0	5.7	0.2	0.1	90	0.57	0.17
C	1.7	17.2	17.5	4.0	0.3	0.1		0.48	0.12
C		15.4	15.9	3.0	0.4	0.1		0.53	0.16

HAPLIC CHERNOZEM Ch

Classification (Canada)	Orthic Black, Oxbow Association, Saskatchewan
Location	Regina Map Sheet 721, Saskatchewan
Altitude	735 m (approximately)
Physiography	Gently rolling glacial till plain
Drainage	Well drained
Parent material	Medium textured, moderately calcareous glacial till
Vegetation	Fescue prairie (<i>Festuca scabrella</i>)
Climate	Cool boreal; subhumid

Profile description

Ah	0-6 inch	Dark grey (10YR 4/1 dry) sandy clay loam; weak coarse prismatic structure breaking to weak coarse and medium subangular blocky.
AB	6-11 inch	Very dark grey (10YR 3/1 dry) sandy clay loam; weak coarse prismatic structure breaking to moderate coarse and medium subangular blocky.
Bw1	11-17 inch	Brown (10YR 5/3 dry) sandy clay loam; moderate coarse and medium prismatic structure breaking to weak medium and fine subangular blocky.
Bw2	17-21 inch	Dark brown (10YR 4/3 dry) sandy clay loam; moderate medium subangular blocky structure which crushes to moderate, fine, granular.
Bw3	21-25 inch	Very dark brown (10YR 2/2 moist) sandy clay loam; moderate, medium subangular blocky structure which crushes to moderate, fine, granular.
Ck	25-43 inch	Brown (10YR 5/3 moist) sandy clay loam; massive to weak medium and coarse subangular blocky structure which crushes to moderate, fine, granular; moderate effervescence.
2Ck	43+ inch	Light brownish grey (2.5Y 5/2 moist) sandy loam; massive, crushes to moderate, fine, granular; moderate effervescence.

HAPLIC CHERNOZEM

Canada

Horizon	Depth inches	Particle size distribution % 3A1b							Organic matter		6E1e	5A1b	Exchangeable cations 5B1b me/100 g					8C1b	8B1a
		Coarse and medium sand	Fine sand	Very fine sand	Total sand	Silt	Total clay	Fine clay	6B1a	6A2	CaCO ₃ equiv. %	CEC me/100 g	Ca	Mg	K	Na	H	pH	EC mmhos/ cm
									N %	OC %									
Ah	0—6	21.5	15.2	14.2	50.9	28.9	20.2	13.3	0.32	3.65		25.1	21.1	6.2	2.6	0.0		7.2	0.5
AB	6—11	18.1	14.2	14.4	47.8	30.8	21.4	16.3	0.18	2.06		22.3	18.3	6.8	1.8	0.1		7.6	0.6
Bw1	11—17	19.7	15.1	15.7	50.1	29.3	20.6	17.5	0.10	0.97		18.4	12.4	4.9	1.5	0.7		7.7	0.2
Bw2	17—21	18.2	12.9	16.2	48.3	30.8	20.9	16.9			0.85							7.9	4.3
Bw3	21—25	14.1	9.8	12.7	36.6	40.4	23.0	16.2			2.40							8.1	5.1
Ck	25—43	22.2	14.4	12.4	48.9	30.0	21.1	12.3			13.70							8.2	7.7
2Ck	43+	24.4	15.2	10.5	50.0	33.2	16.7	10.0			14.40							8.4	9.0

CALCIC CHERNOZEM Ck

Classification (Canada)	Calcareous Black, Oxbow Association, Saskatchewan
Location	Regina Map Sheet 721, Saskatchewan
Altitude	735 m (approximately)
Physiography	Gently rolling glacial till plain
Drainage	Well drained
Parent material	Medium textured, strongly calcareous glacial till
Vegetation	Fescue prairie (<i>Festuca scabrella</i>), field crops
Climate	Cool boreal; subhumid

Profile description

Ap	0-9 inch	Very dark brown (10YR 2/2 moist) sandy loam; moderate medium subangular blocky and granular structure which crushes to moderate, fine, granular.
Bw	9-16 inch	Pale brown (10YR 6/3 dry) sandy loam; moderate, medium to coarse, prismatic structure breaking to moderate, medium and coarse, subangular blocky; moderate effervescence.
Ck1	16-24 inch	Light olive brown (2.5Y 5/4 moist) sandy loam; massive to weak, coarse, prismatic structure, breaking to moderate, medium and coarse, subangular blocky; strong effervescence.
Ck2	24+ inch	Light olive brown (2.5Y 5/4 moist) sandy loam; massive, crushes to moderate, fine, granular; strong effervescence.

LUVIC CHERNOZEM CI

Classification (Canada)	Eluviated Black, Angus Ridge Series, Alberta
Location	Edmonton Map Sheet 83H, Alberta
Physiography	Undulating to rolling till plain
Drainage	Well drained
Parent material	Medium textured, moderately calcareous till
Vegetation	Parkland-fescue prairie (<i>Festuca scabrella</i>)
Climate	Moderately cold cryoboreal; humid to subhumid

Profile description

Ah	0-13 inch	Black (10YR 2/1 moist, 2/2 dry) clay loam; weak, coarse, prismatic; friable; gradual wavy boundary; neutral.
AE	13-19 inch	Dark greyish brown (10YR 4/2 moist, dry) loam; weak, coarse, prismatic; friable; clear wavy boundary; medium acid.
E	19-22 inch	Light brownish grey (10YR 5/2 moist, 6/2 dry) loam; weak, fine, platy; very friable; clear wavy boundary; medium acid.
Bt	22-40 inch	Yellowish brown (10YR 5/4 moist, 5/3 dry) sandy clay loam; compound, moderate, fine prismatic and moderate fine subangular blocky; friable; gradual wavy boundary; strongly acid.
BC	40-50 inch	Yellowish brown (10YR 5/5 moist, 5/3 dry) loam; compound, moderate, medium prismatic and moderate medium subangular blocky; friable; clear wavy boundary; slightly acid.
Ck	50+ inch	Brown (10YR 5/3 moist, dry) loam to clay loam; moderate, coarse blocky; friable; moderately effervescent; moderately calcareous; mildly to moderately alkaline.

CALCIC CHERNOZEM

Canada

Horizon	Depth inches	Particle size distribution % 3A1b							Organic matter		6E1e	5A1b	Exchangeable cations 5B1b me/100 g					8C1b	8B1a
		Coarse and medium sand	Fine sand	Very fine sand	Total sand	Silt	Total clay	Fine clay	6B1a	6A2	CaCO ₃ equiv. %	CEC me/100 g	Ca	Mg	K	Na	H	pH	EC mmhos/cm
									N %	OC %									
Ap	0—9	31.7	18.1	11.2	61.0	20.8	18.2	13.1	0.23	2.72		19.8	29.0	4.5	1.7			7.7	0.6
Bw	9—16	34.0	16.9	14.5	65.4	19.0	15.6	12.4			14.65							7.9	0.4
Ck1	16—24	40.7	17.7	11.2	69.6	19.7	10.7	6.6			26.40							8.1	0.4
Ck2	24+	27.8	22.5	16.3	66.6	17.7	15.7	10.8			19.00							8.3	0.4

LUVIC CHERNOZEM

Canada

Horizon	Depth inches	Particle size distribution 3A1b				Textural class	8C1b	Organic matter 6B1a		5A1b	Exchangeable cations 5B1b					6E1a
		Sand %	Silt %	Clay %	Fine clay %		pH	N %	C/N	CEC me/100 g	H %	Na %	K %	Ca %	Mg %	CaCO ₃ equiv.
Ah	0—13	33	38	29	12	cl	6.6	0.56	13	40	7	1	2	79	11	
AE	13—19	39	39	22	10	l	5.6	0.19	12	21	26	1	1	52	20	
E	19—22	44	41	15	7	l	5.6	0.06	11	11	18	2	1	54	25	
Bt	22—40	47	26	37	14	scl	5.2	0.04	10	19	10	1	1	56	32	
BC	40—50	44	33	23	9	l	6.5			18	2	2	1	61	34	
Ck	at 60	43	31	26	9	l	7.8									6.4

EUTRIC PODZOLUVISOL De

Classification (USDA)	Aeric Glossaqualf, fine-loamy, mixed, frigid
Location	Wood County, Wisconsin
Altitude	320 m (approximately)
Physiography	Nearly level (1% slope) on gently undulating, Cary age, ground moraine
Drainage	Somewhat poorly to imperfectly drained with slow to medium runoff, slow internal drainage, slow permeability
Parent material	Shallow to moderately shallow loess over reddish brown clay loam glacial till
Vegetation	Annual crops, maize, small grains, hay
Climate	Boreal; humid

Profile description

Ap	0-8 inch	Dark greyish brown (10YR 4/2) and very dark greyish brown (10YR 3/2) silt loam with weak medium subangular blocky structure; friable; fine fibrous roots common; neutral; abrupt smooth boundary.
E	8-11 inch	Greyish brown (10YR to 2.5Y 5/2) silt to silt loam with weak thin platy structure; friable; has common medium prominent mottles of yellowish brown (10YR 5/6 - 5/8) colour; very strongly acid; abrupt smooth boundary.
EB	11-18 inch	Pale brown (10YR 6/3) and light yellowish brown (2.5Y 6/3) gritty, slightly pebbly, silt loam; has weak medium prismatic structure that displays included weak coarse plates that break under slight pressure to weak fine and medium subangular blocks; friable; thick tongues of silt from E above which invade more than 50 percent of this horizon and exhibit light grey (10YR 7/2) where not mottled, often isolate remnants of B material; few patchy remnants of clay films occur on some blocky ped faces; contains many medium and large distinct mottles of strong brown (7.5YR 5/2-5/8) colour; very strongly acid; clear wavy boundary.
BE	18-24 inch	Pale brown (10YR 6/3) and light yellowish brown (2.5Y 6/4) silt loam with weak medium prismatic structure that breaks under slight pressure to weak medium subangular blocks; friable; moderately thick light grey (10YR 7/2) tongues of bleached silt extend along prism faces, occupying approximately 25 percent of the horizon body; few patchy remnants of clay films occur on some blocky ped faces; contains many large distinct strong brown (7.5YR 5/6) mottles; very strongly acid; abrupt wavy boundary.
2Bt	24-36 inch	Reddish brown (5YR 4/3) pebbly and somewhat cobbly clay loam with weak and moderate coarse prismatic structure that breaks under disturbance to weak and moderate medium subangular blocks; firm; prism faces frequently are dark brown (7.5YR 4/4) in colour; contains many patchy brown (7.5YR 5/2) clay films on prism and some blocky ped faces; infiltrations of powdery bleached silt cover the clay films along many prism faces; common medium distinct reddish yellow (5YR 9/6) mottles; very strongly acid; gradual smooth boundary.
2BC	36-44 inch	Reddish brown (5YR 4/3 to 5/3) clay loam that is somewhat coarser textured than horizon above; weak coarse subangular blocky structure; firm; common medium distinct and prominent yellowish red (5YR 4/6) and brown (7.5YR 5/2) mottles; very strongly acid; gradual smooth boundary.
2C1	44-52 inch	Reddish brown (5YR 4/4) clay loam glacial till interlaid with lenses of silty material; very weak coarse subangular blocky structure to generally massive; firm; few grey (5Y 5/1) clay flows in root and worm channels; few large faint yellowish red (5YR 5/6) mottles; very strongly acid; gradual smooth boundary.
2C2	52-60 inch	Reddish brown (5YR 4/4) generally massive clay loam glacial till; few large faint yellowish red (5YR 5/6) mottles; very strongly acid.

NOTES: All colours shown in the soil profile description are moist. Mineralogy: The very fine sand from the particle-size analysis was examined under the petrographic microscope. Quartz is the most common mineral. A substantial percentage of feldspar is present. Highly altered feldspar is common: a portion of the altered grains is essentially aggregates of clay minerals. Some of the feldspar grains appear quite fresh. Quartz and possibly fresh feldspar increase toward the surface. (Method 7B1)

EUTRIC PODZOLUVISOL

United States

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
Ap	0-8	0.9	2.2	2.0	2.8	4.2	73.5	14.4	41.8	37.1	2	sil
E	8-11	1.1	1.9	1.7	2.6	3.9	76.2	12.6	41.0	40.2	3	sil
EB	11-18	1.2	2.7	3.7	5.9	5.0	61.8	19.7	41.1	28.2	2	sil
BE	18-24	2.1	7.0	12.9	21.5	8.4	34.0	14.1	37.1	13.9	4	1/fs1
2Bt	24-36	3.2	7.6	15.1	26.4	10.1	18.6	19.0	30.7	9.2	6	fs1
2BC	36-44	3.9	7.1	9.8	20.6	10.3	28.8	19.5	35.5	13.5	5	1/fs1
2C1	44-52	3.3	6.5	9.7	20.1	11.4	29.5	19.5	36.2	14.4	4	1
2C2	52-60	2.8	6.6	10.1	20.5	10.9	31.1	18.0	37.7	14.0	5	1

Horizon	8C1a pH 1:1 H ₂ O	Organic matter			Bulk density					Water retention	
		6A1a OC %	6B1a N %	C/N	Field state		30/cm		Air dry	4B1b 1/3-bar pieces %	4B2 15-bar sieved %
					4B4 Water %	4A1a g/cm ³	4B3 Water %	4A1c g/cm ³	4A1b g/cm ³		
Ap	5.7	2.12	0.198	11	19.3	1.38	29.7	13.3	1.39	26.1	8.8
E	4.7	0.30	0.054	6						22.4	6.1
EB	4.4	0.18	0.026							16.9	8.1
BE	4.5	0.09	0.011							13.2	5.1
2Bt	4.5	0.06	0.008							13.4	6.8
2BC	4.4	0.05								15.3	7.4
2C1	4.7	0.04								15.5	7.5
2C2	4.8	0.03								18.6	7.0

Horizon	5A1a CEC NH ₄ OAc	Extractable cations 5B1a					5C1 BS NH ₄ OAc %	5C3 BS on sum cations %	5B1a Sum ext. bases me/100 g	8D1 CEC/ 100 g clay	8D3 Ext. Ca/Mg	6C1a Free iron as Fe ₂ O ₃ %	6G1a Al KCl-ext. me/100 g
		6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K							
		me/100 g											
Ap	15.3	8.4	3.8	7.3	0.1	0.3	82	63	12.6	106	2.2	1.5	—
E	9.6	2.8	2.0	8.0	0.1	0.1	52	38	5.0	76	1.4	1.6	1.7
EB	13.3	3.7	2.8	10.8	0.1	0.2	51	39	6.8	68	1.3	1.5	3.7
BE	9.6	2.8	2.6	6.5	0.1	0.2	59	47	5.7	68	1.1	1.1	2.2
2Bt	13.7	5.2	4.5	6.6	0.1	0.2	73	60	10.0	72	1.2	1.3	1.5
2BC	13.5	5.4	4.4	5.6	0.1	0.2	75	64	10.1	69	1.2	1.2	1.1
2C1	14.0	5.9	4.8	5.6	0.2	0.2	79	66	11.1	72	1.2	1.2	0.9
2C2	12.3	5.8	4.8	4.2	0.2	0.2	89	72	11.0	68	1.2	1.0	0.6

RENDZINA E

Classification (Canada)	Rego-Black with thin Ah and more than 40% CaCO ₃ , Isafold Series, Manitoba
Location	Ste. Rose Map Area, Manitoba
Altitude	285 m (approximately)
Physiography	Well-drained ridges and knolls in the southwest portion to the Westlake Till Plain; topography is level to irregular, gently sloping
Drainage	Well drained, moderate runoff, moderate permeability
Parent material	Very stony, extremely calcareous, medium textured glacial till
Vegetation	Aspen (<i>Populus tremuloides</i>), oak (<i>Quercus macrocarpa</i>), parkland
Climate	Cold to moderately cold cryoboreal; humid to subhumid

Profile description

O	1-0 inch	Very dark greyish brown (10YR 3/2 dry) leaf and sod mat; neutral; clear smooth boundary.
Ah	0-3 inch	Black (10YR 2/1 dry) clay loam; weak, fine, granular; friable when moist, soft when dry; mildly alkaline; moderately calcareous in lower portion; gradual smooth boundary.
ACk	3-6 inch	Grey (10YR 5.5/1 dry) clay loam; weak, fine, pseudogranular; friable when moist, slightly hard; moderately alkaline; extremely calcareous; gradual wavy boundary.
Ck1	6-9 inch	Light grey (2.5Y 7.5/2 dry) clay loam; weak, fine, granular; friable when moist, strongly cemented when dry; moderately alkaline; extremely calcareous; diffuse wavy boundary.
Ck2	9-24 inch	Light grey (2.5Y 7/2 dry) clay loam; weak, medium, pseudogranular; friable, strongly cemented when dry; moderately alkaline; extremely calcareous.

Horizon	Depth inches	Particle size distribution % 3A1			Textural class	8C1e pH CaCl ₂	Organic matter			8A1a EC mmhos/cm	Carbonate 6I		
		Sand	Silt	Clay			6A1a OC %	6B1a N %	C/N		CaCO ₃ equiv. %	Calcite %	Dolomite %
O	1—0					7.2	28.2	1.53	18.4	0.9			
Ah	0—3	34	30	36	cl	7.4	6.1	0.5	12.2	0.8	8.7	2.0	6.1
ACk	3—6	31	39	30	cl	7.9	1.8	0.2	9.0	0.5	54.2	11.3	39.5
Ck1	6—9	27	42	31	cl	8.2	0.6	0.1	6.0	0.4	60.1	12.0	44.4
Ck2	9—24	25	45	30	cl	8.4				0.4	56.2	9.5	43.0

EUTRIC GLEYSOL Ge

Classification (Canada)	Gleysol, Laplaine Clay Series, Ontario
Location	Near Ottawa-Carleton County, Ontario
Physiography	Undulating marine and fresh-water deposits; site was in a depression bounded on three sides by knolls of calcareous till
Drainage	Poor
Parent material	Clayey brackish-water marine deposit
Vegetation	Wooded. Elm (<i>Ulmus</i> spp.), black poplar (<i>Populus balsamifera</i>), cedar (<i>Thuja occidentalis</i>), ash (<i>Fraxinus</i>) with understory of various shrubs and mosses
Climate	Mesic mild humid area with significant inclusions of subaquic regimes

Profile description

Hi	8-7 inch	Raw litter of twigs, leaves, and bark that was partly decomposed at lower boundary.
Ha	7-0 inch	Black (N 2/0 moist, 10YR 2/1 dry) muck; strong, fine to medium, granular; very porous, friable, slightly hard; many roots; abrupt smooth boundary.
Cg1	0-7 inch	Olive grey (5Y 5/2 moist, 6.5/2 dry) clay; discontinuous thin black (10YR 2/1) band at the tops of some of the structural units; few to common with increasing depth, medium distinct yellowish brown (10YR 5/4) mottles; weak, very coarse, blocky; sticky, plastic, very hard; many earthworm holes partly filled with material from H horizon; some roots; clear wavy boundary.
Cg2	7-18 inch	Greyish brown (2.5Y 5/2 moist, 5Y 6.5/1 dry) clay; common to few with increasing depth, medium distinct yellowish brown (10YR 5/4) mottles; moderate, medium, granular becoming amorphous with depth; firm, very hard; few roots; diffuse boundary.
Cg3	18-30 inch	Dark greyish brown (2.5Y 4/2 moist, 5Y 6.5/1 dry) clay; few faint brownish mottles; amorphous breaking to fine and medium subangular pseudoblocky fragments; very few roots; firm, very hard; diffuse boundary.
Cg4	30-36 inch	Dark grey (5Y 4/1 moist, 6.5/1 dry) clay; few faint brownish mottles and very few prominent black coatings on clod surfaces; few faint brownish streaks and mottles in clod interiors; amorphous breaking conchoidally to coarse and very coarse pseudoblocky fragments; very firm, very hard; very few fine roots.
Cg5	36-42 inch	Same as Cg4; no carbonate.

EUTRIC GLEYSOL

Canada

Horizon	Depth inches	Particle size distribution % 3A1b				8C1e pH CaCl ₂	Organic matter	
		Sand	Silt	Clay 2-0.2 μ	Clay < 0.2 μ		6A1a OC %	C/N
Ha	7-0					6.0	73.0	19
Cg1	0-7	0.3	24.6	48.3	26.8	6.5	1.3	14
Cg2	7-18	5.4	21.6	48.6	24.3	6.6	0.5	9
Cg3	18-30	3.8	21.9	48.6	25.5	6.7	0.3	8
Cg4	30-36	2.3	26.1	51.8	19.8	7.0	0.2	6

Horizon	Exchangeable cations 5B1b me/100 g					5A4 Sum cations me/100 g	5C1 BS %	Bulk density
	H	Ca	Mg	K	Na			
Ha	40.0	140.0	11.9	0.4	0.5	193.8	79	0.3
Cg1	8.3	29.4	4.3	0.8	0.2	43.0	80	1.3
Cg2	6.9	26.9	4.1	0.9	0.2	40.0	82	1.2
Cg3	5.8	23.6	3.9	1.0	0.2	34.5	83	1.2
Cg4	4.0	19.5	3.8	1.0	0.2	28.5	86	1.3

Horizon	Total analyses %											6C3a Free Fe ₂ O ₃ %
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	MnO	P ₂ O ₅	CaO	MgO	K ₂ O	Na ₂ O	Loss ignition	
Cg1	56.2	17.9	8.4	1.00	0.10	0.27	2.1	3.4	3.1	2.4	5.1	1.9
Cg2	55.2	18.7	9.0	0.97	0.15	0.24	2.2	3.7	3.4	2.5	4.3	2.2
Cg4	56.6	18.1	8.4	0.97	0.13	0.26	2.8	3.7	3.4	2.9	2.8	1.8

HUMIC GLEYSOL Gh

Classification (USDA)	Mollic Psammaquent, siliceous, thermic
Location	Sarasota County, Florida
Altitude	10 m (approximately)
Physiography	Nearly level
Drainage	Imperfectly drained
Parent material	Moderately thick beds of sands
Vegetation	Pine (<i>Quercus</i> spp.), myrtle (<i>Myrica cerifera</i>), gallberry (<i>Ilex glabra</i>), wiregrass (<i>Cynodon dactylon</i>), saw palmetto (<i>Serenoa repens</i>), small runner oak (<i>Quercus pumila</i>)
Climate	Thermic; aquic

Profile description

Ah1	0-5 inch	Grey (N 5/0) and dark grey (N 4/0) loose fine sand matted together with large number of small roots; abrupt wavy boundary.
Ah2	5-13 inch	Very dark grey (N 3/0) to black (10YR 2/1) nearly loose fine sand with large number of small roots; clear irregular boundary.
ACg	13-18 inch	Dark grey (10YR 4/1) to very dark greyish brown (10YR 3/2) loose fine sand with narrow fingers of material projecting from layer above; common, medium, faint to distinct grey and yellow mottles; moderate percent of small roots; clear irregular boundary.
Cg1	18-25 inch	Light grey (2.5Y 7/2) to light brownish grey loose fine sand with common, medium, distinct mottles of yellow and grey; diffused irregular boundary.
Cg2	25-50 inch	Light grey (10YR 7/2) to white (2.5Y 8/2) loose fine sand with common, medium, distinct yellow mottles.

HUMIC GLEYSOL

United States

Horizon	Depth inches	1B1b Size class and particle diameter (mm) 3A1														
		Total			Sand					Silt			Coarse fragments 3B1			
		Sand (2-0.05)	Silt (0.05- 0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5- 0.25)	Fine (0.25- 0.1)	Very fine (0.1- 0.05)	0.05- 0.02	Int. III (0.02- 0.002)	Int. II (0.2- 0.02)	(2-0.1)	2A2	2-19	19-76
														> 2	% of	
% of < 2 mm												%	< 76 mm			
Ah1	0-5		2.4	1.5	2.6	5.7	16.7	58.1	13.0		2.0	48.6		0		
Ah2	5-13		3.2	2.0	0.5	4.9	16.9	56.6	15.9		2.4	51.7		0		
ACg	13-18		3.3	2.1	0.3	4.7	16.2	56.1	17.3		2.5	53.3		0		
Cg1	18-25		2.6	2.2	0.5	4.6	15.8	57.1	17.2		2.0	54.3		0		
Cg2	25-50		2.7	2.4	0.5	4.6	15.6	56.8	17.4		1.9	54.1		0		

Horizon	6A1a	8C1a	Extractable bases 5B1a				6H1a	5A3a	5C3
	OC	pH (1:1)	6N2d	6O2b	6P2a	6Q2a	Ext. acidity	Sum cations	BS Sum cations
			Ca	Mg	Na	K			
	%	H ₂ O	me/100 g						%
Ah1	2.72	4.5	0.6	0.8	tr	tr	13.6	15.0	9
Ah2	1.23	5.4	—	0.1	tr	tr	7.9	8.0	1
ACg	0.67	5.5	—	—	tr	tr	4.9	4.9	—
Cg1	0.13	5.5	—	0.2	tr	tr	1.6	1.8	11
Cg2	0.09	5.3	—	—	tr	tr	1.3	1.3	—

¹ Organic matter in very coarse sand.

MOLLIC GLEYSOL Gm

Classification (Canada)	Humic Gleysol, Osborne Series, Manitoba
Location	Southern Manitoba
Altitude	235-270 m
Physiography	Near level lacustrine plain
Drainage	Poor
Parent material	Weakly to moderately calcareous lacustrine clay
Vegetation	Cultivated
Climate	Cool boreal; subhumid with significant inclusions of subaquic

Profile description

Ap	0-4 inch	Very dark grey clay (5Y 3/1 dry); massive to weak fine granular; friable when moist, plastic when wet, hard when dry; slightly acid to neutral. Grades through an abrupt smooth boundary into:
Cg1	4-12 inch	Dark grey to olive grey clay (5Y 4/1-4/2 dry); massive; plastic when wet, firm when moist, hard when dry; neutral, and may be weakly calcareous; very fine mottles are partly masked by the dark grey clay.
Cg2	12-24 inch	Dark grey clay (5Y 7/2 dry); sticky and plastic when wet, firm when moist, weakly calcareous; mottled.

GELIC GLEYSOL Gx

Classification (Canada)	Cryic Rego Gleysol
Location	60°50'N-94°25'W. McConnel river, Northwest Territories, west shore of Hudson Bay, south of Eskimo Point
Altitude	1.7 m
Drainage	Poor
Parent material	Sandy alluvium over sandy marine clay
Vegetation	Very sparse; reedgrass (<i>Calamagrostis deschampsoides</i>)
Climate	Arctic, extremely cold; humid with significant aquic inclusion

Profile description

Cg1	0-30 cm	Very dark grey to dark grey (N 3/0, to 4/0 moist) fine sandy loam; surface of soil is brown, amorphous; soft; clear smooth boundary; approximate Eh +186 mv; pH 6.8.
Cg2	30-42 cm	Greyish brown (2.5Y 5/2 moist) sand; many coarse prominent yellowish brown (10YR 5/6 moist) mottles; amorphous; soft; abrupt smooth boundary; approximate Eh +425 mv; pH 6.2.
Cg3	42+ cm	Greyish brown (2.5Y 5/2 moist) gravelly sand; many coarse prominent yellowish brown (10YR 5/6 moist) mottles; single grain; loose; contains cobbles.

NOTE: The Eh values indicate the soil is weakly reduced in 0-30 cm horizon and moderately oxidized in 30-42 cm horizon. The reduced condition and lack of root aeration probably account for the lack of plant growth.

MOLLIC GLEYSOL

Canada

Horizon	Depth inches	Particle size distribution % 3A1			Textural class	4B1a	8C1	8A1a	Organic matter		5A1a	Exchangeable cations 5B1b me/100 g			
		Sand	Silt	Clay		Water retention 1/3 atm.	pH	EC	6A1a OC %	6B1a N %	CEC	Ca	Mg	K	Na
						mmhos/cm									
Ap	0—4	3.68	25.89	72.93	cl	50.5	7.05	0.8	2.08	0.27	52.58	22.95	21.67	1.78	0.42
Cg1	4—12	4.05	25.19	70.76	cl	45.9	8.00	0.3	0.31	0.08	46.85	25.30	21.52	1.39	0.64
Cg2	12—24	4.46	25.21	70.33	cl	45.8	7.80	0.2	0.00	0.09	39.39	25.50	22.12	0.82	0.95
		3.85	21.95	74.20		46.4	7.88	0.1	0.14	0.06					

GELIC GLEYSOL

Canada

Horizon	Depth cm	pH		Organic matter		Fe + Al				Exchangeable cations		EC CaCl ₂	Soluble P ppm
		8C1a	8C1e	6A1c	6B1	Dithionite 6C3		Oxalate 6C6		Ca, Na, Al	K		
		H ₂ O	CaCl ₂	OC %	N %	Fe %	Al %	Fe %	Al %	me/100 g			
Cg1	0—30	6.8	6.7	1.02	—	0.27	0.06	0.25	0.05	4.09	0.25	5.64	5.6
Cg2	30—42	6.2	6.2	0.62	—	0.27	0.05	0.15	0.03	2.38	0.18	4.08	1.4

GLEYIC PHAEOZEM Hg

Classification (USDA)	Typic Argiaquoll, fine, montmorillonitic, mesic
Location	Madison County, Iowa
Altitude	300 m (approximately)
Physiography	Broad upland divide; appears to be highest elevation within the watershed; slope less than 1%
Drainage	Poorly drained; slow to moderately slow permeability, water table at 40 inches; very moist
Parent material	Wisconsin loess
Vegetation	Clover field
Climate	Mesic; humid

Profile description

Ap	0-7 inch	Black (10YR 2/1) ¹ light silty clay loam, 10YR 4/1 dry; moderate medium subangular blocky structure; firm ² ; common worm holes and casts; abundant fine root channels; abrupt smooth boundary.
Ah	7-13 inch	Black (10YR 2/1) light silty clay loam, 10YR 4/1 dry; moderate fine granular and few peds with weak subangular blocky structure; friable; very faint grainy coatings noted when moist and distinct when dry; common fine and very fine inped tubular pores; common worm holes and casts; gradual smooth boundary.
AB	13-18 inch	Black (10YR 2/1) medium silty clay loam, 10YR 5/1 dry, 10YR 2/2 kneaded; weak very fine subangular blocky structure; friable to firm; very faint grainy coatings noted when moist and distinct when dry; many fine and very fine inped tubular pores; few very fine soft oxide concretions; common worm holes and casts; clear smooth boundary.
Bt1	18-24 inch	Very dark grey (10YR 3/1 mixed with 2.5Y 3/2) medium to heavy silty clay loam (10YR 5/1 dry, 2.5Y 3/2 kneaded); moderate to strong very fine subangular blocky structure; friable to firm; very faint imbedded grainy coatings noted when moist, distinct when dry; majority of peds are 10YR 3/1 but a few are 2.5Y 3/2; many fine and very fine inped tubular pores; thin continuous clay films on all ped surfaces; few very fine soft concretions and few fine hard oxide concretions; few worm holes and casts; clear smooth boundary.
Bt2	24-28 inch	Dark grey (10YR 4/1 mixed with 2.5Y 3/2) heavy silty clay loam; weak medium prismatic breaking to strong fine and medium subangular blocky structure; firm; ped exteriors are 10YR 4/1, interiors 2.5Y 3/2, with common fine distinct 10YR 4/4 mottles; few fine inped tubular pores; distinct moderately thick continuous clay films on all peds; few very fine hard concretions and common very fine soft oxide concretions; clear wavy boundary.
Bt3	28-34 inch	Dark grey (5Y 4/1) and olive grey (5Y 5/2) medium silty clay loam; weak medium prismatic breaking to moderate medium subangular blocky structure; firm; ped exteriors are 5Y 4/1, interiors 5Y 5/2, with common fine distinct 2.5Y 4/4 and few fine distinct 10YR 5/4 mottles; common 10YR 3/1 stains on vertical cleavage faces; many fine and very fine inped tubular pores; thin discontinuous clay films on peds; few fine hard spherical and moderately hard tubular-shaped concretions and few fine soft oxide concretions; gradual smooth boundary.
BC1	34-40 inch	Grey (5Y 5/1) and olive grey (5Y 5/2) medium silty clay loam (5Y 5/3 kneaded); moderate medium prismatic breaking to moderate medium subangular blocky structure; firm; ped exterior colours mixed so majority of peds are 5Y 5/1 with some 5Y 4/1 in places; interiors 5Y 5/2 with common fine 2.5Y 4/4 and few fine distinct 10YR 4/4 mottles; few distinct 7.5YR 5/6 segregations; some 10YR 3/1 stains on prism faces; many fine and very fine inped tubular pores; thin discontinuous clay films on prism faces and some peds; common to many fine and medium soft oxide concretions; gradual wavy boundary.

(continued on page 146)

¹ Munsell colour for moist soil.
² Consistence at moist field conditions.

GLEYIC PHAEZEM

United States

Horizon	Depth inches	Particle size distribution (mm) % 3A1										Textural class
		IB1b										
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
Ap	0-7	0.1	0.2	0.2	0.4	0.7	70.0	28.4	31.1	39.8	—	
Ah	7-13	0.2	0.4	0.6	0.5	0.9	64.6	32.8	29.7	36.0	—	
AB	13-18	0.2	0.4	0.4	0.6	0.9	60.6	36.9	28.2	33.6	—	
Bt1	18-24	0.3	0.5	0.4	0.5	0.8	56.8	40.7	25.9	31.9	—	
Bt2	24-28	0.6	0.7	0.4	0.6	0.8	55.0	41.9	24.4	31.7	—	
Bt3	28-34	0.3	0.3	0.2	0.4	1.1	56.7	41.0	26.3	31.7	—	
BC1	34-40	0.5	0.6	0.3	0.5	1.0	58.9	38.2	28.0	32.2	—	
BC2	40-47	0.4	0.7	0.4	0.6	0.9	61.6	35.4	28.9	34.0	—	
BC3	47-56	0.2	0.4	0.3	0.6	1.0	63.7	33.8	30.6	34.5	—	
C1	56-63	0.1	0.2	0.2	0.7	1.0	67.3	30.5	34.1	34.7	—	
C2	63-71	0.1	0.3	0.3	0.6	1.0	68.3	29.4	34.3	35.4	—	
C3	71-75	0.1	0.1	0.1	0.3	0.6	69.6	29.2	34.4	36.0	—	
C4	75-81	—	0.1	0.1	0.1	0.7	70.0	29.0	36.0	34.8	—	

Horizon	8C1a		6E1b			Organic matter					Bulk density					Moisture retention		
	pH (1:1)	CaCO ₃ equiv.	6A1a OC	6B1a N	C/N	Field moist.		30 cm		Air dry	4B1b 1/3-bar pieces	4C1 15-to 1/3-bar	4B2 15-bar sieved					
						4B4 Water	4A1a g/cm ³	4B3 Water	4A1c g/cm ³	4A1b g/cm ³								
	H ₂ O	%	%	%	%	%	g/cm ³	%	g/cm ³	g/cm ³	%	in/in	%					
Ap	5.7		2.44	0.186	13	21.1	1.52	26.0	1.45	1.61	24.8	0.17	13.2					
Ah	5.5		1.64	0.127	13	25.9	1.32	29.5	1.29	1.46	28.1	0.18	14.0					
AB	5.5		1.31	0.100	13								15.3					
Bt1	5.7		1.07	0.083	13								17.0					
Bt2	5.6		0.83	0.069	12	29.2	1.37	24.5	1.41	1.73	30.0	0.16	18.6					
Bt3	5.9		0.33										18.1					
BC1	6.0		0.30										17.8					
BC2	6.2		0.22										17.4					
BC3	6.5	—	0.14			28.0	1.45	31.2	1.37	1.64	30.7	0.19	16.9					
C1	7.0	—	0.12										15.4					
C2	7.4	—	0.09										15.3					
C3	7.7	3	0.09			27.6	1.48	30.2	1.38	1.61	34.6	0.27	14.7					
C4	7.7	5	0.09										13.4					

Horizon	5A1a		Extractable cations 5B1a					5A3a	BS		8D1	8D3	6C1a
	CEC NH ₄ OAc	6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	Sum cations	5C1 BS NH ₄ OAc	5C3 BS on sum cations	Ratio to clay NH ₄ OAc CEC	Ca/Mg	Ext. iron as Fe	
								%	%				
Ap	24.0	17.6	4.0	9.0	tr	0.5	31.1	92	71	0.84	4.4	0.8	
Ah	24.5	15.8	5.0	9.5	tr	0.6	30.9	87	69	0.75	3.2	0.9	
AB	26.6	16.5	6.4	8.3	tr	0.7	31.9	89	74	0.72	2.6	1.0	
Bt1	29.3	17.8	7.7	7.3	0.1	0.8	33.7	90	78	0.72	2.3	1.2	
Bt2	30.3	18.9	8.6	7.7	0.1	0.8	36.1	94	79	0.72	2.2	1.3	
Bt3	31.3	18.9	9.0	5.9	0.1	0.8	34.7	92	83	0.76	2.1	1.0	
BC1	30.2	19.0	7.5	5.3	0.1	0.8	32.7	91	84	0.79	2.5	1.0	
BC2	28.7	18.4	7.4	5.7	0.1	0.7	32.3	93	82	0.81	2.5	1.7	
BC3	27.6	18.6	7.9	0.2	0.2	0.7	27.6	99	99	0.82	2.4	1.5	
C1	25.2	17.3	8.8	—	0.2	0.6	26.9	107	100	0.83	2.0	1.0	
C2	24.2	17.1	8.0	—	0.1	0.6	25.8	107	100	0.82	2.1	1.7	
C3	23.0			—	0.1	0.6				0.79		1.2	
C4	22.3			0.4	0.1	0.6				0.77		0.5	

GLEYIC PHAEOZEM, United States (concluded)

BC2	40-47 inch	Grey (5Y 5/1) and olive grey (5Y 5/2) light to medium silty clay loam; weak coarse prismatic breaking to weak medium to coarse angular blocky structure; firm; ped exteriors are 5Y 5/1, interiors are 5Y 5/2 with common to many fine distinct 10YR 5/4 mottles; common distinct 7.5YR 5/6 segregations; many very fine and fine inped tubular pores; few thin discontinuous clay films on prism faces; common 10YR 3/1 clay fills in fine pores; many fine soft oxide concretions; gradual smooth boundary.
BC3	47-56 inch	Olive grey (5Y 5/2) and grey (5Y 5/1) light silty clay loam; weak coarse prismatic breaking to weak coarse angular blocky structure; firm; peds predominantly 5Y 5/2 with few exteriors 5Y 5/1; many medium 2.5Y 4/4 mottles; common distinct 7.5YR 5/6 vertical streaks; many medium and fine inped tubular pores; common 10YR 3/1 clay fills in pores with very few thin discontinuous clay films on some prism faces; common coarse soft concretions and few fine hard oxide concretions; gradual smooth boundary.
C1	56-63 inch	Olive grey (5Y 5/2) light silty clay loam; massive with some vertical cleavage; firm; common medium 10YR 5/4 mottles; common prominent 7.5YR 5/6 vertical streaks; some vertical cleavage faces have grey (5Y 5/1) exteriors; common medium and fine inped tubular pores; few 10YR 3/1 clay fills in very fine and fine pores; many fine soft oxide concretions; clear wavy boundary.
C2	63-71 inch	Predominantly yellowish brown (10YR 5/6) mixed with 5Y 5/2 heavy silt loam; massive with some vertical cleavage; firm; prominent wavy 7.5YR 5/6 horizontal band and a few individual segregations; common medium and fine inped tubular pores; common 10YR 3/1 clay fills (more distinct than in horizons above or below) in very fine and fine pores; very few very fine soft oxide concretions; clear smooth boundary.
C3	71-75 inch	Light olive grey (5Y 6/2) silt loam; massive with some vertical cleavage; firm; common large prominent 7.5YR 5/6 and common fine distinct 10YR 5/6 mottles; many medium and fine inped tubular pores; few 10YR 3/1 clay fills in very fine pores but most pores free of clay or stains; common fine soft oxide concretions and smears; matrix not calcareous but a hard carbonate concretion present at 72 inches; diffuse smooth boundary.
C4	75-81 inch	Light olive grey (5Y 6/2) silt loam; massive with some vertical cleavage; firm; common fine faint 2.5Y 4/4 mottles; many medium and fine inped tubular pores; few 10YR 3/1 clay fills in very fine pores; common very fine soft oxide concretions and a few 5 to 10 mm in diameter moderately hard tubular concretions; few hard carbonate concretions but matrix is not calcareous.

NOTES: Roots plentiful from 0 to 18 inches, common from 18 to 28, few from 28 to 56 and nearly absent below 56 inches. Several krotovinas present below 62 inches; there is a black (N 2/0) clay coating in krotovina and interiors have some mixed olive grey and strong brown material. Oxides are spherical in shape, dark brown to black, and considered predominantly iron-manganese unless otherwise noted. Strong brown (7.5YR 5/6 to 5/8) segregations, horizontal bands and vertical streaks are considered higher in iron oxide than the associated matrix. Horizons Ap, Bt3 and C2 were sampled for the Bureau of Public Roads.

HAPLIC PHAEOZEM Hh

Classification (USDA)	Typic Hapludoll, fine-silty, mixed, mesic
Location	Cass County, Iowa
Altitude	400 m (approximately)
Physiography	Sideslope of a short interfluvium; 6 to 7% to W, NW
Drainage	Well drained; moderately permeable
Parent material	Wisconsin loess
Vegetation	Ploughed for annual crops
Climate	Mesic; humid

Profile description

Ap	0-6 inch	Very dark brown (10YR 2/2) to very dark greyish brown (10YR 3/2) light to medium silty clay loam, greyish brown (10YR 5/2) dry; weak medium subangular blocky breaking to weak fine granular structure; friable; few medium root channels; kneaded colour the same; pH 5.4; abrupt smooth boundary.
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(continued on page 148)

HAPLIC PHAEZEM

United States

Horizon	Depth inches	Size class and particle diameter (mm) 3A1														
		Total			Sand					Silt			Coarse fragments			
		Sand (2-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	0.05-0.02	Int. III (0.02-0.002)	Int. II (0.2-0.02)	(2-0.1)	2A2 > 2	2-19	19-76
		% of < 2 mm														
														%	% of < 76 mm	
Ap	0-6	3.3	65.0	31.7	—	0.1	0.1	0.2	2.9	39.5	25.5	42.5	0.4	—		
AB	6-10	3.0	63.7	33.3	—	tr	0.1	0.2	2.7	36.3	27.4	39.1	0.3	—		
Bw1	10-18	2.9	65.8	31.3	—	tr	0.1	0.2	2.6	36.6	29.2	39.3	0.3	—		
Bw2	18-25	2.8	67.2	30.0	—	tr	0.1	0.2	2.5	36.9	30.3	39.5	0.3	—		
BCg1	25-32	3.0	67.4	29.6	—	tr	0.1	0.2	2.7	37.8	29.6	40.6	0.3	—		
BCg2	32-39	2.6	68.2	29.2	—	tr	0.1	0.2	2.3	38.2	30.0	40.6	0.3	—		
BCg3	39-44	2.5	69.7	27.8	—	tr	0.1	0.2	2.2	40.1	29.6	42.4	0.3	—		
BCg4	44-47	2.5	67.0	30.5	—	tr	0.1	0.3	2.1	36.8	30.2	39.1	0.4	—		
Cg1	47-53	2.7	69.0	28.3	—	tr	tr	0.1	2.6	40.9	28.1	43.6	0.1	—		
Cg2	53-58	2.4	71.0	26.6	—	tr	tr	0.2	2.2	39.9	31.1	42.2	0.2	—		
Cg3	58-60	2.3	69.9	27.8	—	tr	tr	0.1	2.2	39.1	30.8	41.4	0.1	—		
Cg4	60-63	2.3	72.1	25.6	—	tr	tr	0.2	2.1	40.1	32.0	42.3	0.2	—		
Cg5	63-69	3.4	72.4	24.2	—	tr	0.1	0.5	2.8	42.0	30.4	45.2	0.6	—		
Cg6	69-77	2.7	71.4	25.9	—	tr	0.1	0.2	2.4	39.4	32.0	41.9	0.3	—		

(continued on page 149)

HAPLIC PHAEOZEM, United States (concluded)

AB	6-10 inch	Very dark greyish brown (10YR 3/2), greyish brown (10YR 5/2), and some pale brown (10YR 6/3 dry) medium silty clay loam; weak fine subangular blocky breaking to weak fine granular structure; friable; common fine and medium root channels; some mixing of dark brown to brown (10YR 4/3) ped; few very dark brown (10YR 2/2) fills in vertical pores; very dark greyish brown (10YR 3/2) to dark brown (10YR 3/3) when kneaded; pH 5.6; clear smooth boundary.
Bw1	10-18 inch	Dark brown to brown (10YR 4/3), pale brown (10YR 6/3 dry) light to medium silty clay loam; weak to moderate fine subangular blocky structure; friable; common fine and medium imbed tubular pores; few peds have thin discontinuous stains of very dark greyish brown (10YR 3/2) colour; yellowish brown (10YR 5/4) when kneaded; few 0.12-inch fills in pores of very dark brown to very dark greyish brown material from above; pH 6.4; gradual smooth boundary.
Bw2	18-25 inch	Dark brown to brown (10YR 4/3) and yellowish brown (10YR 5/4) light silty clay loam; weak medium prismatic breaking to weak fine subangular blocky structure; very few fine greyish brown (2.5Y 5/2) mottles; friable; pores as above; few very thin discontinuous clay films on some vertical faces; ped exteriors are dark brown to brown (10YR 4/3) and ped interiors are yellowish brown (10YR 5/4), slight increase in mottles in ped interiors; distinct 0.5-inch spherical voids in this horizon; pH 6.4; clear smooth boundary.
BCg1	25-32 inch	Colour, texture and structure same as above; common fine greyish brown (2.5Y 5/2), dark yellowish brown (10YR 4/4), and yellowish brown (10YR 5/6) mottles; friable; pores as above; very few thin discontinuous clay films on some vertical faces; pH 6.4; gradual smooth boundary.
BCg2	32-39 inch	Mottled yellowish brown (10YR 5/4), dark brown to brown (10YR 4/3), and olive grey (5Y 5/2) heavy silt loam to light silty clay loam; structure as above but medium in size; friable; tubular pores as above; common fine soft dark brown to black oxide concretions; few indistinct grainy silt coats on some peds; pH 6.4; gradual smooth boundary.
BCg3	39-44 inch	Colour, texture and structure like BCg2 horizon; many fine strong brown (7.5YR 5/6) to yellowish brown (10YR 5/6) mottles; friable; pores as above; oxides as above; few 0.5-inch spherical voids; few indistinct grainy silt coats on vertical ped faces; pH 6.6; abrupt smooth boundary.
BCg4	44-47 inch	Dark brown to brown (7.5YR 4/4) and strong brown (7.5YR 5/8) silt loam; weak coarse prismatic structure; common fine olive grey (5Y 5/2) mottles; friable; pores as above; zone of iron accumulation; pH 6.4; abrupt smooth boundary.
Cg1	47-53 inch	Olive grey (5Y 5/2) silt loam; massive with some vertical cleavage; tubular pores finer than above; many 0.25- to 0.5-inch soft to moderately hard "pipe-stems" of strong brown (7.5YR 5/8) and dark brown to brown (7.5YR 4/4) iron concretions; friable; few 0.5-inch spherical voids; pH 6.4; gradual wavy boundary.
Cg2	53-58 inch	Mottled light olive brown (2.5Y 5/4) to yellowish brown (10YR 5/4) and olive grey (5Y 5/2) silt loam; massive; friable; pores as above; common very fine soft dark brown to black oxide concretions; pH 6.4; abrupt smooth boundary.
Cg3	58-60 inch	Yellowish brown (10YR 5/6) silt loam; massive; common medium olive grey (5Y 5/2) and few fine dark brown to brown (7.5YR 4/4) mottles; friable; pores as above; few moderately hard "pipestems" of strong brown (7.5YR 5/8); weak zone of iron accumulation; pH 6.6; abrupt smooth boundary.
Cg4	60-63 inch	Olive grey (5Y 5/2) silt loam; massive; common fine yellowish brown (10YR 5/6) mottles; friable; pores as above; few 0.25-inch soft "pipestems" as above; pH 6.6; clear smooth boundary.
Cg5	63-69 inch	Colour, texture and mottles like Cg2 horizon; massive; friable; pores as above; common dark brown to brown (7.5YR 4/4) moderately hard "pipestems"; pH 6.6; clear irregular boundary.
Cg6	69-77 inch	Colour, texture and mottles like Cg4 horizon; massive; friable; pores as above; common 0.25- to 0.5-inch moderately hard to hard "pipestems" of dark brown to brown (7.5YR 4/4) colour; pH 6.6.

NOTES: Zones of iron accumulation at 44 to 47 inches are distinct, 58 to 60 inches moderate, and 63 to 69 inches weak; 3-inch rodent fill at 10 inches, another at 18 inches, and one at 25 inches. Iron band at 44 to 47 inches is continuous around pit and slopes slightly to the west-northwest. Mottles at 18 inches plus are considered to be relict and related to the deoxidized zone below. Marshall soils S63Iowa-15-1, 15-2 and 15-3 were sampled in transect. Munsell colours are for fully moist soil unless otherwise indicated. Consistence is at moist field condition. Field pH determined by LaMotte solutions.

HAPLIC PHAEZEM
United States (concluded)

Horizon	Organic matter			6E1a	6C2a	Bulk density			4D1	Water content				pH
	6A1a OC ^a %	6B1a N %	C/N	Carbonate as CaCO ₃ %	Ext. iron as Fe %	4A1a Field state g/cm ³	4A1d 1/3-bar g/cm ³	4A1b Air dry g/cm ³	COLE	4B4 Field state %	4B1c 1/3-bar %	4B2 15-bar %	4C1 1/3- to 15-bar in/in	8C1a (1 : 1) H ₂ O
Ap	2.05	0.170	12		1.2	1.39	1.40	1.52	0.028	26.6	25.0	13.7	0.16	5.6
AB	1.45	0.129	11		1.4	1.23	1.23	1.34	0.028	28.3	27.3	13.0	0.18	5.6
Bw1	0.86	0.085	10		1.4	1.22	1.20	1.32	0.032	28.2	27.2	13.2	0.17	6.0
Bw2	0.54	0.058	9		1.4	1.20	1.20	1.32	0.032	28.4	26.1	13.6	0.15	5.9
BCg1	0.33				1.3	1.22	1.25	1.39	0.036	28.8	27.2	14.6	0.16	5.9
BCg2	0.24				1.3	1.30	1.27	1.41	0.036	28.3	27.6	14.3	0.17	5.9
BCg3	0.17				1.4	1.34	1.31	1.44	0.032	22.0	27.6	14.0	0.18	6.0
BCg4	0.19				4.2	1.23	1.22	1.34	0.032	29.0	33.2	12.8	0.25	6.1
Cg1	0.10				1.0	1.36	1.32	1.46	0.036	24.4	28.1	13.8	0.19	6.4
Cg2	0.13				1.0	1.36	1.32	1.43	0.028	25.3	27.9	13.1	0.20	6.4
Cg3	0.08				1.7		*1.3					13.3		6.4
Cg4	0.07				1.0							14.0		6.5
Cg5	0.06				1.3	1.36	1.30	1.40	0.024	28.6	29.1	13.2	0.21	6.5
Cg6	0.06			—(s)	1.0	1.39	1.32	1.45	0.032	28.9	28.8	13.4	0.20	7.0

Horizon	5A1a	Extractable bases 5B1a					6H1a	5A3a	BS		Ratios to clay 8D1			Resis- tivity ^d Ohms	8B1a	6P1a	5D2	8B	8D3
	CEC	6N2a	6O2a	6P2a	6Q2a	Sum	Ext. acidity	Sum cations	5C3 Sum cations	5C1 NH ₄ OAc	NH ₄ OAc	Ext. iron	15-bar water		EC	Soluble Na	Exch. Na	Water at sat.	Ca/Mg
	NH ₄ OAc	Ca	Mg	Na	K	me/100 g			%	%	CEC				mmhos/ cm	me/litre	%	%	
Ap	22.4	13.4	5.6	0.1	0.7	19.8	11.0	30.8	64	88	0.71	0.038	0.43					2.4	
AB	22.8	14.1	6.3	0.1	0.6	21.1	10.1	31.2	68	93	0.68	0.042	0.39					2.2	
Bw1	22.4	14.5	7.0	0.1	0.5	22.1	7.6	29.7	74	99	0.72	0.045	0.42					2.1	
Bw2	22.5	14.6	7.3	0.1	0.6	22.6	6.5	29.1	78	100	0.75	0.047	0.45					2.0	
BCg1	23.1	14.9	7.6	0.2	0.6	23.3	5.8	29.1	80	101	0.78	0.044	0.49					2.0	
BCg2	23.3	15.0	7.9	0.2	0.6	23.7	5.6	29.3	81	102	0.80	0.045	0.49					1.9	
BCg3	22.0	14.8	7.6	0.2	0.6	23.2	5.6	28.8	81	105	0.79	0.050	0.50	1 600	0.71	1.1	0.5	51.5	1.9
BCg4	21.5	14.5	7.6	0.2	0.6	22.9	6.2	29.1	79	107	0.70	0.14	0.49					1.9	
Cg1	21.3	14.6	8.0	0.2	0.6	23.4	3.5	26.9	87	110	0.75	0.035	0.49					1.8	
Cg2	21.0	14.2	7.9	0.2	0.6	22.9	3.5	26.4	87	109	0.79	0.038	0.49					1.8	
Cg3	20.7	13.9	7.6	0.2	0.6	22.3	4.0	26.3	85	108	0.74	0.061	0.48					1.8	
Cg4	20.8	13.9	7.6	0.2	0.6	22.3	3.2	25.5	87	107	0.81	0.039	0.55					1.8	
Cg5	19.7	13.7	7.5	0.2	0.6	22.0	3.7	25.7	86	112	0.81	0.054	0.55					1.8	
Cg6	20.7	14.3	8.2	0.2	0.6	23.3	1.9	25.2	92	113	0.80	0.039	0.52					1.7	

^a Fe-Mn nodules: > 50 percent (1-0.1 mm). — * 12 kg/m² to 60 inches (Method 6A). — * Estimated. — ^d Saturated paste.

LUVIC PHAEOZEM HI

Classification (USDA)	Aquic Argiudoll, fine-silty, mixed, mesic
Location	Pike County, Illinois
Altitude	185 m (approximately)
Physiography	Illinoian till plain; slope 3.5% N
Drainage	Imperfect, moderate to moderately slow permeability
Parent material	Peorian loess to 140 inches on farmdale loess
Vegetation	Rotation pasture
Climate	Mesic; humid

Profile description

Ap	9-7 inch	Very dark greyish brown to very dark brown (10YR 2.5/2) silt loam; weak fine crumb structure; friable.
Ah	7-13 inch	Very dark brown (10YR 2/2) silt loam; moderate to strong very fine subangular blocky structure which breaks to a weak to moderate medium crumb structure; friable.
AB	13-15 inch	Very dark greyish brown (10YR 3/2) with some dark yellowish brown (10YR 4/4) heavy silt loam; strong fine subangular blocky structure; friable.
BA	15-19 inch	Dark yellowish brown (10YR 4/4) light silty clay loam, heavily coated with very dark greyish brown (10YR 3/2); strong fine subangular blocky structure.
Bt1	19-24 inch	Yellowish brown (10YR 5/6) silty clay loam, heavily coated with dark greyish brown (10YR 4/2) and mottled with many fine prominent light brownish grey (10YR 6/2) mottles; strong fine to medium subangular blocky structure.
Bt2	24-34 inch	Yellowish brown (10YR 5/6) silty clay loam, mottled with many fine prominent light brownish grey (10YR 6/2) and a few fine distinct reddish brown (5YR 4/4) mottles; moderate to strong medium subangular blocky structure.
Bt3	34-42 inch	Strong brown (7.5YR 5/8) silty clay loam, mottled with common fine prominent light grey (10YR 7/1) and few fine distinct dark brown (7.5YR 3/2); weak coarse subangular blocky to very weak coarse prismatic structure.
BC	42-52 inch	Yellowish red (5YR 4/6 to 5/8) light silty clay loam, mottled with many coarse light grey (10YR 7/1) mottles; very weak very coarse subangular blocky structure.
C1	52-66 inch	Yellowish red (5YR 4/6 to 5/8) silt loam; mottled with many coarse prominent light grey (10YR 7/1) mottles.
C2	66-70 inch	Yellowish red (5YR 4/7 to 5/8) silt loam; mottled with common coarse prominent light grey (10YR 7/1) mottles. Calcareous.

NOTE: Colours refer to moist soil.

Horizon	Depth inches	1B1b Size class and particle diameter (mm) 3A1															
		Total			Sand					Silt		Int. II (0.2- 0.02)	(2-0.1)	Coarse fragments 3B1			
		Sand (2-0.05)	Silt (0.05- 0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5- 0.25)	Fine (0.25- 0.1)	Very fine (0.1- 0.05)	0.05- 0.02	Int. III (0.2- 0.002)			2A2 > 2	2-19	19-76	
		% of < 2 mm											%	% of < 76 mm			
Ap	0-7		76.4	19.7	—	0.7	0.8	0.8	1.6			37.1	41.2		—		
Ah	7-13		72.1	24.8	—	0.5	0.6	0.6	1.4			37.2	36.5		—		
AB	13-15		70.4	27.6	—	0.4	0.5	0.5	0.7			36.8	34.4		—		
BA	15-19		66.6	31.6	—	0.3	0.4	0.4	0.7			36.7	30.8		—		
Bt1	19-24		66.2	32.2	—	0.2	0.3	0.3	0.8			36.1	31.0		—		
Bt2	24-34		68.3	30.3	—	0.3	0.3	0.3	0.6			36.5	32.5		—		
Bt3	34-42		69.2	28.7	0.1	0.6	0.3	0.4	0.7			38.6	31.5		—		
BC	42-52		67.6	30.7	0.1	0.3	0.2	0.3	0.8			37.6	30.9		—		
C1	52-66		79.8	19.4	—	—	0.1	0.1	0.5			39.6	40.8		—		
C2	66-70		86.9	12.0	—	0.1	0.1	0.2	0.7			36.0	51.7		—		

Horizon	6A1a	8C1a	Extractable bases 5B1a				6H1a	5A3a	6G1d	BS	
	OC %	pH (1:1) H ₂ O	6N2d	6O2b	6P2a	6Q2a	Ext. acidity	Sum cations	Ext. Al	5C3	5C1
			Ca	Mg	Na	K				Sum cations %	NH ₄ OAc %
			me/100 g								
Ap	1.52	6.0	13.9	3.4	0.1	0.4	6.8	24.6		72	
Ah	1.36	5.6	10.6	3.7	0.1	0.3	9.1	23.8		62	
AB	0.99	5.4	13.3	4.7	0.1	0.4	9.1	27.6		67	
BA	0.72	5.4	12.0	5.6	0.1	0.4	9.1	27.2		66	
Bt1	0.58	5.3	12.0	6.1	0.1	0.5	8.7	27.4		68	
Bt2	0.42	5.4	13.7	8.0	0.2	0.4	7.5	29.8		75	
Bt3	0.28	5.5	10.4	5.3	0.2	0.4	6.9	23.2		70	
BC	0.23	5.8	15.5	10.0	0.2	0.4	6.1	32.2		81	
C1	0.12	6.8	9.7	5.8	0.2	0.3	2.8	18.8		85	
C2	0.07	7.8									

¹ Sample is calcareous.

CALCARIC FLUVISOL Je

Classification (USDA)	Typic Torrifuvent; coarse loamy, mixed, calcareous, thermic
Location	El Paso County, Texas
Altitude	1 220 m (approximately)
Physiography	Nearly level flood plain of the Rio Grande
Drainage	Well drained
Parent material	Recent alluvial deposits
Vegetation	Cultivated field
Climate	Thermic; arid

Profile description

Ap	0-12	inch	Pink (7.5YR 7/4) loam; structureless; very hard fragments; friable; plentiful roots; calcareous; abrupt smooth boundary.
C1	12-19	inch	Dark brown (7.5YR 4/2 moist) silt loam; discontinuous zones with weak to medium coarse subangular blocky structure; friable when moist; no bedding planes evident in the horizon; plentiful roots; calcareous; abrupt wavy boundary.
C2	19-30	inch	Light brown (7.5YR 6/4 moist) loamy very fine sand; structureless; weak bedding planes; few roots; calcareous; abrupt wavy boundary.
C3	30-36	inch	Dark brown (7.5YR 4/2 moist) silt loam; bedding plane structure; calcareous; abrupt wavy boundary
C4	36-46	inch	Dark brown (7.5YR 4/3 moist) very fine sandy loam; structureless; calcareous; abrupt wavy boundary.
C5	46-50	inch	Dark brown (7.5YR 4/3 moist) silty clay loam; structureless; calcareous (sampled with bucket auger).
C6	50-60 +	inch	Pale brown (10YR 6/3) stratified layers of very fine sand; loamy fine sand and silt loam; calcareous (sampled with bucket auger).

NOTE: The C3 horizon is at about field capacity. Moisture content in horizons above the C3 is below field capacity.

CALCARIC FLUVISOL

United States

Horizon	Depth inches	Size class and particle diameter (mm) 3A1															6A1a	
		Total			Sand					Silt			Int. II (0.2-0.02)	(2-0.1)	< 0.074	3A1a Carbo- nate as CaCO ₃ < 0.002	> 2	OC
		Sand (2-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	(0.05-0.02)	Int. III (0.02-0.002)							
		% of < 2 mm															%	%
Ap	0-12	39.6	43.1	17.3	0.2	0.6	0.8	9.0	29.0	23.1	20.0	59.8	10.6	79.1	—	tr	0.92	
C1	12-19	42.7	41.6	15.7	0.1	0.4	0.7	10.7	30.8	21.7	19.9	61.9	11.9	76.0	—	tr	0.70	
C2	19-30	74.1	21.5	4.4	—	0.1	0.2	20.9	52.9	17.9	3.6	91.0	21.2	53.0	tr	—	0.07	
C3	30-36	31.7	47.9	20.4	—	0.1	0.5	20.3	10.8	14.7	33.2	40.9	20.9	73.6	tr	—	0.22	
C4	36-46	43.8	46.4	9.8	—	0.1	0.1	6.7	36.9	34.0	12.4	76.7	6.9	83.6	—	—	0.21	
C5	46-50														—	—	0.34	
C6	50-60+														—	—	0.05	

DYSTRIC FLUVISOL Jd

Classification (Canada)	Cumulic Regosol, Acadia Series, Nova Scotia
Location	Hants County, Nova Scotia
Physiography	Alluvial marine lowlands; level to depressional
Drainage	Imperfect
Parent material	Marine alluvium
Vegetation	Salt grasses
Climate	Cool boreal; perhumid

Profile description

Ap	0-6 inch	Light reddish brown (5YR 6/4) silt loam; weak platy structure; moderately plastic; fibrous roots; pH 4.4.
Cg1	6-23 inch	Grey (N/5) silty clay loam; medium blocky structure; mottled with dark brown streaks; firm; numerous roots; pH 3.8.
Cg2	23+ inch	Dark reddish grey (5YR 4/2) silty clay loam; amorphous; plastic; firm; greyish mottling; remains of sedges and marsh grasses; pH 3.5.

EUTRIC FLUVISOL Je

Classification (Canada)	Cumulic Regosol, Little Buffalo Series
Location	Slave river lowland, Northwest Territories. 60°06'N-112°16'W
Altitude	192 m (approximately)
Physiography	Alluvial terrace of Slave river
Drainage	Well drained, low surface runoff
Parent material	Loamy calcareous alluvium, rich in organic matter
Vegetation	Mixed woods. White spruce (<i>Picea glauca</i>), black poplar (<i>Populus balsamifera</i>), trembling aspen (<i>Populus tremuloides</i>), willow (<i>Salix</i> spp.)
Climate	Subarctic to cold cryoboreal; humid to subhumid

Profile description

O	2-0 inch	Litter of leaves and twigs, somewhat decomposed at lower edge.
Ah	0-7 inch	Very dark grey (5YR 3/1 moist) loam; moderate, fine granular; friable; non-calcareous; clear smooth boundary.
C1	7-17 inch	Dark greyish brown (2.5Y 4/2 moist) interstratified loam and silt loam; fine pseudoplaty; friable; weakly calcareous; abrupt smooth boundary.
C2	17-40 inch	Dark greyish brown (2.5Y 4/2 moist) loam and silt loam plus black (5YR 2/1 moist) streaks of organic matter; stratified; friable; weakly calcareous.

DYSTRIC FLUVISOL

Canada

Horizon	Depth inches	Particle size distribution %				Textural class	pH	Organic matter					Exchangeable cations me/100 g				
		Gravel	Sand	Silt	Clay			Loss ignition %	Total C %	Total N %	Total SiO ₂ %	Total R ₂ O ₃ %	Free Fe ₂ O ₃ %	H	Ca	Mg	K
Ap	0—6	0.2	17.4	61.8	20.8	sil	4.4	6.14	1.55	0.16	67.9	21.5	1.36	6.8	4.02	2.64	0.21
Cg1	6—23	0	9.6	61.2	29.3	cl	3.8	4.99	0.77	0.10	66.7	22.9	1.51	9.6	2.28	2.28	0.35
Cg2	23+	0	15.1	53.0	31.9		3.5	6.14	1.39	0.12	62.0	26.8		11.6	1.04	1.54	0.36

EUTRIC FLUVISOL

Canada

Horizon	Depth inches	Textural class	pH		Organic matter		Soluble P ppm	Calcite	Dolomite	Moisture equiv. %	Wilting %	4A3a Bulk density g/cm ³
			8C1a 1:1 H ₂ O	8C1e CaCl ₂	6A1a OC %	6B1a N %						
Ah	0—7	l	6.9	6.6	10.5	0.44	13.9			41.4	17.0	0.8
C1	7—17	l + sil	7.5	7.4	5.2	0.33	2.5	0.8	0.4	33.1	15.3	1.0
C2	17—40	l + sil	8.1	8.0	7.7	0.25	2.0	0.9	0.2	34.5	16.3	0.8

HAPLIC KASTANOZEM Kh

Classification (Canada)	Dark Brown Chernozemic, Orthic Dark Brown, Weyburn Association, Saskatchewan
Location	Rosetown Map Sheet 72-0, Saskatchewan
Altitude	670 m
Physiography	Undulating and gently rolling till plain
Drainage	Well drained
Parent material	Medium to moderately fine textured glacial till, moderately calcareous
Vegetation	Field crops and mixed prairie (<i>Stipa-Bouteloua</i>)
Climate	Cool boreal; semiarid

Profile description

Ap	0-4 inch	Very dark greyish brown (10YR 3/2 moist) to greyish brown (10YR 5/2 dry) sandy loam; moderate, medium subangular blocky structure, which crushes to moderate, fine, granular.
BA	4-8 inch	Dark greyish brown (10YR 4/2 moist) to brown (10YR 5/3 dry) sandy clay loam; moderate medium prismatic structure breaking to moderate medium subangular blocky, which crushes to moderate, fine, granular.
Bw	8-10 inch	Dark greyish brown (10YR 4/2 moist) to brown (10YR 5/3 dry) sandy clay loam; moderate medium prismatic structure which crushes to moderate, fine, granular; none to very weak effervescence.
Ck1	10-19 inch	Greyish brown (2.5Y 5/2 moist) to light brownish grey (2.5Y 6/2 dry) sandy loam; weak coarse prismatic to massive structure, which crushes to moderate, fine, granular; moderate to strong effervescence.
Ck2	19+ inch	Greyish brown (2.5Y 5/2 moist) to light brownish grey (2.5Y 6/2 dry) sandy clay loam; massive, crushes to moderate, fine, granular; moderate to strong effervescence.

CALCIC KASTANOZEM Kk

Classification (USDA)	Vertic Argiustoll; fine, mixed, thermic
Location	Uvalde County, Texas
Altitude	300 m (approximately)
Physiography	Nearly level, very broad stream terraces
Drainage	Well drained; runoff is slow to moderate; permeability is slow
Parent material	Clayey Pleistocene alluvium underlain by more loamy alluvium
Vegetation	Formerly cultivated land; now fallow
Climate	Thermic; subhumid

Profile description

Ap	0-6 inch	Brown (4/2) clay, dark brown (9YR 2.5/2) moist; weak subangular blocky and blocky structure, mostly cloddy dry; upper 2 inches is a loose mulch of very fine discrete flattened granules covered by a thin easily broken crust; hard; very firm but crumbly; about 2 percent fine CaCO ₃ concretions; many reddish
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(continued on page 158)

HAPLIC KASTANOZEM

Canada

Horizon	Depth inches	Particle size distribution % 3A1b							Organic matter		6E1e	5A1b	Exchangeable cations 5B1b me/100 g					8C1b	8B1a
		Coarse medium sand	Fine sand	Very fine sand	Total sand	Silt	Total clay	Fine clay	6B1a	6A2	CaCO ₃ equiv. %	CEC me/100 g	Ca	Mg	K	Na	H	pH	EC mmhos/ cm
									N %	OC %									
Ap	0—4	21.2	15.1	16.5	52.8	28.9	18.3	14.3	0.19	2.07	0.35	18.1	13.6	4.4	2.6	0.2		7.1	0.9
BA	4—8	22.8	18.8	14.4	56.0	20.2	23.8	13.3	0.08	0.83	0.15	17.1	13.7	4.9	1.8	0.2		6.5	0.5
Bw	8—10	27.5	19.4	11.9	58.8	20.4	20.8	16.9	0.07	0.53	1.70	13.6	20.7	4.3	1.8	0.2		7.4	0.6
Ck1	10—19	30.2	18.1	11.2	59.5	20.7	19.8	9.6			16.00							7.9	0.6
Ck2	19+	30.1	17.6	11.0	58.7	21.2	20.0	9.0			14.25							8.1	1.7

CALCIC KASTANOZEM

United States

Horizon	Depth inches	Size class and particle diameter (mm) 3A1													Coarse fragments 2A2		
		Total			Sand					Silt			Int. II (0.2- 0.02)	(2-0.1)	3A1a Non carbon- ate < 0.002	3B1 19-2 wt	3B2 19-2 vol.
		Sand (2-0.05)	Silt (0.05- 0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5- 0.25)	Fine (0.25- 0.1)	Very fine (0.1- 0.05)	0.05- 0.02	Int. III (0.02- 0.002)	% of < 2 mm					
													% of < 19 mm				
Ap	0—6	13.2	36.3	50.5	0.3	0.4	0.7	3.4	8.4	14.7	21.6	25.6	4.8	48	tr		
Ah1	6—12	12.4	37.3	50.3	0.5	0.8	0.6	2.9	7.6	17.3	20.0	27.0	4.8	43	tr		
Ah2	12—24	12.3	37.3	50.4	0.2	0.6	0.6	3.0	7.9	12.9	24.4	23.0	4.4	42	tr		
Bw	24—34	11.5	37.8	50.7	0.6	0.6	0.5	2.7	7.1	12.8	25.0	21.9	4.4	42	tr		
Bck1	34—37	11.8	42.2	46.0	1.2	0.9	0.6	2.8	6.3	11.5	30.7	19.8	5.5	35	4	2	
Bck2	37—45	14.0	48.1	37.9	3.4	2.1	1.0	2.5	5.0	9.5	38.6	16.2	9.0	25	11	6	
Bck3	45—57	11.7	51.7	36.6	1.7	1.7	0.8	2.5	5.0	10.7	41.0	17.4	6.7	27	6	5	
Cck1	57—78	8.8	53.8	37.4	0.7	0.5	0.4	2.1	5.1	11.6	42.2	18.2	3.7	27	6	3	
Cck2	78—96														9		
Cck3	96—120														6		
Cck4	120—139														6		

(continued on page 159)

CALCIC KASTANOZEM, United States (concluded)

		particles or grit; many worm casts and termite channels; moderately alkaline; calcareous; smooth abrupt lower boundary.
Ah1	6-12 inch	Brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate to strong very fine subangular blocky and irregular blocky structure; shiny peds; extremely hard; very firm but crumbly; crushed colour (7.5YR 4/3); few very fine CaCO ₃ concretions; few shell fragments; common worm casts and termite channels; few fine white mycelia-like mould; moderately alkaline; calcareous; slightly wavy clear lower boundary.
Ah2	12-24 inch	Reddish brown (6YR 4/3) clay, dark reddish brown (6YR 2/3) moist; strong medium and coarse blocky structure, dry; breaking to strong very fine irregular blocky structure moist; very shiny ped surfaces; extremely hard; very firm but crumbly; about 4 percent fine CaCO ₃ concretions; few worm casts and filled termite channels; common filled cracks of greyish soil fines; very fine or thin mould persists; few fine quartz pebbles; moderately alkaline; calcareous; seemingly weak prismatic structure; slightly wavy gradual lower boundary.
Bw	24-34 inch	Reddish brown (6YR 4/4) clay, dark reddish brown (6YR 3/4) moist; strong medium blocky, dry; very fine strong irregular blocky, moist; macrostructure of weak prismatic, dry; shiny peds; extremely hard; very firm but crumbly; about 4 percent CaCO ₃ concretions; common dark greyish filled cracks and worm channels; casts and termite channels persist; few quartz pebbles, scattered; suggestions of slickensides but could not confirm; moderately alkaline; calcareous; clear wavy lower boundary.
Bck1	34-37 inch	Brown (7.5YR 4/4) clay, dark reddish brown (6YR 3/4) moist; weak prismatic breaking to moderate medium blocky structure; extremely hard; very firm but very crumbly; shiny patches on ped surfaces; many very fine whitish threads; estimated 10 to 12 percent CaCO ₃ concretions; common dark filled worm channels; moderately alkaline; calcareous; clear wavy boundary.
Bck2	37-45 inch	Brown (7.5YR 5/4) clay loam, strong brown (7.5YR 5/6) moist; moderate to strong medium and fine blocky and subangular blocky structure, dry; very hard; very firm; estimated 30 percent CaCO ₃ concretions and soft masses; common worm casts of nearly black and reddish colours; moderately alkaline; calcareous; gradual wavy to irregular lower boundary with tongues 6 inches in width extending 12 inches into next horizon.
Bck3	45-57 inch	Reddish brown (5YR 5/4) clay loam, yellowish red (5YR 5/6) moist; estimated 10 to 15 percent CaCO ₃ ; same as horizon above for other characteristics; clear wavy lower boundary.
Cck1	57-78 inch	Reddish brown (5YR 5/4) clay loam, darker reddish brown (5YR 4/4) moist; weak blocky and prismatic structure; about 10 percent CaCO ₃ concretions and soft masses; very few worm casts; contains streaks of brown (7.5YR 5/4); clear wavy lower boundary.
Cck2	78-96 inch	Light brown (7.5YR 6/4) light clay loam, brown (7.5YR 5/4) moist; auger samples here and below.
Cck3	96-120 inch	Same as preceding horizon except the CaCO ₃ content as concretions and masses increased to about 25 percent.
Cck4	120-139 inch	Same; estimated 15 percent CaCO ₃ and decreasing with depth with colour becoming less pale and a stronger brown; clay loam textured.

CALCIC KASTANOZEM

United States (concluded)

Horizon	Organic matter			Carbonate as CaCO ₃		Bulk density			4D1 COLE ⁴	Water content			8C1a pH 1:1 H ₂ O
	6A1a OC ¹ %	6B1a N %	C/N	6E1b < 2 mm %	3A1a < 0.002 mm %	4A1d 1/3-bar ³ g/cm ³	4A1d 1/3-bar g/cm ³	4A1b Air dry g/cm ³		4B1c 1/3-bar %	4B2 15-bar %	4C1 1/3- to 15-bar ⁴ in/in	
Ap	1.81			14	3		1.14	1.42	0.078	32.0	18.8	0.15	7.9
Ah1	1.29			18	7		1.23	1.60	0.092	32.3	19.5	0.16	7.8
Ah2	1.01			20	8		⁵ 1.30				19.0		7.8
Bw	0.78			24	9		1.32	1.70	0.087	30.4	18.3	0.16	7.9
Bck1	0.57			37	11	⁵ 1.30	⁵ 1.30				16.4		7.9
Bck2	0.31			54	13	1.28	1.36	1.50	0.030	25.0	12.8	0.16	8.0
Bck3	0.22			54	10	⁵ 1.30	⁵ 1.40				12.6		7.9
Cck1	0.15			49	10	1.44	1.48	1.68	0.043	21.4	13.3	0.12	7.9
Cck2				57									
Cck3				60									
Cck4				62									

Horizon	Extractable bases 5B1a					5A1a CEC NH ₄ OAc	Ratios to clay 8D2		
	6N4b Ca	6O4b Mg	6P2a Na	6Q2a K	Sum		NH ₄ OAc CEC	Ext. iron	15-bar water
	me/100 g								
Ap	30.3	0.9	tr	2.9	34.1	30.0	0.63		0.39
Ah1	29.5	0.7				29.6	0.69		0.45
Ah2	29.8	1.0	0.1	1.2	32.1	28.0	0.67		0.45
Bw	28.9	1.0	0.1	1.1	31.1	26.7	0.64		0.44
Bck1	24.9	0.7	0.1	0.9	26.6	23.1	0.66		0.47
Bck2	18.9	0.7	0.1	0.7	20.4	17.7	0.71		0.51
Bck3	18.6	1.0	0.1	0.7	20.4	17.5	0.65		0.47
Cck1	18.2	1.0	0.1	0.7	20.0	17.5	0.65		0.49
Cck2									
Cck3									
Cck4									

¹ Carbonate comprises 10 to 20 percent of the sand. - ² 15 kg/m³ to 60 inches (Method 6A). - ³ Calculated to include volume but not weight of 2- to 19-mm material (Method 3B2). - ⁴ Less than 19-mm material. - ⁵ Estimated.

LUVIC KASTANOZEM K1

Classification (Canada)	Eluviated Dark Brown, Elstow Association, Saskatchewan
Location	Rosetown Map Sheet 72-0, Saskatchewan
Altitude	650-715 m
Physiography	Nearly level to gently sloping lacustrine plain
Drainage	Well drained
Vegetation	Field crops and mixed prairie (<i>Stipa-Bouteloua</i>)
Parent material	Medium to moderately fine textured, moderately calcareous, silty glaciolacustrine deposit
Climate	Cool boreal; semiarid

Profile description

Ap	0-8 inch	Greyish brown (10YR 5/2 dry) to very dark greyish brown (10YR 3/2 moist) loam; moderate medium subangular blocky structure crushing to moderate fine granular.
AB	8-14 inch	Greyish brown (10YR 5/2 dry) to dark greyish brown (10YR 4/2 moist) loam; moderate medium subangular blocky structure breaking to moderate coarse platy which crushes to moderate fine granular.
BA	14-19 inch	Brown (10YR 5/3 dry) to dark brown (10Y 4/3 moist) loam; moderate medium prismatic structure, which crushes to moderate fine granular.
Bt1	19-22 inch	Brown (10YR 5/3 dry) to dark greyish brown (10YR 4/2 moist) loam; moderate medium prismatic structure breaking to moderate medium subangular blocky which crushes to moderate fine granular.
Bt2	22-27 inch	Pale brown (10YR 6/3 dry) to brown (10YR 5/3 moist) silty clay loam; moderate medium prismatic structure breaking to moderate medium subangular blocky which crushes to moderate fine granular.
BCK	27-32 inch	Light brownish grey (10YR 6/2 dry) to greyish brown (10YR 5/2 moist) silty clay loam; weak, medium to coarse prismatic structure which crushes to moderate fine granular; moderate to strong effervescence.
Ck	32+ inch	Light brownish grey (10YR 6/2 dry) to greyish brown (10YR 5/2 moist) silty clay loam; massive, crushes to moderate fine granular structure; moderate effervescence.

LUVIC KASTANOZEM

Canada

Horizon	Depth inches	Particle size distribution % 3A1b							Organic matter		6E1e	5A1b	Exchangeable cations 5B1b me/100 g					8C1b	8B1a
		Coarse and medium sand	Fine sand	Very fine sand	Total sand	Silt	Total clay	Fine clay	6B1a N %	6A2 OC %	CaCO ₃ equiv. %	CEC me/100 g	Ca	Mg	K	Na	H	pH	EC mmhos/ cm
Ap	0—8	1.2	3.5	28.8	33.5	38.5	24.3	15.2	0.33	3.58		25.8	20.1	4.1	1.4	0.2		6.4	1.2
AB	8—14	0.5	4.4	36.9	41.8	33.2	25.0	17.0	0.14	1.19		19.1	11.9	3.7	1.2	0.2		5.7	0.4
BA	14—19		0.7	36.8	37.5	38.2	24.3	21.5	0.11	0.71		22.7	16.7	6.0	1.0	0.2		6.5	1.1
Bt1	19—22		0.5	35.4	35.9	38.9	25.1	17.7				22.4	15.1	6.5	0.9	0.2		6.7	1.0
Bt2	22—27		0.2	12.7	12.9	55.6	31.5	19.2					18.4	7.5	0.9	0.2		6.6	1.0
BCk	27—32			3.0	3.0	67.6	29.4	18.6			16.55							7.4	0.9
Ck	32+		1.0	20.8	21.8	53.2	25.1	17.1			14.80							7.5	0.8

ALBIC LUVISOL La

Classification (Canada)	Orthic Gray Wooded (Gray Luvisol), Cooking Lake Series, Alberta
Location	53°22'N - 113°10'W. East of Edmonton, Alberta
Altitude	800 m (approximately)
Physiography	Gently rolling morainic plain
Drainage	Well drained
Vegetation	Mixed wood boreal forest, dominantly aspen (<i>Populus</i> spp.)
Climate	Cold boreal; subhumid

Profile description

O	4-0	cm	Partly decomposed leaves and roots (10YR 2/1 moist).
Ah1	0-3	cm	Black to very dark grey (10YR 2/1 moist, 10YR 3.5/1 dry) sandy loam; moderate fine granular structure; very friable, soft; many roots, white sand grains.
Ah2	3-8	cm	Very dark greyish brown (10YR 3.5/2 moist) to greyish brown (10YR 5.5/1.5 dry) sandy loam; weak medium platy to granular structure; very friable, soft.
E1	8-13	cm	Dark greyish brown (10YR 4/2 moist) to light brownish grey (10YR 6/1.5 dry) sandy loam; moderate medium platy structure; very friable, soft, many roots, few gravels.
E2	13-18	cm	Brown (10YR 5/2.5 moist) to light grey (10YR 7/2 dry) loam to sandy clay loam; weak subangular blocky to platy; friable, slightly hard; few roots.
EB	18-23	cm	Brown (10YR 5/3 moist) to pale brown (10YR 6/2.5 dry) sandy clay loam; weak subangular blocky structure; firm, hard, compact, low porosity.
BE	23-33	cm	Brown (10YR 5/3 moist) to pale brown (10YR 6/2.5 dry) clay loam; strong medium subangular blocky structure; firm, hard; tongues of E horizon; some clayskins.
Bt	33-73	cm	Dark brown (10YR 4/3 moist) to pale brown (10YR 6/3 dry) clay loam; coarse prismatic and strong blocky structure; firm, very hard; nearly continuous thin dark clayskins.
BC	73-92	cm	Brown (10YR 4.5/3 moist) to pale brown (10YR 6/2.5 dry) clay loam; coarse prismatic to blocky structure; firm, very hard; discontinuous clayskins.
BCK	92-105	cm	Olive brown (2.5Y 4.5/3 moist) to light brownish grey (2.5Y 5.5/2 dry) clay loam; coarse prismatic to pseudoblocky structure; firm, very hard; few clayskins; carbonate flecks.
C	105-118	cm	Greyish brown (2.5Y 4.5/2 moist) to light brownish grey (2.5Y 5.5/2) sandy clay loam; pseudoblocky to coarse platy structure; firm, very hard; calcareous till.

Horizon	Depth cm	4A1b Bulk density	3A1b Sand 2000-50 μ	3A1b Silt 50-2 μ	3A1b Clay 2-0 μ	3A1b Fine clay < 0.2 μ	Fine clay Total clay	Organic matter		8C1d pH	Exchangeable cations me/100 g		6C5		6C3a
								6A1a OC %	6B1a N %		Ca + Mg	Al	Oxalate Fe+Al %	Dithi- onite Fe %	
								% of < 2 mm							
O	4—0	—	—	—	—	—	—	30.0	1.0	6.9	42.0	0	0.12	0.10	0.68
Ah1	0—3	—	—	—	—	—	—	24.0	0.86	6.6	37.0	0	0.14	0.08	0.38
Ah2	3—8	—	54	34	12	6.1	51	1.6	0.09	5.9	6.3	0	0.14	0.06	0.47
E1	8—13	—	54	36	10	2.3	23	0.6	0.04	5.8	4.1	0	0.09	0.05	0.36
E2	13—18	1.9	50	28	22	9.7	44	0.7	—	5.5	10.0	0.1	0.09	0.08	0.50
EB	18—23	1.9	43	27	30	16.0	53	0.8	—	5.1	13.0	0.1	0.09	0.10	0.59
BE	23—33	1.8	38	26	36	22.0	61	0.8	—	4.6	17.0	0.4	0.10	0.18	1.10
Bt	33—53	1.9	40	25	35	22.0	63	1.0	0.07	4.5	17.0	0.4	0.20	0.15	1.20
Bt	53—73	1.9	41	25	34	21.0	62	0.9	—	5.0	19.0	0	0.20	0.10	1.20
BC	73—92	1.9	41	26	33	19.0	57	0.8	—	5.3	19.0	0	0.18	0.09	1.10
BCK	92—105	1.9	—	—	—	—	—	0.9	—	>7	—	—	0.15	0.06	1.10
C	105—118	—	46	25	29	16.0	55	0.9	0.06	>7	—	—	0.15	0.06	1.00

The CaCO₃ equivalent of the C horizon was 6.0% (3.7% was calcite).

CHROMIC LUVISOL Lc

Classification (USDA)	Ultic Haplustalf, fine-loamy, siliceous, thermic
Location	Parker County, Texas
Altitude	335 m (approximately)
Physiography	Uniform surface of about 4% gradient sloping east, in gently rolling upland
Drainage	Well drained
Parent material	Weakly indurated banded noncalcareous sandstone
Vegetation	Very thinly forested pastures; forest species consist of blackjack and post oak (<i>Quercus marilandica</i> and <i>Quercus stellata</i>); moderately thick ground cover of native grasses and herbs
Climate	Thermic; subhumid

Profile description

Ah	0-5 inch	Very dark greyish brown (10YR 3/2) when moist, dark greyish brown (10YR 4/2) when dry, very friable fine sandy loam with poorly developed fine granular structure; roots, mostly small, are fairly numerous and uniformly distributed. This grades into the horizon below.
E	5-15.5 inch	Dark brown to brown (7.5YR 4/3) when moist, light brown (7.5YR 6/3) when dry, nearly loose fine sandy loam; roots are less numerous than in layer above; a thin transition layer of very friable loam or heavy fine sandy loam forms lower part of this horizon.
Bt1	15.5-24.5 inch	Reddish brown (5YR 4/4) when moist, yellowish red (5YR 4/8) when dry, sandy clay loam. It is friable when moist and displaced pieces break down into weakly developed medium blocky aggregates; slightly plastic when wet and hard when dry; a few rounded pebbles are present; uncrushed surfaces are slightly darker than crushed. This horizon grades into the one below.
Bt2	24.5-36 inch	Yellowish red (5YR 4/8) when moist, yellowish red (5YR 5/6) when dry, sandy clay loam somewhat more sandy than the overlying horizon; friable when moist and displaced pieces break down readily into poorly developed medium blocky aggregates; uncrushed surfaces are slightly darker than when crushed; this layer also contains a small amount of rounded pebbles. It grades into the material below.
BC	36-39 inch	Fine sandy loam with pockets of sandy clay or clay, reddish yellow (7.5YR 6/8) mottled with dark yellowish red (5YR 5/8) when moist, and reddish yellow (7.5YR 7/6) when dry; very friable when moist; little or no structure. This rests abruptly on the material below.
2C	39-49 inch	Weakly indurated banded noncalcareous sandstone; the dominant colours are strong brown (7.5YR 5/6), and yellowish red (5YR 5/8).

CHROMIC LUVISOL

United States

Horizon	Depth inches	Size classes %							
		Clay	Int. III (0.02—0.002)	USDA silt	Very fine sand	Fine sand	Medium sand	Coarse sand	Very coarse sand
Ah	0—5	6.3	4.2	19.5	45.1	28.8	0.2	0.1	0
E	5—15.5	6.4	3.2	15.5	46.9	31.0	0.1	0.1	0
Bt1	15.5—24.5	24.7	3.4	13.7	37.1	24.1	0.2	0.1	0.1
Bt2	24.5—36	23.9	3.2	13.0	42.7	20.2	0.1	0.1	0
BC	36—39	21.8	2.1	11.2	61.6	5.9	0	0	0
2C	39—49	19.0	4.2	20.0	52.2	8.7	0.1	0	0

Horizon	Extractable cations me/100g soil						BS %	pH	OC %	P ppm
	Ca	Mg	K	Mn	H	Sum cations				
Ah	3.6	0.7	0.4	0.03	1.2	5.9	80	6.9	0.81	6.0
E	1.9	0.5	0.4	0.01	0.8	3.6	88	6.6	0.29	2.8
Bt1	4.7	2.4	0.5	tr	4.6	12.2	62	5.3	0.44	3.2
Bt2	5.0	3.0	0.5	tr	4.0	12.5	68	5.4	0.31	2.8
BC	5.4	3.2	0.5	tr	4.0	13.1	69	5.2	0.25	4.4
2C	5.8	3.0	0.4	tr	2.7	11.9	77	5.4	0.20	1.2

Horizon	Exchange capacity me/100 g	¹ Surface m ² /g			Inner surface %	Kaolin %	Quartz %	Gibbsite %
		Total	Exterior	Inner				
E		250	135	115	15	10	30	0
Bt2	52	390	100	290	40	10		0
C	63	620	130	490	65	10		0

¹Results of X-ray diffraction patterns of oriented samples. 5-15-1/2 kaolin, mixed layer mineral.

GLEYIC LUVISOL Lg

Classification (USDA)	Aeric Ochraqualf, fine-silty, mixed, mesic
Location	Fountain County, Indiana
Altitude	225 m (approximately)
Physiography	Level
Drainage	Somewhat poorly (imperfectly) drained; slowly permeable
Parent material	Stratified material underlain by strata of coarse sand with some gravel
Vegetation	Soybeans
Climate	Mesic; aquic

Profile description

Ap	0-7 inch	Dark greyish brown (10YR 4/2) silt loam; weak granular structure to massive; friable to nonsticky and nonplastic; slightly acid (pH 6.2); boundary abrupt and smooth.
ABg	7-10 inch	Greyish brown (2.5Y 5/2) silt loam with common to many, fine to medium, faint to distinct grey (10YR 5/1) and yellowish brown (10YR 5/4) mottles; weak thin platy structure; firm to friable; medium acid (pH 5.8); boundary clear and smooth.
BAg	10-14 inch	Mottled yellowish brown (10YR 5/4, 50 percent) and grey (10YR 5/1, 50 percent) light silty clay loam; moderate to strong fine and medium subangular blocky structure; firm to slightly plastic; ped interiors mainly yellowish brown (10YR 5/4) with ped surfaces grey (10YR 5/1); common very fine pores in ped interiors and few very fine pores on ped surfaces; ped surfaces high in silt; medium acid (pH 5.6); roots few; boundary clear and smooth.
Btg1	14-21 inch	Grey (10YR 5/1) silty clay loam; many medium prominent yellowish brown (10YR 5/8) mottles; moderate to strong medium blocky structure with peds tending to arrange in fine to medium prismatic structure; firm to slightly sticky and plastic; ped interiors are yellowish brown (10YR 5/8) with grey (10YR 5/1) surfaces, and grey (10YR 5/1) around pores; common very fine pores in ped interiors; no observed clay films inside peds; ped surfaces silt rich; very few soft Fe-Mn aggregates; strongly acid (pH 5.4); boundary clear and smooth.
Btg2	21-29 inch	Mottled grey (10YR 5/1 40 percent) and yellowish brown (10YR 5/8 60 percent) silty clay loam; moderate medium prismatic structure breaking to moderate medium blocky structure; firm; major ped surfaces are grey (10YR 5/1); common fine pores in ped interiors; patchy faint clay films on less prominent cleavage planes and in some fine pores; major ped surfaces are high in silt; strongly acid (pH 5.2); few Fe-Mn aggregates; boundary smooth and gradual.
Btg3	29-37 inch	Grey (10YR 5/1) silty clay loam with many medium distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure breaking to weak, coarse blocky structure; firm to plastic and slightly sticky; major cleavage planes are grey (10YR 5/1); many very fine pores on ped surfaces, common fine pores in ped interiors; distinct clay films in fine pores; major cleavage planes high in silt; medium acid (pH 5.6); no roots; few Fe-Mn aggregates; boundary clear and smooth.
2Btg1	37-50 inch	Grey (10YR 5/1) sandy clay loam with some dark grey (10YR 4/1) vertical surfaces; massive; plastic and slightly sticky; many medium distinct yellowish brown (10YR 5/8) mottles; very dark grey (10YR 3/1) clay films on void surfaces; common fine voids; distinct broken very dark grey (10YR 3/1) clay films on void surfaces and planes of weakness; slightly acid (pH 6.4); few rotten micaceous minerals; boundary clear and wavy.
2BCg	50-63 inch	Dark grey (10YR 4/1) gravelly sandy clay loam in upper part, grading to loamy sand below; massive in upper part, grading to single grain below; slightly sticky and slightly plastic in upper part, grading to nonsticky and nonplastic below; common coarse prominent mottles; neutral (pH 6.6); boundary abrupt and wavy.
2Cg	63-73 inch	Light olive brown (2.5Y 5/4) stratified fine sand and gravelly coarse sand with bands of dirty yellowish brown (10YR 5/8) coarse sand; single grain, nonsticky and nonplastic; calcareous; water table present.

See notes on opposite page.

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
Ap	0-7	12.0	33.7	33.6	34.1	31.9	70.1	14.6	29.1	44.4	tr	si1
ABg	7-10	10.5	22.0	22.1	22.3	31.3	70.2	21.6	24.4	48.0	tr	si1
BAG	10-14	10.5	21.0	20.9	21.0	31.0	63.3	32.3	20.4	44.3	—	si1
Btg1	14-21	<0.1	20.2	20.3	20.4	31.2	59.9	38.0	24.9	36.4	tr	si1
Btg2	21-29	10.1	20.4	20.4	20.5	31.8	62.3	34.5	28.6	35.7	—	si1
Btg3	29-37	10.3	21.8	22.2	23.2	33.1	58.5	30.9	35.0	27.7	—	si1
2Btg1	37-50	5.8	11.0	12.8	17.9	5.1	26.0	21.4	24.7	13.1	12	sc1
2BCg	50-63	9.8	22.2	27.1	19.3	2.2	8.0	11.4	10.0	5.6	21	cos1
2Cg	63-73	13.9	15.0	14.5	17.2	5.5	9.7	4.2	25.1	5.5	21	cos

Horizon	8C1a	6E1a	Carbonate clay	Organic matter			6C1a	Bulk density		Water content			
	pH (1:1)	Carbonate as CaCO ₃ %		6A1a OC %	6B1a N %	C/N	Free iron Fe ₂ O ₃ %	4A1c 30 cm g/cc	4A1h Oven dry g/cc	4C1 1/3-bar to 15-bar %	4B3 30 cm %	4B1b 1/3-bar pieces %	4B2 15-bar %
Ap	5.9			1.08	0.107	10	1.6	1.42	1.46	13.2	23.5	19.8	6.6
ABg	4.6			0.32	0.045	7	1.6	1.53	1.56	14.3	23.3	22.8	8.5
BAG	4.5			0.27	0.041	7	1.7	1.46	1.51	12.0	24.0	24.6	12.6
Btg1	4.5			0.26	0.037	7	1.8			14.8		31.0	16.2
Btg2	4.6			0.24	0.033		2.2	1.48	1.64	12.8	25.9	28.2	15.4
Btg3	5.3			0.20			2.0	1.45	1.62	11.8	25.1	25.9	14.1
2Btg1	6.3			0.10			1.5	1.55	1.73	7.9	22.2	17.9	10.1
2BCg	6.9	<1		0.16			1.4						4.8
2Cg	8.3	23		0.21			1.0						1.3

Horizon	5A1a	Extractable cations 5B1a					5C1	5C3	5B1a	5A3a	8D3	6G2a	8D1
	CEC NH ₄ OAc	6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	BS % NH ₄ OAc Exch.	BS % on sum cations	Sum ext. bases	Sum ext. cations	Ca/Mg	KCl-Ext. Al	CEC me/100 g clay
		me/100 g							me/100 g			me/100 g	
Ap	10.1	6.2	1.4	6.1	<0.1	0.3	78	56	7.9	14.0	4.4	<1	69
ABg	10.7	3.9	1.2	9.3	<0.1	0.2	50	36	5.3	14.6	3.2	3	50
BAG	16.7	6.0	2.9	13.2	0.1	0.3	56	41	9.3	22.5	2.1	6	52
Btg1	23.1	8.7	5.5	15.4	0.1	0.5	64	49	14.8	30.2	1.6	7	61
Btg2	21.2	9.1	6.3	12.6	0.1	0.4	75	56	15.9	28.5	1.4	4	61
Btg3	20.6	11.6	7.4	6.2	0.1	0.5	95	76	19.6	25.8	1.6	1	67
2Btg1	14.8	9.3	5.5	3.2	0.1	0.3	103	83	15.2	18.4	1.7	<1	69
2BCg	7.2	4.7	2.3	1.2	0.1	0.2	101	86	7.3	8.5	2.0		68
2Cg	1.7		0.9	<0.1	<0.1	<0.1							40

¹ Many Fe-Mn concretions. - ² Common Fe-Mn concretions. - ³ Few Fe-Mn concretions. - ⁴ Few carbonates.

NOTES ON PROFILE DESCRIPTION, page 166:

All colours based on field moisture conditions. Soil voids are described according to following classes:

Abundance classes: Few 1 to 3 per square inch
Common 4 to 7 per square inch
Many 7 to 14 per square inch

Diameter classes: Very fine < 1 mm
Fine 1 to 2 mm
Medium 2 to 5 mm
Coarse 5 to 10 mm
Very coarse > 10 mm

ORTHIC LUVISOL Lo

Classification (USDA)	Ultic Hapludalf, fine-silty, mixed, mesic
Location	Posey County, Indiana
Altitude	125 m (approximately)
Physiography	3 to 4% slope; no or slight erosion
Drainage	Well drained
Parent material	Wisconsin loess
Vegetation	Maple, tulip tree, beech and elm (<i>Acer</i> spp.; <i>Liriodendron tulipifera</i> , <i>Fagus</i> and <i>Ulmus</i> spp.)
Climate	Mesic; humid

Profile description

Ah	0-2	inch	Very dark greyish brown (10YR 3/2 moist) silt loam; weak fine granular structure; friable when moist; numerous fine feeder tree roots; abrupt smooth boundary; 0.25 to 2 inches of accumulation of recent leaves on surface, very few leaves present from previous year.
E1	2-4	inch	Dark greyish brown to dark grey (10YR 4/2 to 4/1 moist) silt loam; some penetration of Ah in worm holes and along small cracks; weak fine subangular blocky structure; friable when moist; abrupt smooth boundary.
E2	4-10	inch	Brown (10YR 4/3 moist) silt loam; penetration of Ah in root channels and worm casts; weak to moderate fine subangular blocky structure; friable when moist; abrupt smooth boundary.
BA	10-15	inch	Yellowish brown (10YR 5/4 to 5/6 moist) silt loam; moderate fine subangular blocky structure; friable when moist; clear smooth boundary.
Bt1	15-19	inch	Brown (7.5YR 4/4 moist) heavy silt loam; very thin coating of light brownish grey to pale brown (10YR 6/2 to 6/3 moist) on most peds; dark brown (7.5YR 4/4 to 4/2 moist) clayskins are common; moderate medium and coarse subangular blocky structure; firm when moist; clear wavy boundary.
Bt2	19-31	inch	Brown to strong brown (7.5YR 4/4 to 5/6 moist) light silty clay loam; dark brown (7.5YR 4/3 moist) clayskins are common; pale brown (10YR 6/3 dry) occurs along vertical cracks; cracks up to 0.12 inch wide decrease with depth; a few very dark brown (10YR 2/2 moist) thin coatings and streaks present; weak medium prismatic to moderate to strong coarse subangular blocky structure; very hard when dry and firm when moist; clear wavy boundary.
Bt3	31-37	inch	Strong brown (7.5YR 5/6 moist) light silty clay loam; reddish brown (5YR 4/3 moist) clayskins are numerous; yellowish brown (10YR 5/4 moist), light grey (10YR 7/2 dry) streaks and crack fillings; cracks are up to 0.25 inch in diameter; numerous very dark brown (10YR 2/2 moist) thin coatings and streaks; moderate coarse and very coarse subangular to very weak coarse prismatic structure; very hard when dry and firm when moist; gradual wavy boundary.
BC	37-49	inch	Brown to strong brown (7.5YR 4/4 to 5/6 moist) silt loam; a few reddish brown (5YR 4/3 moist) clayskins; very few very dark brown (10YR 2/2 moist) thin coatings and streaks; a few thin coatings and a few crack fillings of brown (10YR 5/3 moist) light grey (10YR 7/2 dry); very weak very coarse subangular blocky structure; very hard when dry and friable when moist; gradual wavy boundary.
C	49-66+	inch	Brown to strong brown (7.5YR 4/4 to 5/6 moist) silt loam; a few streaks of brown (10YR 5/3 moist); massive; hard when dry and friable when moist.

NOTE: Mineralogy (Method 7A2): X-ray diffraction analyses on the B horizons showed the clay to be dominantly montmorillonite with lesser amounts of illite and some kaolinite.

Horizon	Depth inches	Particle size distribution (mm) % 3A1										Textural class
		1B1a										
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
Ah	0-2	0.4	2.0	0.8	1.3	1.6	86.7	7.2	37.1	51.9	—	si
E1	2-4	0.1	0.3	0.2	0.4	1.0	84.8	13.2	36.0	50.0	—	si1
E2	4-10	—	0.1	0.2	0.2	0.8	83.0	15.7	36.2	47.7	—	si1
BA	10-15	—	0.1	0.1	0.3	0.8	79.6	19.1	35.9	44.7	—	si1
Bt1	15-19	—	—	—	0.1	0.8	73.0	26.1	34.2	39.7	—	si1
Bt2	19-31	—	—	—	0.1	1.0	69.8	29.1	37.4	33.5	—	si1
Bt3	31-37	—	—	—	0.1	1.7	74.3	23.9	42.4	33.7	—	si1
BC	37-49	—	—	—	0.2	1.7	78.0	20.1	45.5	34.3	—	si1
C	49-66+	—	—	—	0.2	1.5	78.1	20.2	49.3	30.4	—	si1

Horizon	pH			Organic matter			Moisture tensions		
	8C1a (1:1) H ₂ O	(1:5)	(1:10)	6A1a OC %	6B1a N %	C/N	1/10 atm. %	1/3 atm. %	4B2 15 atm. %
Ah	6.6			3.63	0.303	12			12.0
E1	6.4			2.10	0.209	10			9.1
E2	6.0			0.85	0.096	9			7.0
BA	5.0			0.40	0.053	8			7.4
Bt1	4.8			0.24	0.041				10.3
Bt2	4.8			0.17	0.030				12.2
Bt3	4.7			0.15					10.4
BC	4.7			0.11					9.2
C	4.7			0.11					8.9

Horizon	5A1a	Extractable cations 5B1a					5C1	5C3	5B1a	5A3a	8D3
	CEC NH ₄ OAc	6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	BS % NH ₄ OAc exch.	BS % on sum cations	Sum bases	Sum cations	Ca/Mg
		me/100 g							me/100 g		
Ah	19.2	15.0	3.3	4.9	—	0.5	98	79	18.8	23.7	4.5
E1	14.4	9.4	3.4	4.5	—	0.3	91	74	13.1	17.6	2.8
E2	9.4	4.8	2.0	5.7	0.1	0.2	76	55	7.1	12.8	2.4
BA	9.3	3.8	1.9	5.3	0.1	0.2	64	53	6.0	11.3	2.0
Bt1	13.3	4.3	2.9	9.2	0.1	0.3	57	45	7.6	16.8	1.5
Bt2	16.3	5.3	4.0	10.1	0.1	0.4	60	49	9.8	19.9	1.3
Bt3	14.1	4.2	3.8	9.7	0.1	0.3	60	46	8.4	18.1	1.1
BC	12.4	3.3	3.2	9.2	0.1	0.2	55	43	6.8	16.0	1.0
C	11.6	3.0	2.9	8.2	0.2	0.2	54	43	6.3	14.5	1.0

ORTHIC GREYZEM Mo

Classification (Canada)	Orthic Dark Gray, Winterburn Series, Alberta
Location	Buck Lake and Wabamun Lake areas, 83SE, Alberta
Physiography	Undulating to rolling glaciofluvial plain
Drainage	Well drained
Parent material	Medium to fine textured glaciofluvial, pitted deltaic deposits
Vegetation	Transition, mixed wood forest and parkland fescue prairie (<i>Festuca scabrella</i>)
Climate	Cold cryoboreal; humid

Profile description

O	1-0	inch	Dark coloured organic litter.
Ah	0-3	inch	Very dark brown to very dark greyish brown (10YR 2/2 to 3/2 dry) silt loam; granular; soft; pH 6.1.
E	3-17	inch	Dark greyish brown (10YR 4/2 dry) silt loam; weak platy; slightly hard; pH 6.0.
EB	17-24	inch	Yellowish brown (10YR 5/4 dry) silty clay loam; fine to medium subangular blocky; slightly hard; pH 5.9.
Bt	24-44	inch	Yellowish brown (10YR 5/4 dry) silt loam matrix with thin silty clay loam bands; subangular blocky; slightly hard; pH 6.2.
C	44+	inch	Pale brown to light yellowish brown (10YR 6/3 to 6/4 dry) silt loam with distinct finer textured bands; pH 7.1.

ORTHIC GREYZEM

Canada

Horizon	Depth inches	Particle size distribution % 3A1b				Textural class	8C1b pH	Organic matter		
		Sand	Silt	Clay < 2 μ	Fine clay < 0.2 μ			6B1a N %	6A1a OC %	C/N
Ah	0—3	13	63	24	12	sil	6.1	0.32	3.30	10
E	3—17	15	62	23	15	sil	6.0	0.22	2.81	13
EB	17—24	16	53	31	18	silcl	5.9	0.06	0.84	14
Bt	24—44	5	69	26	11	sil	6.2	0.06	0.58	10
C	44+	5	77	18	6	sil	7.1	0.05		

Horizon	5A1b TEC me/100 g	BS %	Exchangeable cations 5B1b					Ca/Na	6E1e CaCO ₃ equiv. %
			H %	Na %	K %	Ca %	Mg %		
Ah	34.3	93	7	0	3	54	36	10	
E	30.5	94	6	0	2	81	11	13	
EB	24.6	96	4	1	2	76	17	14	
Bt	25.1	96	4	1	1	78	16	10	
C	20.4	100	0	2	1	79	18		0.0

DYSTRIC HISTOSOL Od

Classification (Canada)	Mesic Fibrisol, Whithorn Series, Manitoba
Location	Grahamdale Map Sheet Area, Manitoba
Physiography	Level to depression areas in the Lake Winnipeg portion of the Manitoba plain
Drainage	Very poor, ponded
Vegetation	Stunted black spruce (<i>Picea mariana</i>) and tamarack (<i>Larix laricina</i>) with an understorey of sphagnum moss and sedges or ericaceous shrubs
Climate	Cryoboreal, moderately cold; subhumid with significant aquatic inclusion

Profile description

Hi1	0-18 inch	Light yellowish brown to very pale brown (10YR 6/4 to 7/3 wet) nonwoody, coarse fibred, spongy sphagnum moss; extremely acid; fibre content approximately 93 percent.
Hi2	18-36 inch	Reddish yellow (7.5YR 6/6 wet) nonwoody, moderately coarse fibred, spongy, compacted, sphagnum moss; very strongly acid; unrubbed fibre content approximately 70 percent; with thin mesic layers of dark brown (7.5YR 3/2 to 2/2 wet) amorphous granular to coarse-fibred material of mixed origin (feathermosses, woody fibre, shrubby remains and leaves); very strongly acid; unrubbed fibre content about 84 percent.
He1	36-48 inch	Dark reddish brown to very dark brown (5YR 3/2 to 2/2 and 10YR 2/2 wet) amorphous granular to coarse woody fibred, compacted, moderately decomposed mesic material of mixed origin; very strongly acid; unrubbed fibre content approximately 68 percent; upper portion of the layer contains a high percentage of woody fibres.
He2	48-68 inch	Dark brown to very dark brown (7.5YR 4/4 to 3/2 and 10YR 2/2 wet) nonwoody, moderately coarse fibred, compacted mesic layer derived from herbaceous material; medium acid; unrubbed fibre content approximately 62 percent.
Ha	68-72 inch	Very dark brown to black (10YR 2/2 to 2/1 wet) amorphous granular, fine-fibred nonwoody humic, compacted or matted, herbaceous material; neutral; unrubbed fibre content about 26 percent.

DYSTRIC HISTOSOL

Canada

Horizon	Depth inches	Fibre content unrubbed	8C1c pH 1 : 1 KCl	Organic matter			Pyro- phosphate sol. %	Ash %	4A3a Bulk density	5A1b Exch. cap.	Exchangeable cations 6B1b me/100 g				
				6A1a OC %	6B1a N %	C/N					Ca	Mg	K	Na	H
Hi1	0—18	93	3.0	55.5	0.9	64	0.12	2.7	0.05	138.9	14.0	15.0	0.5	0.4	109.2
Hi2	18—36	84	3.8	54.6	1.0	55	0.37	7.2	0.08	162.2	61.2	28.8	0.3	0.4	47.8
He1	36—48	68	4.7	49.9	1.7	29	0.17	9.8	0.11	221.8	94.4	41.0	0.4	0.5	39.0
He2	48—68	62	5.6	57.1	3.4	17	0.13	8.9	0.09	125.8	76.9	26.7	0.3	0.3	14.6
Ha	68—72	26	7.1	37.4	2.6	14	0.81	37.6	0.11	140.9	131.5	27.4	0.4	0.4	0.8

EUTRIC HISTOSOL Oe

Classification (Canada)	Typic Mesisol, Stead Series, Manitoba
Location	Grahamdale Map Area, Manitoba
Physiography	Level to depression area in the Lake Winnipeg portion of the Manitoba plain
Drainage	Very poorly to poorly drained, under influence of minerotrophic water
Vegetation	Sedges, mosses, reeds, willows (<i>Salix</i> spp.), swamp birch (<i>Betula grandulosa</i>)
Climate	Moderately cold cryoboreal; subhumid with significant aquic inclusions

Profile description

Hi	0-12 inch	Very dark brown (10YR 2/2 moist) nonwoody, fine fibric, sedge material with significant mosses; neutral; unrubbed fibre content approximately 71 percent.
He	12-46 inch	Brown (7.5YR 4/2 moist) to very dark brown (10YR 2/2 moist) medium fibred, mesic, matted to felt-like herbaceous material; medium acid; unrubbed fibre content ranges from approximately 64 percent near the top to 58 percent near the bottom.
Ha	46-52 inch	Very dark brown to black (10YR 2/2 to 2/1 moist) amorphous granular, matted to felt-like humic; medium acid; unrubbed fibre content approximately 23 percent.
2Cg1	52-55 inch	Black (5Y 2/1 wet) clay; amorphous, breaking to fine granular; sticky, very plastic; mildly alkaline; moderately effervescent; clear smooth boundary.
2Cg2	55+ inch	Light grey (5Y 7/1 wet) clay; amorphous massive; sticky, very plastic; mildly alkaline; strongly effervescent.

GELIC HISTOSOL Ox

Classification (Canada)	Cryic Fibrisol, Batty Lake Series, Manitoba
Location	54-55°N-100-102°W. Near Cranberry Portage, Manitoba
Physiography	Peat plateau in a peat bog area; general ground terrain rolling bedrock thinly mantled by lacustrine and glacial outwash sediments
Drainage	Imperfect
Parent material	Forest peat
Vegetation	Black spruce (<i>Picea mariana</i>), feathermoss
Climate	Cryoboreal, cold to moderately cold; humid to subhumid with aquic inclusions; locally area is one of discontinuous permafrost occurring within a peat plateau in a spruce sphagnum bog; represents one of the most southerly observations of discontinuous permafrost in Manitoba

Profile description

Hi	0-37 inch	Very dark grey (10YR 3/1 moist), slightly woody, fibrous feathermoss peat; very strongly acid; fibre content approximately 73 percent.
He	37-170 inch	Black (10YR 2/1 moist), frozen, moderately decomposed, mixed feathermoss and woody peat with segregated ice crystals and ice lenses; strongly acid; fibre content approximately 57 percent.
Ha	170+ inch	Black (10YR 2/1 moist), moderately well decomposed, mixed feathermoss and woody peat.

EUTRIC HISTOSOL
Canada

Horizon	Depth inches	Particle size distribution 3A1b			Fibre content unrubbed %	Textural class	8C1c pH 1:1 KCl	Organic matter		
		Sand %	Silt %	Clay %				6A1a OC %	6B1a N %	C/N ratio
Hi	0—12				71		6.8	51.7	3.1	17
He	12—24				64		5.9	54.9	3.1	18
He	24—46				57		5.8	50.4	2.8	18
Ha	46—52				23		5.6	35.8	2.4	15
2Cg1	52—55	35	25	40		cl	7.7	2.3	0.2	11
2Cg2	55+									

Horizon	Pyrophosphate sol.	Ash %	4A3a Bulk density	5A1b CEC me/100 g	Exchangeable cations 6B1b me/100 g				
					Ca	Mg	K	Na	H
Hi	0.11	11.4	0.12	108.8	72.9	26.8	0.5	0.6	9.7
He	0.12	9.2	0.13	123.9	76.2	27.5	0.4	0.6	12.8
He	0.18	17.6	0.12	131.8	88.9	25.7	0.4	0.8	10.9
Ha	0.92	38.3	0.12	143.3	82.3	37.6	0.4	0.8	11.7
2Cg1	—	98.2		28.0	16.9	15.6	1.0	0.6	3.9
2Cg2									

GELIC HISTOSOL
Canada

Horizon	Depth inches	Unrubbed fibre %	8C1c pH 1:1 KCl	Organic matter			Ash %	Pyro-phosphate sol.	5A1b CEC me/100 g	Exchangeable cations 5B1b me/100 g				
				6A1a OC %	6B1a N %	C/N				Ca	Mg	K	Na	H
Hi	0—37	72.9	4.7	56.1	1.11	50	7.8	0.09	107.9	60.8	20.6	0.7	0.5	41.5
He	37—170	56.9	5.3	50.0	1.65	30		0.08	60.1	73.3	18.8	0.3	0.6	27.8
Ha	170+													

GLEYIC PODZOL Pg

Classification (USDA)	Aeric Haplaquod, sandy, mixed, mesic, ortstein
Location	Ottawa County, Michigan
Altitude	200 m (approximately)
Physiography	Nearly level plain with slight depressions, 1 to 2 feet below the general level of the area
Drainage	Imperfectly to poorly drained
Parent material	Sand
Vegetation	Overstorey of oaks (<i>Quercus</i> spp.) and white pines (<i>Pinus strobus</i>); understorey of birch (<i>Betula</i> spp.), aspen (<i>Populus</i> spp.), sassafras (<i>Sassafras albidum</i>) and maple (<i>Acer</i> spp.); ground cover of green brier (<i>Smilax</i> spp.) and bracken fern (<i>Pteris aquilina</i>)
Climate	Average annual precipitation about 32 inches; average annual temperature about 46°F (8°C); mesic; aquatic

Profile description

O	2-0	inch	Mat of partially decomposed leaves and twigs, with a mat of roots.
Ah	0-4	inch	Black (7.5YR 2/0) light loamy sand; a sprinkling of light grey (7.5YR 7/0) sand contrasts sharply with the mass colour; very weak fine granular structure; very friable; a mat of fine roots composes about 40 percent of volume; very strongly acid; abrupt smooth boundary.
E	4-7	inch	Reddish grey (5YR 5/2) or brown (7.5YR 5/2) light loamy sand or sand; very weak medium subangular blocky structure; very friable; contains a mass of fine roots; very strongly acid; abrupt wavy boundary.
Bh1	7-8	inch	Black (5YR 2/1) or dark reddish brown (5YR 2/2) sand; very weak fine and medium subangular blocky structure; very friable; contains many fine roots, but less than in above horizons; very strongly acid; abrupt wavy boundary.
Bh2	8-9	inch	Very dusky red (2.5YR 2/2) sand; very weak very thin platy structure; very friable; contains many fine roots; very strongly acid; abrupt wavy boundary.
Bms1	9-11	inch	Dark reddish brown (2.5YR 2/4) sand; moderate to strong thin platy structure; weakly to strongly cemented ortstein; a few tongues, 2 to 4 inches thick, extend into horizon below; very strongly acid; abrupt wavy boundary.
Bms2	11-13	inch	Dark reddish brown (5YR 3/4-2.5YR 3/4) sand; moderate thin platy structure; strongly cemented ortstein; a mass of fine roots along horizontal planes, between plates; very strongly acid; abrupt wavy boundary.
Bms3	13-19	inch	Reddish yellow (7.5YR 6/6) sand, with streaks of dark reddish brown (5YR 3/4) occurring at irregular intervals; very few roots; massive; strongly cemented; very strongly acid; gradual irregular boundary.
BC	19-23	inch	Reddish yellow (7.5YR 7/6) or light yellowish brown (10YR 6/4) sand; contains numerous vertical stems or channels, from less than 1 mm to about 3 mm in diameter, and blotches of dark reddish brown (5YR 3/3) and dark brown (7.5YR 4/4); the channels or tubes are from about 1 inch to 3 inches long; the strongest or redder colour is in the centre of the channels, with a gradual fading of colour outward; very strongly acid; clear wavy boundary.
C1	23-30	inch	Very pale brown (10YR 7/4) sand; dark brown (7.5YR 4/4) channels or tubes, less than 1 mm to about 3 mm in diameter and from 0.5 to 5 inches in length, are plentiful in upper part, and decrease in number with depth; single grain; loose; strongly acid; gradual wavy boundary.
C2	30-42+	inch	Light brownish grey (10YR 6/2) or pale brown (10YR 6/3) sand; contains a few fine vertical channels or tubes of dark brown (7.5YR 4/4); single grain; loose; strongly acid.

GLEYIC PODZOL

United States

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
O	2-0											
Ah	0-4	1.2	3.5	24.5	46.1	3.2	17.1	4.4	19.6	12.8	—	1s
E	4-7	0.1	2.3	25.6	56.7	3.4	11.5	0.4	19.9	10.1	—	fs
Bh1	7-8	1.4	2.7	24.1	59.0	5.5	5.4	1.9	24.8	3.3	—	fs
Bh2	8-9	0.9	2.8	22.7	58.4	8.5	4.3	2.4	29.6	2.1	—	fs
Bms1	9-11	0.2	2.2	24.0	54.2	8.6	5.4	5.4	27.8	3.0	—	fs
Bms2	11-13	0.1	2.9	27.8	52.9	7.0	5.3	4.0	23.8	2.9	—	fs
Bms3	13-19	<0.1	2.4	29.4	58.1	4.0	3.8	2.3	19.8	2.2	—	fs
BC	19-23	<0.1	1.4	24.6	69.8	2.4	1.2	0.6	20.8	0.5	—	fs
C1	23-30	<0.1	1.8	30.6	63.2	3.4	0.7	0.3	25.7	0.7	—	fs
C2	30-42+	<0.1	1.7	32.1	60.8	5.0	0.4	<0.1	25.9	1.0	—	fs

Horizon	pH			Organic matter			6C1a Free iron Fe ₂ O ₃ %
	8C1a (1:1) H ₂ O	(1:5)	(1:10)	6A1a OC %	6B1a N %	C/N	
O	14.5			39.84	1.768	22.5	
Ah	3.7			10.12	0.501	20.2	0.1
E	3.8			1.56	0.087	17.9	<0.1
Bh1	3.9			6.59	0.295	22.3	<0.1
Bh2	4.1			10.94	0.484	22.6	<0.1
Bms1	4.4			7.26	0.295	24.6	0.1
Bms2	4.5			4.51	0.167	27.0	0.1
Bms3	4.6			2.04	0.081	25.2	<0.1
BC	4.7			0.63	0.018	35	<0.1
C1	4.8			0.33	0.012	28	<0.1
C2	4.9			0.14	0.005	28	<0.1

Horizon	5A1a CEC NH ₄ OAc	Extractable cations					5C1 BS % on NH ₄ OAc exch.	5C3 BS % on sum cations	5B1a Sum bases	5A3a Sum cations	8D3 Ca/Mg
		6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6O2a K					
		me/100 g							me/100 g		
O											
Ah	29.9	1.6	0.9	29.6	<0.1	0.3	9	9	2.8	32.4	1.8
E	5.1	0.1	0.1	8.3	<0.1	<0.1	4	2	0.2	8.5	1.0
Bh1	21.7	0.1	0.4	42.5	<0.1	0.1	3	1	0.6	43.1	0.2
Bh2	36.3	<0.1	0.4	63.0	<0.1	0.1	1	1	0.5	63.5	<0.1
Bms1	29.8	<0.1	0.1	66.2	<0.1	0.1	1	<1	0.2	66.4	<0.1
Bms2	20.3	<0.1	0.2	54.3	<0.1	<0.1	1	<1	0.3	54.6	<0.1
Bms3	9.9	<0.1	0.2	29.2	<0.1	<0.1	2	1	0.2	29.4	<0.1
BC	3.0	0.1	0.3	8.3	<0.1	<0.1	13	4	0.4	8.7	0.3
C1	1.6	<0.1	<0.1	4.3	<0.1	<0.1	<1	<1	<0.1	4.3	<0.1
C2	0.9	0.1	0.1	2.0	<0.1	<0.1	22	9	0.2	2.2	1.0

LEPTIC PODZOL PI

Classification (USDA)	Typic Fragiorthod, coarse-loamy, frigid
Location	Franklin County, Massachusetts
Altitude	150 m (approximately)
Physiography	Slope 2%
Drainage	Well drained
Parent material	Glacial till
Vegetation	Forest; beech (<i>Fagus</i> spp.), yellow and white birch (<i>Betula lutea</i> and <i>B. populi-folia</i>), black cherry (<i>Prunus serotina</i>), sugar maple (<i>Acer saccharum</i>), striped maple (<i>A. pennsylvanicum</i>), hemlock (<i>Tsuga</i> spp.)
Climate	Boreal; humid

Profile description

O1	2-1.5	inch	Loose recently fallen leaves.
O2	1.5-0	inch	Loose leaves from previous leaf falls, partly broken or eaten and tied together weakly by mycelium and rootlets.
Ah	0-3	inch	10YR 2/1-2/2, very friable silt loam, very high in organic matter; rootlets are numerous and bind the soil material together; weak moderate very fine granular structure.
E	3-4	inch	Discontinuous. 10YR 4/1-3/2, very friable loam with very weak thin platy structure; no pores in the plates; this horizon is discontinuous and may occur in not over 20 percent of the area.
Bs1	4-6	inch	5YR 3/4-4/4 very friable silt loam, with about 5 percent coarse skeleton; weak fine granular structure with very little tendency for weak subangular structure; roots are numerous.
Bs2	6-10	inch	10YR 4/3-3/3 very friable loam with about 5 percent coarse skeleton; when broken out, there is about an equal amount of weak fine granular structure and very weak, very coarse subangular structure; there are no pores and no clay coats; the material is nonsticky, nonplastic, and not distinctly micaceous; roots are numerous.
BC1	10-18	inch	10YR 3/3 (toward 2.5y) very friable loam with about 5 percent coarse skeleton; when broken out, about one half to three fourths weak coarse subangular blocky, and the remainder weak fine granular structure; nonporous and with no glazing; roots are numerous.
BC2	18-25	inch	2.5y 4/4-3/3 friable loam with about 5 percent coarse skeleton; when broken out there are about equal proportions of weak fine granular and weak coarse subangular blocky peds; nonporous, nonsticky, nonplastic and not distinctly micaceous.
Cl	25-34	inch	2.5y 3/2 firm loam till with about 10-20 percent coarse skeleton in the 1-3 inch diameter range; slightly more olive brown than the horizon below and with very faint fine 2.5y 4/4 mottles on a few peds; very weak coarse platy structure with no pores or glazes on or in peds; roots occur and tend to be partially rotted leaving dark brown stains on the surrounding soil material.
C2	34-40+	inch	2.5y 3/2 very firm gravelly loam till with 30-60 percent coarse skeleton dominantly in the 1-4 inch diameter range; essentially massive in place with perhaps a tendency for very weak coarse platy structure; a few brown coated fine pores are faintly visible; not distinctly micaceous, nonplastic, nonsticky.

LEPTIC PODZOL

United States

Horizon	Depth inches	1B1b Size class and particle diameter (mm) 3A1														
		Total			Sand					Silt		Int. II (0.2- 0.02)	(2-0.1)	Coarse fragments 3B1		
		Sand (2-0.05)	Silt (0.05- 0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5- 0.25)	Fine (0.25- 0.1)	Very fine (0.1- 0.05)	0.05- 0.02	Int. III (0.02- 0.002)			2A2 > 2	2-19	19-76
		% of < 2 mm													%	% of < $\frac{76}{16}$ mm
Ah	0-3	59.1	36.5	4.4	9.6	8.0	6.8	17.3	17.4	12.5	24.0	39.9	41.7	15		
E	3-4	56.1	39.8	4.1	5.8	29.9	3.4	9.5	7.5	13.7	26.1	25.0	48.6	10		
Bs1	4-6	51.8	42.2	6.0	8.2	7.4	5.3	13.4	17.5	16.4	25.8	41.7	34.3	17		
Bs2	6-10	52.5	44.7	2.8	8.5	6.9	5.4	13.5	18.2	17.5	27.2	44.2	34.3	15		
BC1	10-18	54.0	43.4	2.6	9.4	7.3	5.3	14.0	18.0	17.9	25.5	44.6	36.0	18		
BC2	18-25	54.9	41.9	3.2	8.7	8.0	5.6	14.2	18.4	17.4	24.5	44.2	36.5	17		
C1	25-34	54.7	41.5	3.8	7.8	7.6	5.7	15.6	18.0	16.2	25.3	44.0	36.7	28		
C2	34-40+	55.6	41.5	2.9	7.3	7.6	5.6	15.6	19.5	16.6	24.9	45.9	36.1	42		

Horizon	Organic matter			6E1e	6C1a	Bulk density			Water content		pH	
	6A1a	6B1a	C/N	Carbonate as CaCO ₃	Ext. iron as Fe	g/cm ³	4A1e	4A1h	4B1e	4B2	8C1c	8C1a
	OC %	N %					$\frac{1}{3}$ -bar g/cm ³	Oven dry g/cm ³	$\frac{1}{3}$ -bar %	15-bar %	(1:1) KCl	(1:1) H ₂ O
Ah	18.2	0.397	46		1.0							3.5
E	2.68	0.144	19		0.6							3.5
Bs1	3.88	0.230	17		3.4							3.8
Bs2	3.32	0.181	18		2.2							4.5
BC1	2.09	0.122	17		1.5							4.6
BC2	1.09	0.076	14		1.4							4.8
C1	0.49	0.038	13		1.2							4.7
C2	0.22	0.024			1.3							4.7

Horizon	Extractable bases 5B1a					6H1a	5A3a	Ratios to clay 8D1			8D3	BS	
	6N2d	6O2b	6P2a	6Q2a	Sum	Ext. acidity	Sum cations	CEC sum	Ext. iron	15-bar water	Ca/Mg	5C3	5C1
	Ca	Mg	Na	K								Sum cations	Sum cations
me/100 g													
Ah	1.9	0.5	0.2	0.9	3.5	48.2	51.7	11.75	0.23			7	
E	0.3	0.1	0.1	0.4	0.9	13.0	13.9	3.39	0.15			6	
Bs1	0.1	0.3	0.1	0.2	0.7	42.0	42.7	7.12	0.57			2	
Bs2	0.1	0.1	0.1	0.3	0.6	31.0	31.6	11.28	0.78			2	
BC1	0.1	0.1	0.1	0.3	0.6	19.2	19.8	7.62	0.58			3	
BC2	0.1	0.1	0.1	0.2	0.5	13.8	14.3	4.47	0.44			3	
C1	tr	0.1	0.1	0.3	0.5	6.6	7.1	1.87	0.32			7	
C2	0.1	0.2	0.1	0.2	0.6	4.2	4.8	1.66	0.45			12	

ORTHIC PODZOL Po

Classification (USDA)	Typic Haplorthod, sandy, mixed, frigid
Location	Osceola County, Michigan
Altitude	400 m (approximately)
Physiography	Moraine; slope 3 to 4% east
Drainage	Well drained
Parent material	Sand
Vegetation	Red maple (<i>Acer rubrum</i>), aspen (<i>Populus</i> spp.), bracken fern (<i>Pteris aquilina</i>)
Climate	Boreal; humid

Profile description

Ah1	3-1	inch	Very dark grey (10YR 3/1) when crushed, sand; appears as a mixture of black (N 2/) and light grey (10YR 6/2) imparting a salt and pepper effect; single grain; loose; very strongly acid; abrupt smooth boundary.
Ah2	1-0	inch	Black (N 2/) well-decomposed leaf litter; moderate medium granular structure; very friable; many fibrous roots; very strongly acid; clear smooth boundary.
E1	0-4	inch	Greyish brown (10YR 5/2) sand; very weak medium granular structure; very friable; few fibrous roots; medium acid; abrupt irregular boundary.
E2	4-13	inch	Light grey to grey (10YR 6/1) when moist, and light grey (10YR 7/1) when dry, sand; very weak coarse to medium granular structure; very friable; medium acid; abrupt irregular boundary.
Bh	13-15	inch	Dark reddish brown (5YR 2/2-3/2) sand; weak coarse to medium subangular blocky structure to massive in spots; very friable; weakly cemented in spots; many fibrous roots; no roots in cemented chunks; very strongly acid; abrupt irregular boundary.
Bhs1	15-19	inch	Dark reddish brown (5YR 3/3-3/4) sand with patches of reddish brown (5YR 4/4) weak coarse subangular blocky structure to massive in spots; very friable to strongly cemented in spots; few roots; very strongly acid; clear irregular boundary.
Bhs2	19-27	inch	Dark yellowish brown (10YR 4/4) to brown or dark brown (7.5YR 4/4) representing 90 percent of the colour, dark brown (10YR 3/3) representing the other 10 percent, sand; weak coarse subangular blocky structure to massive in spots; very friable to strongly cemented chunks; strongly acid; clear irregular boundary.
BC	27-37	inch	Yellowish brown (10YR 5/4) sand with few dark yellowish brown (10YR 4/4) concretions; weak coarse granular structure; very friable; medium acid; clear wavy boundary.
C1	37-63	inch	Light yellowish brown (10YR 6/4) to very pale brown (10YR 7/4) sand; single grain; loose; slightly acid; gradual wavy boundary.
C2	63-86	inch	Light yellowish brown (10YR 6/4) sand with a few 0.25-inch yellowish brown (10YR 5/6) colour bands of light loamy sand in the lower 10 inches of the horizon; single grain; loose; bands are coherent and very friable; medium acid; gradual wavy boundary.
C3	86-119	inch	Light yellowish brown (10YR 6/4) sand; single grain; loose; medium acid.

NOTES: Ortstein occurs in lower part of Bh and in the Bhs1 and Bhs2 horizons in the form of chunks. The ortstein represents approximately 10 percent of the surface area of the pit occupied by these horizons. The colour of the cemented chunks includes those of the Bh, Bhs1 and Bhs2 horizons in about equal proportions. The chunks are strongly cemented. Colours refer to moist conditions, unless otherwise stated. Ah1 and Ah2 sampled together.

ORTHIC PODZOL

United States

Horizon	Depth inches	1B1b Size class and particle diameter (mm) 3A1													Coarse fragments 3B1		
		Total			Sand					Silt		Int. II (0.2-0.02)	(2-0.1)	2A2 > 2 < 76	2-19	19-76	
		Sand (2-0.05)	Silt (0.05-0.002)	Clay (< 0.02)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	0.05-0.02	Int. III (0.02-0.002)						
		% of < 2 mm													%	% of mm	
Ah	3-0													3	3	0	
E1	0-4	93.4	5.7	0.9	0.2	9.3	40.5	41.7	1.7	1.9	3.8	14.5	91.7	tr	tr	0	
E2	4-13	95.7	3.7	0.6	0.2	10.0	44.6	39.8	1.1	1.4	2.3	12.0	94.6	tr	tr	0	
Bh	13-15	93.5	2.6	3.9	0.2	6.1	37.5	48.6	1.1	0.7	1.9	15.3	92.4	tr	tr	0	
Bhs1	15-19	97.5	1.2	1.3	0.6	5.0	36.0	54.8	1.1	0.8	0.4	16.3	96.4	tr	tr	0	
Bhs2	19-27	98.6	0.4	1.0	0.3	5.2	35.8	55.0	1.5	0.0	1.2	17.2	97.1	1	1	0	
BC	27-37	99.0	0.5	0.5	0.2	6.9	33.9	56.6	1.2	0.0	0.7	17.7	97.8	1	1	0	
C1	37-63	99.2	0.2	0.6	0.2	2.7	34.5	60.4	1.4	0.2	0.0	18.8	97.8	tr	tr	0	
C2	63-86	98.6	0.9	0.5	0.2	4.6	27.4	63.3	3.0	0.0	1.0	26.4	95.6	2	1	1	
C3	86-119	99.1	0.7	0.2	0.8	8.6	43.8	44.2	1.3	0.0	1.1	13.7	97.8	2	2	0	
Ortstein		98.2	0.9	0.9	0.5	3.5	34.3	58.4	1.1	0.0	1.3	16.0	97.1	1	1	0	

Horizon	Organic matter			6E1e	6C2a	Bulk density			Water content			pH	
	6A1a OC	6B2a N	C/N	Carbonate as CaCO ₃	Ext. iron as Fe	4A3a Field moist	4A1e 1/3-bar	4A1h Oven dry	4B1c 1/20-bar	4B1c 1/10-bar	4B2 15-bar	8C1c (1:1) KCl	8C1a (1:1) H ₂ O
	%	%		%	%	g/cm ³	g/cm ³	g/cm ³	%	%	%		
Ah	3.20	0.18	18		0.1						9.5	3.9	4.8
E1	0.28				0.1	1.35			8.9	6.0	2.2	3.8	4.3
E2	0.04				0.1	1.41			5.8	3.7	1.3	3.8	4.3
Bh	0.77	0.04	19		0.3	1.27			9.0	6.7	2.6	3.6	4.5
Bhs1	0.72	0.03	24		0.3	1.10			6.4	6.0	2.4	3.6	4.7
Bhs2	0.47	0.02	24		0.2	1.27			6.2	3.8	1.7	4.0	5.0
BC	0.16				0.1	1.34			4.2	2.5	0.6	4.1	5.1
C1	0.08				0.1	1.46			4.2	1.9	0.4	4.1	5.4
C2					0.1						0.4	4.2	5.5
C3					0.1						0.3	4.2	5.5
Ortstein	0.69	0.02	34		0.2						2.4	4.0	5.5

Horizon	Extractable bases 5B1c					6H2a	5A3a	6G1d	Ratios to clay 8D1			8D3	BS	
	6N2e Ca	6O2d Mg	6P2b Na	6Q2b K	Sum	Ext. acidity	Sum cations	Ext. Al	CEC sum	Ext. iron	15-bar water	Ca/Mg	5C3 Sum cations	5C1 NH ₄ OAc
	me/100 g												%	%
Ah	1.6	0.4	tr	0.2	2.2	9.3	11.5	0.6					19	
E1	0.1	tr	—	tr	0.1	1.7	1.8	0.4	2.00	0.11	2.44		6	
E2	—	tr	0.1	tr	0.1	0.6	0.7	0.3	1.17	0.17	2.17		14	
Bh	0.2	tr	tr	tr	0.2	10.6	10.8	4.0	2.77	0.08	0.67		2	
Bhs1	—	tr	tr	tr	tr	10.2	10.2	2.3	7.85	0.23	0.18		tr	
Bhs2	—	—	tr	tr	tr	7.2	7.2	1.3	7.20	0.20	0.17		tr	
BC	—	—	—	—	—	2.4	2.4	0.5	4.80	0.20	1.20		—	
C1	—	—	—	—	—	1.3	1.3	0.2	2.17	0.17	0.67		—	
C2	—	—	—	—	—	1.4		0.3		0.20	0.80			
C3	—	—	—	—	—	0.7		0.1		0.50	1.50			
Ortstein	0.1	tr	—	—	0.1	12.8	12.9	2.1	14.33	0.22	2.67		1	

(continued on page 183)

ORTHIC PODZOL Po

Classification (Canada)	Orthic Humo-Ferric Podzol, Holmesville Series, New Brunswick
Location	Gillespie settlement, 4 miles south of Grand Falls, New Brunswick, 47°N-67°40'W
Physiography	Undulating ground moraine
Drainage	Well drained
Parent material	Gravelly moderately coarse (SL) till
Vegetation	Mixed wood, balsam (<i>Abies balsamea</i>), maple (<i>Acer</i> spp.), birch (<i>Betula</i> spp.), shrubs
Climate	Boreal cool; perhumid

Profile description

O	4-0 cm	Moderately and well decomposed litter of needles and twigs.
E	0-5 cm	Pinkish grey (5YR 6.5/1.5 moist, 8/1 dry) silt loam; very weak, medium platy; very friable; plentiful roots; abrupt irregular boundary; extremely acid.
Bhs	5-15 cm	Yellowish red to strong brown (5YR to 7.5YR 5/6 moist, 8.5YR 6/5 dry) silt loam; moderate medium granular; very friable; plentiful to few roots; abrupt wavy boundary; very strongly acid.
Bs	15-33 cm	Light olive brown (2.5Y 5/5 moist, 10YR 7/4 dry) sandy loam; weak, fine granular; very friable; plentiful to few roots; abrupt smooth boundary; medium acid.
BC	33-71 cm	Light olive brown (2.5Y 5/3 moist, 6/2 dry) sandy loam; very weak, fine granular to amorphous; friable; few roots; some pebbles; clear smooth boundary.
C	71-81 cm	Dark greyish brown (2.5Y 4.5/2 moist, 6.5/2 dry) gravelly sandy loam; pseudo-platy; slightly firm and compact; medium acid.

ORTHIC PODZOL
United States (concluded)

Horizon	Pyrophosphate-dithionite extractable			Ratio of C + Fe + Al to clay	Petrographic analysis % (0.25–0.05 mm)												
	Carbon %	Iron %	Aluminum %		Resistant minerals					Weatherable minerals							
					Qtz.	Aggr.	Mag.	Spi.	Total	Fld.	Ens.	Aug.	Horn.	Sph.	Epi.	Total	
Ah																	
E1																	
E2																	
Bh	0.95	0.58	0.28	0.46													
Bhs1	0.88	0.26	0.65	1.38	58.0	16.0	2.3	0.8	77.1	19.1	0.5	0.8	1.8	0.8	tr	23.0	
Bhs2																	
BC																	
C1																	
C2																	
C3																	
Ortstein	1.10	0.22	0.83	2.39													

Aggr. = aggregates, Aug. = augite, Ens. = enstatite, Epi. = epidote, Fld. = feldspars, Horn. = hornblende, Mag. = magnetite, Qtz. = quartz, Sph. = sphene, Spi. = spinel.

ORTHIC PODZOL
Canada

Horizon	Depth cm	Particle size distribution 3A1b			8C1e pH CaCl ₂	6A1a OC %	Fe + Al				5A6 CEC me/100 g	Exchangeable cations		BS %	Acetate exch. cap.	Acetate BS
		Total sand %	Total clay %	Fine clay < 1 μ			Dithionite 6C3a		Oxalate 6C6			Ca + Mg me/100 g	Al me/100 g			
							Fe %	Al %	Fe %	Al %						
O	4–0															
E	0–5	24.7	8.5	6.5	3.3	1.88	0.18	0.16	0.05	0.15	7.4	1.7	5.7	23	14.7	12
Bhs	5–15	31.4	16.8	12.7	4.3	7.26	3.26	1.40	2.60	1.38	5.6	1.5	4.1	27	28.0	5
Bs	15–33	55.4	7.8	5.6	4.9	2.13	1.22	0.79	0.56	1.01	1.5	0.6	0.9	40	9.8	6
BC	33–71	—	—													
C	71–81	59.0	9.9	3.5	5.1	0.22	0.56	0.38	0.18	0.18	0.6	0.5	0.1	83	4.6	11

CALCARIC REGOSOL **Re**

Classification (USDA)	Typic Udorthent, fine-silty, mixed (calcareous), mesic
Location	Fremont County, Iowa
Altitude	335 m (approximately)
Physiography	Slope 15%, facing south
Drainage	Well drained
Parent material	Calcareous loess of Wisconsin age
Vegetation	Cultivated, alfalfa hay
Climate	Mesic; humid

Profile description

ACp	0-7 inch	Dark brown (10YR 4/3) and dark greyish brown (10YR 4/2) heavy silt loam; weak fine platy breaking to very fine granular; very friable moist or dry; common fine roots; platiness seems to be due to compaction; many fine pores; many worm casts; calcareous; boundary gradual and wavy.
C1	7-13 inch	Yellowish brown (10YR 5/4) medium silt loam; weak very fine granular; very friable wet or dry; few very fine roots; numerous very fine pores; many dark brown (10YR 4/3) and few dark brown (10YR 3/3) worm casts; calcareous; boundary diffuse.
C2	13-22 inch	Yellowish brown (10YR 5/4) silt loam and few fine light brownish grey (2.5Y 6/2) mottles; weak medium prismatic breaking to very fine granular; very friable moist or dry; few very fine roots; many fine and very fine pores; few 0.25- to 0.5-inch hard lime concretions; numerous worm casts; calcareous; boundary diffuse.
C3	22-32 inch	Yellowish brown (10YR 5/4) coarse silt loam with few fine light brownish grey (2.5Y 6/2) mottles; weak medium prismatic breaking to very fine granular; very friable; abundant very fine and fine pores; very few fine roots; lime concretions as in above horizon; few distinct dark soft oxides; few worm casts; calcareous; boundary diffuse.
C4	32-48 inch	Yellowish brown (10YR 5/6) coarse silt loam; few fine light brownish grey (2.5Y 6/2) mottles; weak fine granular to massive; very friable; abundant very fine and fine pores; very few fine roots; lime concretions as in above horizon; few distinct dark soft oxides; worm casts appear to be absent; calcareous.

NOTES: All colours are moist. Pit description, profile very wet; about 75 feet downslope from Monona ridgetop.

CALCARIC REGOSOL

United States

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
ACp	0-7	10.1	10.1	20.1	20.2	26.3	70.8	22.4	55.4	21.8	—	sil
C1	7-13	10.2	10.1	10.1	10.4	24.7	73.3	21.2	54.3	23.9	—	sil
C2	13-22	10.3	10.2	10.2	10.4	24.9	73.9	20.1	53.1	25.9	—	sil
C3	22-32	<0.1	10.3	10.2	10.4	24.3	75.6	19.2	54.1	26.0	tr	sil
C4	32-48	10.2	10.4	10.2	10.4	25.5	75.8	17.5	56.6	24.9	tr	sil

Horizon	pH			Organic matter			6E1c	5A1a	Extractable cations					BS	8D1 CEC/ 100 g clay	
	8C1a			6A1a	CB1a		CaCO ₃ equiv.	CEC NH ₄ OAc	Ca	Mg	H	Na	K			
	(1:1) H ₂ O	(1:5)	(1:10)	OC %	N %	C/N	%		me/100 g							%
ACp	7.6			0.84			4	18.9								84
C1	7.8			0.67			7	18.1								85
C2	7.7			0.49			8	17.5								87
C3	7.8			0.25			8	17.0								88
C4	7.8			0.13			8	16.2								92

¹ Many carbonate concretions. CaCO₃? - ² Few carbonate concretions. CaCO₃?

DYSTRIC REGOSOL Rd

Classification (USDA)	Aquic Quartzipsamment, siliceous, thermic
Location	Sarasota County, Florida
Altitude	10 m (approximately)
Physiography	Nearly level
Drainage	Somewhat poorly drained
Parent material	Thick beds of unconsolidated sands
Vegetation	Live oaks (<i>Quercus virginiana</i>), pine (<i>Pinus</i> spp.), saw palmetto (<i>Serenoa repens</i>), wiregrass (<i>Cynodon racemiflora</i>), runner oak (<i>Q. pumila</i>)
Climate	Thermic; humid

Profile description

A1	0-5 inch	Very dark grey (10YR 3/1) loose fine sand with small percent of light grey fine sand; acid; many small fine roots; abrupt wavy boundary.
C1	5-14 inch	Light yellowish brown to brown (10YR 6/4-5/3) loose fine sand containing small lumps of slightly coherent material; some medium and small roots; acid; gradual irregular boundary.
C2	14-20 inch	Pale brown (10YR 6/3) loose fine sand; a few small roots; acid; clear irregular boundary.
Cg1	20-30 inch	Light grey (10YR 7/2) loose fine sand with a few small faint yellow mottles; acid; few roots; clear irregular boundary.
Cg2	30-48 inch	White (10YR 8/2) loose fine sand; acid.

EUTRIC REGOSOL Re

Classification (Canada)	Orthic Regosol. Whitehorse Series, Yukon Territory
Location	60°50'N-135°10'W. Near confluence of Takhini and Yukon rivers north of Whitehorse, Yukon Territory
Elevation	735 m
Physiography	Undulating to rolling dunes; wind-modified glaciofluvial plain
Drainage	Well to excessively drained
Parent material	Sandy aeolian-glacial fluvial deposit
Vegetation	Sparse productive to nonproductive lodgepole pine (<i>Pinus contorta</i>) with bearberry (<i>Arctostaphylos uva-ursi</i>), grass (<i>Poaceae</i> spp.), patches of bare soil
Climate	Subarctic, very cold; humid to subhumid

Profile description

Ah	0-2 inch	Dark greyish brown (10YR 4.5/2 dry) soft structureless loamy sand; pH 6.8.
C1	2-6 inch	Light grey to white (10YR 7/2 and 8/2 dry) soft structureless sandy loam containing a wavy layer of grey volcanic ash.
C2	6-15 inch	Pale olive (5Y 6/3 dry) loamy sand; soft; single grained; coherent in situ; weakly calcareous; pH 8.2.
C3	15-25 inch	Light yellowish brown (2.5Y 6/4 dry) loamy sand; weakly calcareous; pH 8.6.
C4	25-36 inch	Light brownish grey (2.5Y 6/2 dry, 6/4 moist) loamy sand; slightly calcareous; pH 8.7.
C5	36+ inch	Grey slightly calcareous sand; pH 8.7.

DYSTRIC REGOSOL

United States

Horizon	Depth inches	1B1b Size class and particle diameter (mm) 3A1													
		Total			Sand					Silt			Coarse fragments 3B1		
		Sand (2-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	0.05-0.02	Int. III (0.02-0.002)	Int. II (0.2-0.02)		(2-0.1)	
													2A2 > 2		2-19
% of < 2 mm												%	% of mm		
A1	0-5	1.4	2.7	0.2	8.6	30.7	48.1	8.3			1.5	32.5	0		
C1	5-14	1.8	3.2	0.4	7.8	30.5	47.8	8.5			1.5	33.5	0		
C2	14-20	1.6	3.0	0.3	7.4	27.7	50.0	10.0			1.0	38.7	0		
Cg1	20-30	0.9	3.6	0.4	7.5	26.4	51.8	9.4			0.7	38.1	0		
Cg2	30-48	1.1	3.5	0.2	7.6	25.4	52.1	10.1			0.7	39.8	0		

Horizon	6A1a	8C1a	Extractable bases 5B1a				6H1a	5A3a	5C3
	OC	pH (1:1)	6N2d Ca	6O2b Mg	6P2a Na	6Q2a K	Ext. acidity	Sum cations	BS Sum cations
	%	H ₂ O	me/100 g						
									%
A1	1.10	5.1	0.5	—	tr	tr	5.8	6.3	8
C1	0.42	5.4	0.2	—	tr	tr	4.6	4.8	4
C2	0.15	5.4	—	—	tr	tr	2.2	2.2	—
Cg1	0.14	5.1	0.3	—	tr	tr	1.3	1.6	20
Cg2	0.12	4.9	0.3	0.1	tr	tr	1.2	1.6	25

EUTRIC REGOSOL

Canada

Horizon	Depth inches	Textural class	8C1a	Organic matter			6S1a	6I
			pH 1:1	6A1a OM %	6B1a N %	C/N	Total P %	CaCO ₃ %
			H ₂ O					
Ah	0-2	ls	6.8	1.6	0.05	19	0.04	
C1	2-6					—		
C2	6-15	ls	8.2	0.6	0.03	12	0.03	0.3
C3	15-25	ls	8.6	0.3	0.01	17	0.03	0.2
C4	25-36	ls	8.7	0.1	0.01	6	0.03	0.4
C5	36+	s	8.7	0.1	0.02	3	0.03	0.2

GELIC REGOSOL Rx

Classification (Canada)	Cryic Regosol, Yukon Territory
Location	68°42'N-134°07'W, 2 miles east of Reindeer Depot, Yukon Territory
Altitude	185 m
Physiography	On crest and eastern flank of Caribou hills, gently to moderately undulating till plain with rough microtopography
Drainage	Well drained
Parent material	Noncalcareous clay to clay loam till containing a few pebbles and cobbles
Vegetation	Tundra; <i>Betula glandulosa</i> , <i>Eriophorum vaginatum</i> , <i>Ledum palustris</i> , <i>Vaccinium vitis-idaea</i> , <i>Vaccinium uliginosum</i> , <i>Empetrum nigrum</i>
Climate	Arctic, extremely cold; humid with significant aquatic inclusions

Profile description

O1	3-2.5 inch	Litter of twigs and leaves.
O2	2.5-0 inch	Reddish black (10R 2/1) muck.
C1	0-1 inch	Very dark brown (10YR 3/2) silty clay; very weak, very fine granular; pH 5.5.
C2	1-7 inch	Very dark greyish brown (10YR 3/2) friable clay loam; weak, fine granular; a few pebbles; boundary diffuse; pH 5.3.
C3	7-14 inch	Very dark greyish brown (10YR 3/2) friable silty clay; moderate, fine granular; noncalcareous; a few pebbles; pH 6.0.
C4 (frozen)	14-21 inch	Very dark greyish brown (10YR 3/2) noncalcareous clay containing a few small pebbles and stones; weak, fine granular; frozen, segregated ice lenses 0.1 to 0.2 inch thick; pH 5.8.
C5 (frozen)	21-25 inch	Colour and structure as above; pH 6.0.

MOLLIC SOLONETZ Sm

Classification (Canada)	Black Solonetz, Duagh Series, Alberta
Location	Edmonton Map Sheet 83H, Alberta
Physiography	Lacustrine plain, topography level to gently sloping
Drainage	Moderately well to imperfectly drained
Parent material	Stone-free silty clay to clay, slightly to moderately calcareous lacustrine deposit
Vegetation	Open parkland, fescue prairies (<i>Festuca scabrella</i>)
Climate	Moderately cold cryoboreal; humid to subhumid

Profile description

Ah	0-5 inch	Black to very dark grey (10YR 2/1-3/1) silty clay; loose granular; pH 5.3.
Btn1	5-11 inch	Very dark greyish brown (10YR 3/2) clay; very hard columnar to coarse blocky; stained columns may have tapered tops; pH 5.8.
Btn2	11-19 inch	Brown to dark greyish brown (10YR 5/3-4/2) clay; blocky; less staining and definition of structure than in Btn1; pH 7.7.
C1z	at 20 inch	Dark greyish brown (2.5Y 4/2) clay; massive to small blocky; pH 8.0.
C2z	at 48 inch	Dark greyish brown (2.5Y 4/2) silty clay to clay; massive; pH 7.7.

GELIC REGOSOL

Canada

Horizon	Depth inches	Textural class	8C1a pH 1:1 H ₂ O	Organic matter			6C2a Free Fe %	5A4 CEC me/100 g	Exchangeable cations 5B1b				BS %
				6A1a OM %	6B1a N %	C/N			Ca	Mg	K	Na	
O1	3—2.5												
O2	2.5—0		4.8	—	1.56								
C1	0—1	silcl	5.5	16.5	0.53	18	2.8	46.2	22.2	7.4	0.4	0.1	65
C2	1—7	cl-l	5.3	5.0	0.14	21	2.8	25.0	12.8	5.7	0.2	0.1	75
C3	7—14	silcl	6.0	5.2	0.17	19	3.0	26.1	16.9	6.9	0.2	0.1	92
C4	14—21	cl	5.8	10.6	0.31	20	2.4	34.9	19.0	5.9	0.4	0.1	73
C5	21—25	cl	6.0	8.1	0.22	21	3.3	30.7	20.0	7.3	0.2	0.1	90

Mineralogical characteristics of permafrost soils: *Silts*. Largely quartz, some feldspar and smaller amounts of kaolinite and illite. — *Coarse clay*. Largely mixed-layer montmorillonite; illite, quartz, and kaolinite plus small amounts of feldspar. — *Fine clay*. Largely mixed-layer montmorillonite; illite, with some kaolinite.

MOLLIC SOLONETZ

Canada

Horizon	Depth inches	Particle size distribution 3A1b			Textural class	8C1b pH Sat. paste	Organic matter		6E1d CaCO ₃ equiv. %	Hydraulic cond. in/hr	5A1b CEC me/100 g	Exchangeable cations 5B1b				
		Sand	Silt	Clay			6B1a N %	C/N				Ca	Mg	K	Na	H
Ah	0—5	10	52	38	silcl	5.3	1.00	12		5.00	42	36	25	3	10	26
Btn1	5—11	5	19	76	cl	5.8	0.25	10		0.01	44	18	53	3	18	8
Btn2	11—19	4	18	77	cl	7.7	0.07			0.01	38	22	44	3	31	—
C1z	at 20	3	43	54	cl	8.0			5.0	0.20						
C2z	at 48	4	18	78	silcl	7.7				0.05						

ORTHIC SOLONETZ So

Classification (USDA)	Ustollic Natrargid, fine, montmorillonitic, mesic
Location	Natrona County, Wyoming
Altitude	1 600 m (approximately)
Physiography	Sloping faces of old terrace levels; simple convex slope of approximately 5% facing west
Drainage	Well drained
Parent material	Alluvium from alkaline sedimentary rocks
Vegetation	Pasture; medium cover of western wheatgrass (<i>Andropogon</i> spp.), blue grama grass (<i>Bouteloua gracilis</i>), threadleaf sage (<i>Salvia</i> spp.), big sage (<i>Salvia</i> spp.), cactus, some mosses and lichens
Climate	Mesic; arid

Profile description

E	0-3	inch	White (10YR 8/1 dry) to greyish brown (10YR 5/2.5 moist) fine sandy loam; soft when dry, very friable when moist; weak coarse platy breaking to moderate fine granular; noncalcareous; lower boundary clear and smooth.
Btn	3-9	inch	Greyish brown (10YR 5/2.5 dry) to dark greyish brown (10YR 4/2.5 moist) light silty clay; very hard when dry, very firm when moist; moderate medium columnar breaking to strong medium angular blocky; noncalcareous; structural aggregates have well-rounded caps; clear moderately thick clayskins; lower boundary abrupt and smooth.
BCz	9-15	inch	Light yellowish brown (2.5Y 6/3 dry) to light olive brown (2.5Y 5/3 moist) heavy silty clay loam; very hard when dry, firm when moist; moderate coarse prismatic breaking to moderate coarse angular blocky; calcareous; the horizon contains a few small calcium carbonate concretions; lower boundary gradual and irregular.
C1z	15-23	inch	Light brownish grey (2.5Y 6/2 dry) to light olive brown (2.5Y 5/3 moist) light clay loam; very hard when dry, firm when moist; weak coarse angular blocky structure; calcareous; the horizon contains much calcium carbonate and other salts, calcium carbonate chiefly as lime flour but with a few concretions; lower boundary gradational and smooth.
C2z	23-30	inch	Light olive grey (5Y 6/2.5 dry) to olive grey (5Y 5/2.5 moist) light sandy clay loam; very hard when dry, firm when moist; massive to very weak coarse subangular blocky structure; calcareous; horizon contains much accumulated calcium carbonate and other salts, calcium carbonate chiefly as lime flour; there are a few concretions believed to be calcium sulphate in the lower part; lower boundary gradual and smooth.
C3z	30-41+	inch	Pale olive (5Y 6/3 dry and moist) light sandy clay loam; very hard when dry, firm when moist; massive; calcareous; horizon contains some visible calcium carbonate and other salts but much less than the horizons above; this horizon consists principally of reworked clayey alluvium washed down the sides of old terrace levels.

ORTHIC SOLONETZ

United States

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
E	0-3	0.7	3.7	5.1	14.6	34.4	33.1	8.4	61.8	15.2	—	vfs1
Btn	3-9	0.2	1.2	1.8	6.6	23.1	25.8	41.3	42.6	10.8	—	c
BCz	9-15	0.1	0.3	0.8	5.8	32.0	35.3	25.7	59.8	11.9	—	1
C1z	15-23	0.1	0.3	0.8	6.6	37.0	32.3	22.9	61.2	13.1	—	1
C2z	23-30	0.7	1.8	2.1	10.1	35.1	27.0	23.2	57.3	12.1	—	sc1
C3z	30-41	0.2	2.0	2.3	9.5	37.2	24.2	24.6	56.4	11.8	—	sc1

Horizon	pH			Organic matter			8A2	8A1a	6E1a	6F1a	Moisture tensions		
	8C1b Saturated paste	8C1a (1:5)	8C1a (1:10)	6A1a OC %	6B1a N %	C/N	Est % salt (Bureau Cup)	EC mmhos/cm	CaCO ₃ equiv. %	Gypsum me/100 g soil	1/10 atm. %	1/3 atm. %	4B2 15 atm. %
E	7.0	7.3	7.2	0.62	0.058	10.7	—	0.5	1	—	—	—	3.3
Btn	8.0	9.2	9.4	0.73	0.081	9.0	—	1.1	1	—	—	—	16.2
BCz	8.1	8.9	9.1	0.45	0.049	9.2	0.29	6.0	10	—	—	—	9.7
C1z	8.1	8.7	8.9	0.28	—	—	0.43	8.6	10	2	—	—	8.3
C2z	8.3	9.2	9.3	0.18	—	—	0.33	7.3	8	—	—	—	8.3
C3z	8.4	9.5	9.6	0.15	—	—	0.29	5.8	6	—	—	—	9.0

Horizon	5A1a	Extractable cations 5B1a					5D2	8A1 saturation ext. soluble					8A
	CEC NH ₄ OAc	6N2b Ca	6O2b Mg	H	6P2a Na	6Q2a K	exch. Na %	6P1a Na	6Q1a K	6J1a HCO ₃	6K1a Cl	6L1a SO ₄	Moisture at saturation %
		me/100 g						me/litre					
E	6.5	3.9	1.9		0.2	0.6	3	1.7	0.4				26.9
Btn	29.4		14.5		4.7	0.4	14	10.4	0.1				60.7
BCz	15.2				4.9	0.3	16	47.0	0.2	5.1	23.5	51.8	51.6
C1z	13.2				5.3	0.3	17	65.0	0.3	5.6	23.0	106.6	46.9
C2z	12.8				5.4	0.4	20	59.0	0.3	5.1	19.0	76.6	47.1
C3z	14.0				6.1	0.5	25	51.0	0.3	4.6	16.8	52.3	51.7

CHROMIC VERTISOL Vc

Classification (USDA)	Udic Chromustert, fine, montmorillonitic, thermic
Location	Bluebonnet Experiment Station on west edge of McGregor, Texas
Altitude	215 m (approximately)
Physiography	Nearly level landscape with slight gradual increase in elevation and broad slightly depressed areas; slope gradient is less than 1.5%
Drainage	Moderately well to somewhat poorly drained
Parent material	Presumed to be clays developing from interstratified marly clays between the limestone strata
Vegetation	Cultivated, sorghum
Climate	Thermic; subhumid

Profile description

Ap	0-5 inch	Dark brown (7.5YR 3/2) clay, slightly darker moist; weak to moderate very fine granular structure forming a loose mulch in plough layer; very hard; very firm; crumbly; few pink quartz pebbles, and occasional rounded iron concretions; few limestone fragments scattered on the surface; pH 7.0; noncalcareous; abrupt lower boundary.
Ah1	5-12 inch	Brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate very fine irregular blocky structure; common wedge-shaped peds in lower part, and few small slickensides; ped surfaces shiny; extremely hard; extremely firm; few quartz and fine limestone pebbles; pH 6.5; noncalcareous; diffuse lower boundary.
Ah2	12-21 inch	Dark brown (7.5YR 3/2) clay, slightly darker moist; moderate fine and medium blocky structure when dry, breaking to very fine irregular blocky structure when moist; common slickensides and wedge-shaped peds; few scattered pebbles of quartz and limestone; extremely hard; extremely firm; pH 6.5; noncalcareous; diffuse lower boundary.
Ah3	21-28 inch	Dark reddish brown (6YR 3/2) clay, same colour moist; moderate to strong medium blocky structure when dry, breaking to strong very fine irregular blocky structure when moist; common wedge-shaped peds and strong coarse slickensides; few fine quartz pebbles; pH 8.0; noncalcareous except in lower inch; abrupt irregular lower boundary.
AC	28-38 inch	Strata of fractured limestone bedrock having rounded corners and filled with dark reddish brown (5YR 3/3) clay, reddish brown (5YR 3.5/4) moist; estimated 17 percent fine soil, 83 percent rock; moderate very fine irregular blocky structure; mildly alkaline, weakly calcareous; pH 8.2; abrupt irregular lower boundary.
Cck	38-49 inch	Mostly soft mixture of coarse masses of CaCO ₃ , limy yellowish brown mineral fines and red (2.5YR 3/5 moist) clay in irregular pockets leading from above horizon; CaCO ₃ portion: (1) composite mass sampled, (2) sampled separately from red clay.
R	49-50 inch	Moderately hard shale or chalky marl.

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1									2A2 (> 2)
		Very coarse sand (2-1)	Coarse Sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	
Ap	0-5	10.4	10.6	0.8	3.5	5.2	47.8	41.7	32.8	22.3	tr
Ah1	5-12	10.4	10.4	0.7	2.6	4.6	43.8	47.5	28.8	21.1	tr
Ah2	12-21	10.5	10.3	0.7	2.7	4.2	42.5	49.1	27.3	21.0	tr
Ah3	21-28	10.2	10.3	0.6	2.2	3.9	42.5	50.3	26.4	21.3	tr
AC	28-38	12.7	11.1	0.6	1.4	2.5	32.5	59.2	17.1	18.7	22
Cck	38-49	11.3	12.2	1.9	4.5	6.4	58.7	25.0	20.2	47.5	29
Cck (1)	38-49	10.9	11.1	0.9	2.2	3.0	24.8	67.1	11.5	17.5	3
Cck (2)	38-49	10.9	11.6	1.5	3.8	5.9	70.8	15.5	20.3	58.7	19

Horizon	Organic matter			6C1a Ext. iron as Fe %	Bulk density			Water content			4C1 1/3-minus 15-bar H ₂ O in/horizon	Movement
	6A1a % OC	6B1a % N	C/N		4A1a Field state g/cm ³	4A1d 1/3-bar g/cm ³	4A1b Air dry g/cm ³	4B4 Field state %	4B1 1/3-bar %	4B2 15-bar %		
Ap	1.06	0.077	14	1.7						15.3		
Ah1	1.03	0.061	17	1.9	1.50	1.39	1.89	23.6	27.0	17.6	0.9	0.67
Ah2	0.94	0.058	16	1.9	1.58	1.37	1.86	17.9	28.0	18.5	1.2	0.86
Ah3	0.92	0.059	16	1.8	1.62	1.34	1.88	17.5	29.8	20.0	0.9	0.76
AC	1.09	0.063	17	2.4						24.1		
Cck	0.19			0.7						9.2		
Cck (1)	0.56			2.6						27.6		
Cck (2)	0.08			0.4						4.5		

Horizon	6H1a Ext. acidity	Al KCl-ext.	Extractable bases					CEC			BS		
			6N2b Ca	6O2b Mg	6P2a Na	6O2a K	Sum ext. bases	5A1a NH ₄ OAc	NaOAc	5A3a Sum cations	5C1 on NH ₄ OAc CEC %	on NaOAc CEC %	5C3 on sum cations %
Ap	5.3		26.5	3.8	0.1	0.8	31.2	29.3		36.5	106		85
Ah1	6.0		30.4	3.7	0.1	0.6	34.8	33.1		40.8	105		85
Ah2	5.6		32.6	3.3	0.1	0.6	36.6	34.9		42.2	105		87
Ah3	4.4		34.7	3.3	0.1	0.6	38.7	35.5		43.1	109		90
AC					0.1	0.8		40.0					
Cck					0.1	0.3		14.5					
Cck (1)					0.2	0.9		42.6					
Cck (2)					tr	0.1		7.2					

Horizon	6E1a Carbonate as CaCO ₃ %	Carbonate clay %	Noncarbonate clay %	Total clay %	Ratios to clay				Clay * in non-Co ₃ fract. %	Gypsum %
					* NH ₄ OAc CEC	NH ₄ OAc CEC	Ext. iron	Water at 15-bar		
Ap						0.70	0.041	0.37		
Ah1						0.70	0.040	0.37		
Ah2						0.71	0.039	0.38		
Ah3						0.70	0.036	0.40		
AC	6	—	59	59		0.68	0.040	0.41	63	
Cck	72	3	22	25	0.66	0.58	0.028	0.37	78	
Cck (1)	18	tr	67	67		0.63	0.039	0.41	82	
Cck (2)	85	2	14	16	0.51	0.46	0.026	0.29	93	

(continued on page 195)

PELLIC VERTISOL Vp

Classification (USDA)	Udic Pellustert, fine, montmorillonitic, thermic
Location	Collin County, Texas
Altitude	200 m (approximately)
Physiography	Broad level (less than 1% slope) and undissected old alluvial plain
Drainage	Poorly drained
Parent material	Alluvial clays of Pleistocene age
Vegetation	Cultivated, cotton
Climate	Thermic; subhumid

Profile description

Ap	0-6 inch	Dark grey (10YR 4/1) light clay, very dark grey (10YR 3/1) moist; having a crust of light grey (10YR 6/1) light silty clay loam, grey (10YR 5/1) moist, approximately 0.12-0.25 inch thick with about 0.5 inch porous material appended to the platy crust; weak blocky structure, mostly cloddy; very hard; very firm; abrupt smooth lower boundary.
Ah1	6-22 inch	Grey (10YR 5/1) clay, nearly black (10YR 2.5/1) moist; weak fine and very fine irregular blocky structure moist; peds are shiny; extremely hard; extremely firm; common to few fine pores; medium acid, pH 6.0; diffuse lower boundary.
Ah2	22-33 inch	Grey (10YR 5/1) clay, nearly black (10YR 2.5/1) moist; moderate fine and medium irregular blocky structure with strong slickensides; peds are shiny; extremely hard; extremely firm; neutral, pH 7.0; diffuse lower boundary.

(continued on page 196)

CHROMIC VERTISOL
United States (concluded)

Horizon	Water ext. from saturated paste			Water at sat. %	Water soluble bases		Ext. Ca/Mg	pH		
	Na	K	EC mmhos/cm		Na	K		Paste	(1 : 1)	(1 : 10)
	me/litre		me/100 g							
Ap	0.2	0.1	0.34	49.9	tr	tr	7.0	6.0	6.0	6.4
Ah1	0.3	0.1	0.57	56.2	tr	tr	8.2	5.8	5.8	6.2
Ah2	0.3	0.1	0.49	57.8	tr	tr	9.9	6.2	6.2	6.4
Ah3	0.3	tr	0.36	57.9	tr	tr	10.5	6.5	6.6	6.6
AC	0.3	0.1	0.48	70.0	tr	tr		7.5	7.6	7.9
Cck	0.3	tr	0.48	39.6	tr	tr		8.0	8.1	8.5

¹ > 50% Fe-Mn nodules. - ² > 50% carbonate nodules. - ³ 5-25% carbonate nodules. - ⁴ 13 kg/m² to 38 inches. - ⁵ Calculated for non-carbonate clay. - ⁶ Calculated.

PELLIC VERTISOL
United States

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1									
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)
Ap	0-6	¹ tr	¹ 0.1	² 0.2	7.9	14.9	40.7	36.2	43.5	19.4	—
Ah1	6-22	¹ tr	¹ tr	² 0.2	5.9	10.8	39.0	44.1	33.5	21.7	—
Ah2	22-33	¹ tr	¹ tr	² 0.2	5.7	10.2	39.3	44.6	31.9	22.8	—
Ahc1	33-49	¹ tr	¹ tr	² 0.2	5.4	10.0	38.7	45.7	31.3	22.4	—
ACck1	49-64	¹ tr	¹ 0.1	¹ 0.1	³ 5.0	³ 8.9	37.7	48.3	31.5	19.7	tr
ACck2	64-78	⁴ 0.3	⁴ 0.3	⁴ 0.2	⁴ 4.8	⁴ 9.2	35.5	49.7	29.0	20.1	2
Cck1	78-96	⁴ 0.3	⁴ 0.5	⁴ 0.3	⁵ 5.7	⁵ 10.0	33.5	49.4	34.0	14.6	7

Horizon	Organic matter			6C1a Ext. iron as Fe %	Bulk density			Water content			4C1 ¹ / ₃ -minus 15-bar H ₂ O in/horizon ²	Movement
	6A1a	6B1a	C/N		4A1a	4A1d	4A1b	4B4	4B1	4B2		
	OC ¹ %	N %			Field state g/cm ³	¹ / ₃ -bar g/cm ³	Air dry g/cm ³	Field state %	¹ / ₃ -bar %	15-bar %		
Ap	1.05	0.079	13	0.5	1.56	1.46	1.79	16.6	23.3	14.0	0.8	0.38
Ah1	0.87	0.059	15	0.4	1.56	1.43	1.91	20.8	26.9	17.8	2.1	1.47
Ah2	0.83	0.053	16	0.4						18.4		
Ahc1	0.61	0.036	17	0.4	1.71	1.42	1.92	15.8	28.7	18.9	2.2	1.54
ACck1	0.34	0.020	17	0.5						19.6		
ACck2	0.18	0.014	13	0.6						19.8		
Cck1	0.10			1.0	1.63	1.42	1.92	19.6	29.5	19.6	2.4	1.66

(continued on page 197)

PELLIC VERTISOL, United States (concluded)

Ahc1	33-49 inch	Grey (10YR 5/1) clay, dark grey (10YR 4/1) moist; common faint fine yellowish brown mottles; weak to moderate medium and fine irregular blocky structure; strong slickensides of large size; ped surfaces not shiny; extremely hard; extremely firm; about 4-8 percent hard greyish CaCO ₃ concretions, 0.5 to 2 inches in diameter; few filled worm holes; moderately alkaline, noncalcareous; pH 8.0; diffuse lower boundary.
ACck1	49-64 inch	Greyish brown (2.5Y 5/2) clay, dark greyish brown (2.5Y 4/2) moist; with common fine faint olive brown mottles; moderate fine and medium irregular blocky structure; moderate slickensides; extremely hard; extremely firm; common fine and medium CaCO ₃ concretions and many very fine calcareous grains less than 1 mm; moderately alkaline, noncalcareous; pH 8.0; diffuse lower boundary.
ACck2	64-78 inch	Light olive brown (2.5Y 5/4 moist and dry) clay; common faint fine mottling of dark greyish brown and brighter light olive brown; moderate medium blocky structure; many ped faces are very shiny; many moderate to strong slickensides; few grey worm casts and filled cracks of grey (10YR 5/1); extremely hard; extremely firm; common fine CaCO ₃ concretions; moderately alkaline, mass mostly noncalcareous; diffuse lower boundary.
Cck1	78-96 inch	Much mottled dark greyish brown (2.5Y 4/2), yellowish brown (10YR 6/6) clay, with other greys, browns and yellow; strong medium and fine blocky structure; very shiny ped surfaces; occasional slickensides; extremely hard; extremely firm; grey worm casts and filled worm holes and cracks are distinct and few to common; common CaCO ₃ concretions and soft masses with many calcareous very fine sand-sized particles; moderately alkaline, mass noncalcareous but spots effervesce freely; diffuse boundary.
Cck2	96-120 inch	Much mottled sandy clay or light clay, yellowish browns, yellows, and greys; common grey and white masses of CaCO ₃ ; augered (not sampled).

PELLIC VERTISOL
United States (concluded)

Horizon	6H1a Ext. acidity	Al KCl-ext.	Extractable bases				Sum ext. bases	CEC			BS		
			6N2b	602b	6P2a	602a		5A1a	5A2	5A3a	5C1	5C2	5C3
			Ca	Mg	Na	K		NH ₄ OAc	NaOAc	Sum cations	on NH ₄ OAc CEC	on NaOAc CEC	on sum cations
me/100 g											%	%	%
Ap	4.5		23.0	4.3	0.3	0.8	28.4	27.4	28.6	32.9	104	99	86
Ah1	4.7		27.0	4.6	1.4	0.6	33.6	31.7	34.8	38.3	106	96	88
Ah2	3.6		28.4	4.7	2.6	0.6	36.3	32.6	35.3	39.9	111	103	91
Ahcl	1.4		29.5	4.6	3.7	0.7	38.5	32.4	35.3	39.9	119	109	96
ACck1					4.2	0.8		32.5	35.4				
ACck2					4.5	0.8		31.3	34.6				
Cck1					4.5	0.7		28.2	31.2				

Horizon	6E1a Carbonate as CaCO ₃	Carbonate clay	Noncarbonate clay	Total clay	Ratios to clay				Clay ^a in non-CO ₂ fract.	Gypsum
					NAOAc CEC	NH ₄ OAc CEC	Ext. iron	Water at 15-bar		
					%	%	%	%		
Ap						0.76	0.014	0.39		
Ah1						0.72	0.009	0.40		
Ah2	—					0.73	0.009	0.41		
Ahcl	—					0.71	0.009	0.41		
ACck1	1	—	48	48		0.67	0.010	0.40	48	
ACck2	1	—	50	50		0.63	0.012	0.40	50	
Cck1	4	—	49	49		0.57	0.020	0.40	51	tr

Horizon	Water ext. from saturated paste											Water at sat.		
	Ca	Mg	Na	K	CO ₂	HCO ₃	Cl	SO ₄	NO ₃	Sum cations	Sum anions		EC	
	me/litre												mmhos/cm	%
Ap	1.6	0.3	1.0	0.1	—	1.5	0.2	0.3			3.0	2.0	0.34	47.6
Ah1	1.1	0.1	2.9	tr	—	2.8	—	0.3			4.1	3.1	0.44	54.6
Ah2	1.2	0.1	4.5	tr	—	2.5	0.7	1.6			5.8	4.8	0.65	57.0
Ahcl	3.9	0.5	10.6	0.1	—	3.0	1.5	9.8			15.1	14.3	1.59	62.6
ACck1	5.0	0.6	13.7	0.1	—	2.8	2.5	14.9			19.4	20.2	2.00	67.5
ACck2	6.1	0.6	15.8	0.1	—	3.0	3.2	18.0			22.6	24.2	2.23	67.6
Cck1	6.4	0.7	16.4	0.1	—	2.0	3.7	18.8			23.6	24.5	2.34	64.3

Horizon	Water soluble bases				Exchangeable bases				Ext. Ca/Mg	ESP on NaOAc CEC	pH		
	Ca	Mg	Na	K	Ca	Mg	Na	K			Paste	(1 : 1)	(1 : 10)
	me/100 g										%		
Ap	0.1	tr	tr	tr	22.9	4.3	0.3	0.8	5.3	1	6.0	6.4	6.4
Ah1	0.1	tr	0.2	tr	26.9	4.6	1.2	0.6	5.9	3	5.8	6.3	6.7
Ah2	0.1	tr	0.3	tr	28.3	4.7	2.3	0.6	6.0	6	6.6	6.6	7.4
Ahcl	0.2	tr	0.7	tr	29.3	4.6	3.0	0.7	6.4	8	7.5	7.7	7.8
ACck1	0.3	tr	0.9	tr			3.3	0.8		9	7.5	7.6	8.3
ACck2	0.4	tr	1.1	tr			3.4	0.8		10	7.6	7.7	8.4
Cck1	0.4	tr	1.0	tr			3.5	0.7		11	7.7	7.8	8.5

¹ Many Fe-Mn nodules. — ² Few Fe-Mn nodules. — ³ Trace carbonate nodules. — ⁴ Many carbonate nodules. — ⁵ Few carbonate nodules. — ⁶ 16 kg/m² to 60 inches. — ⁷ Calculated to include > 2-mm material — ⁸ Calculated.

CALCIC XEROSOL Xk

Classification (USDA)	Ustic Torriorthent, coarse-silty, mixed (calcareous), mesic
Location	Goshen County, Wyoming
Altitude	1 300 m (approximately)
Physiography	About 2% slope in ridge top
Drainage	Well drained
Parent material	Loess
Vegetation	Cultivated; recently in irrigated beans
Climate	Mesic; subarid

Profile description

Ap	0-8 inch	Greyish brown (10YR 5/2 dry) to dark greyish brown (10YR 4/2 moist) weak fine granular loam; friable when moist, hard when dry; moderately calcareous; clear boundary.
Bw	8-16 inch	Light yellowish brown (10YR 6/4 dry) to dark brown (10YR 4/3 moist) friable silt loam; weak medium prismatic-subangular blocky structure which crushes to very weak fine granules; some roots and organic staining; moderately calcareous; clear boundary.
Ck	16-27 inch	Very pale brown (10YR 7/3 dry) to pale brown (10YR 6/3 moist) friable weak fine granular silt loam; strongly calcareous; gradual boundary.
C1	27-35 inch	Very pale brown (10YR 7/3 dry) to brown (10YR 5/3 moist) friable massive silt loam; strongly calcareous.
C2	35-54 inch	Very pale brown (10YR 7/3 dry) to brown (10YR 5/3 moist) friable massive silt loam; strongly calcareous.
C3	54-62 inch	Very pale brown (10YR 7/3 dry) to brown (10YR 5/3 moist) friable massive silt loam; strongly calcareous.

Horizon	Depth inches	1B1a Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
Ap	0-8	0.1	0.3	1.2	5.4	41.9	32.1	19.0	69.0	9.1	—	1
Bw	8-16	—	0.2	0.7	3.2	31.9	42.2	21.8	61.3	15.3	—	1
Ck	16-27	—	—	0.1	0.9	19.4	59.3	20.3	53.6	25.8	—	sil
C1	27-35	—	—	0.1	0.9	23.2	60.4	15.4	61.2	23.2	—	sil
C2	35-54	—	—	0.2	1.7	31.9	51.5	14.7	67.7	17.1	—	sil
C3	54-62	—	0.1	0.3	1.9	37.7	47.0	13.0	70.9	15.4	—	1

Horizon	pH			Organic matter			8A1a	6E1a	6F1a	Moisture tensions		
	8C1b Saturated paste	8C1a (1:5)	8C1a (1:10)	6A1a OC %	N %	C/N	EC mmhos/cm	CaCO ₃ equiv. %	Gypsum me/100 g soil	1/10 atm. %	1/3 atm. %	4B2 15 atm. %
Ap	7.5	8.6	8.8	0.87			0.9	—	—			10.3
Bw	7.5	8.8	8.9	0.67			1.0	2	—			12.8
Ck	7.6	9.2	9.3	0.45			0.8	17	—			14.3
C1	7.7	9.2	9.4	0.22			0.7	10	—			11.2
C2	7.8	9.3	9.4	0.13			1.1	7	—			9.6
C3	8.2	9.7	9.9	0.13			1.0	6	—			9.0

Horizon	5A1a	Exchangeable cations 5B1b					5D2	Saturation extract soluble 8A1					8A
	CEC NH ₄ OAc	Ca	Mg	H	6P2a Na	6Q2a K	Ech. Na	6P1a Na	6Q1a K				Moisture at saturation
		me/100 g					%	me/litre					%
Ap	20.7				0.3	1.6	1	3.0	0.6				39.6
Bw	24.6				0.3	1.8	1	2.2	0.6				47.0
Ck	24.4				0.3	2.6	1	1.5	1.0				48.4
C1	22.2				0.3	3.5	1	1.5	1.3				42.6
C2	20.7				1.1	3.5	5	5.6	1.4				38.6
C3	20.8				3.0	3.1	14	9.1	0.6				39.6

LUVIC XEROSOL XI

Classification (USDA)	Ustollic Haplargid, coarse-silty, mixed, mesic
Location	Platte County, Wyoming
Altitude	1 400 m (approximately)
Physiography	High terrace: nearly level to gently undulating; 0 to 1% slopes
Drainage	Well drained
Parent material	Alluvium
Vegetation	Cultivated, dry cropland
Climate	Mesic; arid

Profile description

Ap	0-3.5 inch	Light grey or light greyish brown (10YR 6/1.5 dry) to dark grey or dark greyish brown (10YR 4/1.5 moist) very fine sandy loam; soft when dry, very friable when moist; weak medium subangular blocky structure breaking to moderate very fine granules; noncalcareous; lower boundary clear and smooth.
Bt1	3.5-8 inch	Greyish brown or light brownish grey (10YR 5.5/2 dry) to dark greyish brown (10YR 4/2 moist) very fine sandy clay loam; very hard when dry, friable when moist; moderate medium subangular blocks; noncalcareous; there are thin nearly continuous clayskins on the surfaces of the soil aggregates; lower boundary clear and smooth.
Bt2	8-12 inch	Pale brown or light yellowish brown (1.25Y 6/3 dry) to brown or light olive brown (1.25Y 5/3 moist) light clay loam; hard when dry, very friable when moist; weak medium prismatic structure breaking to moderate fine subangular blocks; strongly calcareous; there are thin patchy clayskins on both the horizontal and vertical faces of the soil aggregates; lower boundary gradual and smooth.
Btk	12-16 inch	Light yellowish brown (2.5Y 6/3 dry) to light olive brown (2.5Y 5/3 moist) light clay loam; hard when dry, very friable when moist; moderate medium fine subangular blocks; violently calcareous; this is a very weak horizon of lime accumulation with visible lime occurring mainly as an occasional concretion; insect casts approximately 0.5 inch in diameter are common in this horizon; there are very few thin patchy clayskins on the soil aggregates; lower boundary gradual and smooth.
BCck	16-21 inch	Light yellowish brown (2.5Y 6/3 dry) to light olive brown (2.5Y 5/3 moist) light clay loam or sandy clay loam; hard when dry, very friable when moist; weak medium subangular blocky structure; violently calcareous; this is a weak to moderate lime accumulation with many calcium carbonate concretions; lower boundary gradual and smooth.
Cck1	21-29 inch	White (2.5Y 8/2 dry) to pale yellow (2.5Y 7/3 moist) sandy clay loam; hard when dry, very friable when moist; massive; violently calcareous; this is a strong horizon of lime occurring in divided forms; lower boundary gradual and wavy.
Cck2	29-38 inch	Pale brown (10YR 6/3 dry) to brown (10YR 5/3 moist) sandy clay loam; hard when dry, very friable when moist; massive; violently calcareous; this is a moderate to strong lime horizon with visible lime occurring in finely divided forms and as concretions.

Horizon	Depth inches	Particle size distribution (mm) % 3A1										Textural class
		1B1a										
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 (> 2)	
Ap	0-3.5	1.4	3.3	3.7	15.9	47.9	14.2	13.6	71.4	3.7	8	vfs1
Bt1	3.5-8	1.4	1.9	2.2	10.4	39.0	19.9	25.2	62.3	5.3	3	sci
Bt2	8-12	0.8	1.0	1.1	8.3	35.5	30.1	23.2	61.9	10.6	tr	1
Btk	12-16	0.6	1.3	1.6	9.6	34.8	29.0	23.1	60.7	10.9	tr	1
BCck	16-21	1.8	2.3	2.6	11.1	29.3	26.4	26.6	52.8	11.2	4	sci
Cck1	21-29	3.2	3.7	3.5	8.6	14.7	20.6	45.7	28.8	12.0	6	c
Cck2	29-38	2.8	4.4	4.5	11.1	18.2	23.5	35.5	36.5	12.1	7	cl

Horizon	pH 8C1a			Organic matter			8A2	8A1a	6E1a	Gypsum me/100 g soil	Moisture tensions		
	(1:1)	(1:5)	(1:10)	6A1a OC %	6B1a N %	C/N	Est. % salt (Bureau Cup)	EC mmhos/cm	CaCO ₃ equiv. %		1/10 atm. %	1/3 atm. %	4B2 15 atm. %
Ap	7.5	7.8	7.8	0.83	0.080	10	<0.20	0.5	<1				6.0
Bt1	7.3	7.7	7.9	0.75	0.091	8	<0.20	0.5	<1				11.2
Bt2	8.0	8.6	8.8	0.56	0.070	8	<0.20	0.5	8				11.0
Btk	8.1	8.7	8.9	0.42	0.056	8	<0.20	0.5	9				10.4
BCck	8.1	8.8	9.0	0.38	0.046	8	<0.20	0.5	15				10.2
Cck1	8.4	9.0	9.2	0.27	0.031	9	<0.20	0.6	43				12.5
Cck2	8.7	9.2	9.4	0.17			<0.20	0.8	29				11.1

Horizon	5A1a	Extractable cations 5B1a					5D2	Saturation extract sol. 8A1		8A
	CEC NH ₄ OAc	6N2b Ca	6O2b Mg	6H1a H	6P2a Na	6Q2a K	Exch. Na %	6P1a Na me/litre	6Q1a K me/litre	Moisture at saturation %
Ap	12.7	9.9	2.3	0.4	<0.1	1.4	<1	0.2	1.0	39.0
Bt1	22.2	18.0	4.9	<0.1	<0.1	1.3	<1	0.2	0.4	51.3
Bt2	17.7		5.4	<0.1	<0.1	0.7	<1	0.3	0.3	51.1
Btk	16.9		6.6	<0.1	0.1	0.5	<1	0.3	0.3	49.2
BCck	15.2		7.3	<0.1	0.1	0.8	1	0.5	0.4	46.5
Cck1	9.5		7.2	<0.1	0.4	0.5	3	2.0	0.4	50.8
Cck2	11.2		8.7	<0.1	0.9	0.7	6	3.4	0.3	48.7

¹ Trace CaCO₃ concretions. - ² Few CaCO₃ concretions.

CALCIC YERMOSOL Yk

Classification (USDA)	Typic Calciorthid; coarse-loamy, mixed, thermic
Location	Clark County, Nevada
Altitude	760 m (approximately)
Physiography	Rolling or hummocky low dunes superimposed on old terraces
Drainage	Excessively drained; very slow runoff; very rapid internal drainage and permeability
Parent material	Aeolian sands, derived from mixed sedimentary rocks including sandstones, limestone and sandy miocene lake sediments
Vegetation	Bush vegetation with annual weeds; plant density is approximately 5%
Climate	Thermic; arid; hot dry summers and mild winters; average rainfall 5 inches; mean annual temperature 68°F (20°C) with very wide range; frost-free period approximately 237 days

Profile description

A	0-3	inch	Reddish yellow (5YR 6/6) fine sand, yellowish red (5YR 5/6) when moist; single grained; loose, nonsticky, nonplastic; few very fine fibrous roots; few very fine tubular and many very fine interstitial pores; strongly calcareous; pH 8.2; clear smooth boundary.
C	3-17	inch	Yellowish red (5YR 5/6 moist) fine sand; very weak medium and fine granular structure breaking to single grained; loose to soft, nonsticky, nonplastic; few very fine and fine fibrous roots; many very fine interstitial and few very fine tubular pores; contains approximately 3 percent fine gravels; strongly calcareous; pH 8.8; clear smooth boundary.
2C	17-24	inch	Brown (7.5YR 5/4 moist) light fine sandy loam; weak medium and fine granular structure; slightly hard, very friable, nonsticky, nonplastic; few very fine fibrous roots; few very fine tubular pores; contains approximately 5 percent fine gravel; strongly calcareous; pH 8.6; clear wavy boundary.
2Ck	24-27	inch	Brown (7.5YR 5/4 moist) gravelly fine sandy loam with common medium distinct pink (7.5YR 7/4) lime mottles, lime coated pebbles and soft lime nodules; weak fine and medium granular structure; slightly hard, very friable, nonsticky, nonplastic; few very fine fibrous roots; few very fine tubular pores; strongly calcareous; pH 8.6; abrupt wavy boundary. Discarded from the sample were 10 percent 1-inch gravel, 10 percent cobbles and 3 percent stones.
3Ck	27-40	inch	Pink (7.5YR 8/4 moist) gravelly loam; massive, hard to slightly hard, firm to friable, slightly sticky, slightly plastic; very few very fine fibrous roots; very few very fine tubular pores; strongly calcareous; pH 8.8; clear wavy boundary. Discarded from the sample were 35 percent 1-inch-plus gravels and 15 percent cobbles.
4Ck	40-46+	inch	Light brown (7.5YR 6/4 moist) very gravelly loamy sand; massive; slightly hard, very friable, nonsticky, nonplastic; very few very fine fibrous roots; many very fine interstitial pores; horizon contains approximately 80 percent gravels and 5 percent cobbles, of which 30 percent 1-inch-plus gravels and all cobbles were discarded; strongly calcareous; pH 8.6.

Horizon	Depth inches	1B1b Particle size distribution (mm) % 3A1										Textural class
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)	2A2 ¹ (> 2)	
A	0-3	1.7	8.4	23.7	53.6	8.9	1.6	2.1	37.1	0.0	2	fs
C	3-17	1.4	6.1	20.5	51.2	12.0	4.4	4.4	43.1	0.8	3	fs
2C	17-24	3.2	9.1	13.5	35.3	17.0	10.8	11.1	45.7	3.5	12	fs1
2Ck	24-27	3.4	9.5	11.2	29.6	15.6	17.0	13.7	40.3	10.3	20	fs1
3Ck	27-40	2.6	5.8	8.8	22.7	13.3	29.7	17.1	35.5	21.7	16	fs1
4Ck	40-46+	11.5	11.4	10.9	22.5	11.9	18.6	13.2	32.9	10.8	68	s1

Horizon	8C1b pH Saturated paste (1:1)	6I1a *CO ₂ me/litre	8C1b pH (1:10)	Organic matter			6J1a *HCO ₃ me/litre	8A1a EC mmhos/cm	6E1b CaCO ₃ equiv. %	4A3a Bulk density g/cm	Moisture tensions		
				6A1a OC %	6B1a N %	C/N					1/10 atm. %	1/3 atm. %	4B2 15 atm. %
				A	8.4	—					8.7	0.03	0.005
C	8.3	—	8.7	0.05	0.005		1.8	0.2	3	1.63			2.2
2C	8.3	—	8.8	0.14			2.1	0.3	7				5.9
2Ck	8.2	—	8.6	0.15			1.7	0.3	15				7.0
3Ck	8.2	—	8.7	0.18			1.9	0.3	33				7.8
4Ck	8.0	—	8.9	0.10			2.0	2.1	18				7.4

Horizon	5A2a CEC (Na)	Extractable cations 5B1a					5D1 Exch. Na %	Saturation extract soluble 8A1					8A Moisture at saturation %
		Ca	Mg	H	6P2a	6Q2a		6P1a Na	6Q1a K	6N1a Ca	6O1a Mg	6K1a Cl	
					Na	K							
A	2.9				0.1	0.2	3	0.2	0.3	1.6	0.1	0.5	23.0
C	3.9				0.1	0.4	3	0.3	0.5	1.6	0.1	0.3	22.0
2C	6.4				<0.1	0.6	<2	0.6	0.3	1.0	tr	0.2	32.1
2Ck	5.7				<0.1	0.5	<2	0.4	0.2	1.9	0.3	0.3	39.2
3Ck	5.1				<0.1	0.3	<2	1.0	0.1	1.8	0.4	0.7	39.8
4Ck	6.4				0.9	0.6	14	15.4	0.4	4.0	1.0	9.8	36.3

¹ Percent of < 1 inch fraction; see profile description for gravel > 1 inch. - * Saturation extract soluble - milliequivalents per litre.

LUVIC YERMOSOL YI

Classification (USDA)	Abruptic Haplic Durargid, fine-loamy, mixed, mesic
Location	Lincoln County, Nevada
Altitude	1 500 m
Physiography	Moderately old alluvial fan dissected by V-shaped channels
Drainage	Well drained; medium runoff; moderate to moderately slow permeability
Parent material	Alluvium from olivine basalt, welded tuffs and andesite
Vegetation	About 8% density, consisting of galleta (<i>Hilaria</i> spp.) 47%, shadscale (<i>Atriplex</i> spp.) 25%, budsage (<i>Artemisia spinescens</i>) 25%, annuals 3%
Climate	Annual rainfall about 8 inches; average temperatures: annual 52°F (11°C), January 35°F (2°C), July 71°F (21°C); frost-free period 130 to 150 days; mesic; arid

Profile description

A	0-3 inch	Light brownish grey (10YR 6/2) gravelly sandy loam, dark brown (10YR 4/3) when moist; weak coarse platy structure; soft, friable, nonsticky, nonplastic; plentiful fine, very fine and few medium roots; many very fine, fine and few medium vesicles; noncalcareous with a few spots that are slightly calcareous; pH 8.4; clear smooth boundary.
BA	3-5 inch	Light brownish grey (7.5YR 6/2) gravelly sandy clay loam, brown (7.5YR 5/4) when moist; weak fine platy structure breaking readily to moderate fine sub-angular blocky fragments and with further pressure to moderate fine granules; soft, friable, sticky, plastic; plentiful fine, very fine and few medium roots; many fine and very fine vesicles; many fine and very fine interstitial pores; thin patchy clay films on peds and bridges between sand grains; few horizontal filaments of A; noncalcareous; pH 8.4; clear wavy boundary.
Bt	5-9 inch	Brown (7.5YR 5/4) gravelly sandy clay (30 percent gravel), dark brown (7.5YR 4/4) when moist; moderate medium and moderate fine subangular blocky structure; slightly hard, friable, very sticky, very plastic; plentiful fine, very fine and few medium roots; many fine and very fine tubular pores; many fine and very fine cracks between peds; thick patchy clay films on ped faces and moderately thick clay films on sand grains; noncalcareous, but slightly calcareous in a few spots; pH 8.4; clear wavy boundary.
2Bt	9-17 inch	Brown (10YR 5/4) very gravelly coarse sandy loam (55 percent gravel, 1 percent cobble), dark brown (10YR 4/3) when moist; weak medium and fine sub-angular blocky structure; slightly hard, friable, sticky, plastic; plentiful fine and very fine roots; common fine and very fine tubular pores; thin patchy clay films on ped faces and on sand grains; slightly calcareous but strongly calcareous where few lime veins occur and where lime occurs on the lower side of pebbles; pH 8.6; clear wavy boundary.
2Cmk	17-25 inch	Brown (10YR 5/3) very gravelly coarse sandy loam (55 percent gravel, 2 percent cobble), dark brown (10YR 4/3) when moist; massive; slightly hard with few lenses and irregular masses of lime-cemented material in places; friable, slightly sticky, slightly plastic; few fine and very fine roots; common fine and very fine tubular pores; thin patchy clay films on sand grains; slightly calcareous but very strongly calcareous where lime veins occur and where lime occurs on pebbles and cobbles; pH 8.8; clear wavy boundary.
3Cmk	25-32 inch	Pale brown (10YR 6/3) very gravelly coarse sandy loam (55 percent gravel, 1 percent cobble), dark brown (10YR 4/3) when moist; massive; hard with lime lenses and cemented masses as in the horizon above; friable, nonsticky, nonplastic; few fine and very fine roots; common to many very fine, fine and medium interstitial pores; slightly calcareous but very strongly calcareous where lime veins and lime-cementing material occur; pH 8.8; clear wavy boundary.
3Ck	32-45 inch	Similar in colour, structure, texture and content of gravel and cobble to the horizon above; massive; hard, very friable, nonsticky, nonplastic; devoid of plant roots; common fine and very fine tubular pores; slightly calcareous but strongly calcareous where many medium and coarse faint white (10YR 8/2) lime

(continued on page 206)

Horizon	Depth inches	1B1b Particle size distribution (mm) % 3A1									Textural class	
		Very coarse sand (2-1)	Coarse sand (1-0.5)	Medium sand (0.5-0.25)	Fine sand (0.25-0.10)	Very fine sand (0.10-0.05)	Silt (0.05-0.002)	Clay (< 0.002)	(0.2-0.02)	(0.02-0.002)		2A2 (> 2 ¹)
A	0-3	9.7	22.1	10.6	19.7	11.1	21.6	5.2	33.6	10.5	22	cos1
BA	3-5	5.0	22.0	11.8	16.1	6.5	16.7	21.9	21.0	10.9	19	sc1
Bt	5-9	3.9	12.1	9.8	16.7	7.1	14.6	35.8	22.3	8.8	36	sc-sc1
2Bt	9-17	16.7	29.8	16.0	17.0	3.1	2.6	14.8	12.2	1.1	56	cos1
2Cmk	17-25	14.1	24.7	16.0	17.2	4.3	9.4	14.3	16.9	4.8	60	cos1
3Cmk	25-32	11.1	16.8	10.1	20.0	10.4	14.4	17.2	29.1	7.4	56	cos1
3Ck	32-45	12.6	19.4	10.5	19.2	10.8	12.4	15.1	28.2	6.3	55	cos1
4Ck	45-60	11.3	19.3	16.4	27.3	9.4	6.1	10.2	28.2	2.3	38	lcos
4Cmk	60-66	10.1	20.5	14.3	22.1	8.1	7.9	17.0	24.1	3.7	44	cos1

Horizon	pH		Organic matter			6E1b CaCO ₃ equiv. %	8A1a EC mmhos/cm	Saturation ext. soluble				6C1b Free Fe ₂ O ₃ %	4B2 Soil water 15 atm. %
	8C1b Saturated paste (1:1)	8C1a H ₂ O (1:10)	6A1a OC %	6B1a N %	C/N			CO ₂	6J1a HCO ₃	6L1a SO ₄	6M1a NO ₃		
										me/litre			
A	7.9	9.0	0.15	0.021	7.1	tr	0.8	—	5.5	2.3	1.16	0.9	4.4
BA	7.5	8.5	0.10	0.021	4.8	tr	0.4	—	3.3	1.4	0.37	0.9	8.0
Bt	7.5	8.6	0.28	0.044	6.4	tr	0.6	—	4.3	0.3	0.28	0.9	13.2
2Bt	8.0	9.1	0.15	0.022		2	0.5	—	4.5	0.1	0.19	0.8	8.1
2Cmk	8.2	9.4	0.06			1	0.6	—	5.9		0.22	0.8	7.4
3Cmk	8.3	9.3	0.04			1	0.6	—	4.0	0.6	0.18	0.8	9.2
3Ck	8.2	9.4	0.05			3	0.6	—	4.6	0.5	0.17	0.7	8.5
4Ck	8.1	9.4	0.01			1	1.8	—	3.0	4.5	0.18	0.8	6.5
4Cmk	7.9	9.2	0.05			3	3.6	—	2.5	N.D.	0.17	0.6	8.8

Horizon	5A2a CEC (Na)	Extractable cations 5B1a					5D1 Exch. Na %	Saturation extract soluble 8A1					8A Moisture at saturation %
		6N2b Ca	6O2c Mg	H	6Q2a K	6P2a Na		6P1a Na	6Q1a K	6N1a Ca	6O1a Mg	6K1a Cl	
	me/100 g					me/litre							
A	11.7	12.6	2.9		0.3	2.0	2	2.4	1.2	5.4	0.0	1.0	18.2
BA	18.6	10.2	3.2		0.5	2.5	2	1.9	1.1	2.5	0.0	0.5	20.8
Bt	26.4	16.7	4.2		0.3	2.5	9	2.2	1.1	2.6	0.2	1.4	35.5
2Bt	16.2	23.1	3.1		0.7	2.3	4	3.5	0.7	1.6	0.0	<0.1	26.0
2Cmk	16.2	16.9	3.0		1.2	1.8	7	5.0	0.4	1.7	1.0	1.2	21.4
3Cmk	16.8	21.0	4.7		2.4	2.0	14	5.2	0.3	1.5	0.0	1.0	28.5
3Ck	22.3	20.0	4.5		2.5	1.8	11	5.6	0.2	1.6	0.0	1.0	26.3
4Ck	15.6	17.3	3.9		2.6	1.5	17	14.0	0.6	2.6	0.0	9.8	25.0
4Cmk	17.7	22.0	4.3		3.0	1.5	17	24.5	0.5	6.7	1.3	22.1	30.3

¹ Percent of < 1 inch fraction. - ² Including cations from carbonates in some horizons.

LUVIC YERMOSOL, United States (concluded)

veins occur and where lime is attached to pebbles and cobbles; pH 8.8; clear wavy boundary.

- 4Ck** **45-60 inch** Pale brown (10YR 6/3) gravelly loamy coarse sand (40 percent gravel, 5 percent cobble), dark brown (10YR 4/4) when moist; massive; slightly hard with harder material where lime occurs as veins and on cobbles; friable, nonsticky, nonplastic; no roots; many very fine and fine interstitial pores; slightly calcareous matrix but very strongly calcareous where lime has accumulated as common medium and coarse faint white (10YR 8/2) lime veins and as coatings on pebbles; pH 8.8; abrupt wavy boundary.
- 4Cmk** **60-66 inch** White (10YR 8/2) very gravelly coarse sandy loam (about 45 percent gravel), light grey (10YR 7/2) when moist; massive; very hard because of moderate lime cementation; friable to firm, nonsticky, nonplastic; no roots; many very fine and fine interstitial pores; very strongly calcareous; pH 8.8.

NOTE: Weak desert pavement on bare areas between shrubs.

ORTHIC SOLONCHAK Zo

- Classification (Canada)** Saline Regosol. Big Muddy Association, Saskatchewan
- Location** Willow Bunch lake area, 72H, Saskatchewan
- Altitude** 615 m
- Physiography** Very gently undulating alluvial plain
- Drainage** Moderately well drained
- Parent material** Moderately fine textured (SCL) weakly calcareous saline alluvium
- Vegetation** Pasture, sparse growth of salt-tolerant grasses and forbs
- Climate** Cool to moderately cool boreal; semiarid to subarid

Profile description

- Az** **0-3 inch** Grey (5Y 5/1 dry, 4/2 moist) loam; subangular blocky crushes to granular; soft; weakly calcareous; saline crust on surface.
- Bz** **3-6 inch** Grey (5Y 5/1 dry, 2.5Y 3/2 moist) clay loam to sandy clay loam; very weak prismatic crushing to granular; soft; weakly calcareous.
- Cz1** **6-12 inch** Light olive grey (5Y 6/2 dry, 5/3 moist) sandy clay loam; amorphous; soft; weakly calcareous.
- Cz2** **12-17 inch** Light olive grey (5Y 6/2 dry, 4/3 moist) sandy clay loam; amorphous; soft; weakly calcareous.
- Cz3** **17-40 inch** Light brownish grey (2.5Y 6/2 dry, 5Y 4/3 moist) sandy clay loam; amorphous; soft; weakly calcareous.

ORTHIC SOLONCHAK
Canada

Horizon	Depth inches	Particle size distribution (mm) % 3A1b							Textural class
		1B1a Coarse medium sand	Fine sand	Very fine sand	Total sand	Silt	Total clay	Fine clay	
Az	0—3	14.1	14.4	17.2	45.7	27.3	26.8	16.3	l
Bz	3—6	11.0	14.1	18.5	43.6	23.8	32.4	20.2	cl-scl
Cz1	6—12	17.5	21.7	21.5	60.7	17.5	21.5	13.8	scl
Cz2	12—17	21.4	18.6	18.4	58.4	19.6	21.6	14.3	scl
Cz3	17—40	21.1	21.9	16.3	59.3	18.9	21.7	13.8	scl

Horizon	8C1a pH H ₂ O	Organic matter		6E1d CaCO ₃ equiv. %	Cations Saturation ext. (NH ₄ OAc)				EC mmhos/cm	H ₂ O at sat. %
		6A1a OC %	6B1a N %		Ca	Mg	K	Na		
Az	8.3	2.17	0.13	5.80	26.5	146.4	9.2	1 030.0	51.8	52.8
Bz	8.4	1.94	0.13	7.25	23.2	134.1	4.6	617.8	35.4	63.6
Cz1	8.5			6.40	16.4	113.1	2.5	456.5	28.0	50.8
Cz2	8.4			5.90	17.1	109.3	2.0	413.0	27.6	50.4
Cz3	8.4			6.15	20.7	151.6	2.4	449.0	30.5	46.4

Appendix 2

TABLE OF CORRELATED LEGENDS OF REFERENCE SOIL MAPS

CLASSIFICATION AND SYMBOLS		
FAO/Unesco Soil Map of North America	Map of Soils, 1 : 7 500 000, National Atlas of the United States	Soil Map of Canada 1 : 5 000 000
J Fluvisols Je Eutric Jc Calcaric Jd Dystric	E 7 Xerorthent E 2 Torrifuvent <i>No United States unit</i>	F 2 Cumulic Regosol <i>No Canadian unit</i> F 2 Cumulic Regosol
G Gleysols Ge Eutric Gd Dystric Gm Mollic Gh Humic Gx Gelic	I 5 Haplaquept I 5 Haplaquept I 4 Cryaquept E 1 Psammaquent M 2 Haplaquoll I 6 Humaquept I 4 Cryaquept	G 2 Gleysol G 2 Gleysol G 1 Humic Gleysol G 1 Humic Gleysol G 1 Cryic Gleysol
R Regosols Re Eutric Rc Calcaric Rd Dystric Rx Gleyic	E 11 Torripsamment E 12 Udipsamment E 13 Ustipsamment E 14 Xeropsamment E 3 Torriorthent E 4 Torriorthent (shallow) E 5 Ustorthent E 7 Xerorthent E 10 Quartzipsamment <i>No United States unit</i>	F 1 Orthic Regosol <i>No Canadian unit</i> F 1 Orthic Regosol F 3 Cryic Regosol
I Lithosols	X Rockland	R Rockland
E Rendzinas	<i>No United States unit</i>	A 3 Black Chernozemic
T Andosols Tv Vitric	I 1 Cryandept	<i>No Canadian unit</i>
V Vertisols Vp Pellic Vc Chromic	V 2 Pelludert V 4 Pellustert V 1 Chromudert V 3 Chromustert V 5 Chromoxerert	<i>No Canadian unit</i> <i>No Canadian unit</i>
Z Solonchaks Zo Orthic	<i>No United States unit</i>	F 1 Orthic Regosol (saline phase)
S Solonetz So Orthic Sm Mollic Sg Gleyic	D 3 Natrargid M 14 Natrustoll <i>No United States unit</i>	<i>No Canadian unit</i> B 1 Brown Solonetz B 2 Black Solonetz B 3 Black Solod Gleyed subgroups of B1, B2 and B3

CLASSIFICATION AND SYMBOLS

FAO/Unesco Soil Map of North America	Map of Soils, 1 : 7 500 000, National Atlas of the United States	Soil Map of Canada 1 : 5 000 000
Y Yermosols Yl Luvic Yk Calcic Yh Haplic	D 2 Haplargid (Typic subgroup) D 5 Calciorthid D 6 Camborthid	No Canadian unit No Canadian unit No Canadian unit
X Xerosols Xl Luvic Xk Calcic Xh Haplic	D 2 Haplargid (Mollic subgroup) D 4 Paleargid M 15 Argixeroll D 5 Calciorthid D 2 Haplargid M 16 Haploxeroll	No Canadian unit No Canadian unit No Canadian unit
K Kastanozems Kh Haplic Kk Calcic Kl Luvic	M 3 Argiboroll M 5 Haploboroll M 12 Haplustoll M 13 Haplustoll (shallow) M 16 Haploxeroll M 10 Calciustoll M 11 Calciustoll (shallow) M 3 Argiboroll M 9 Argiustoll M 15 Argixeroll	A 1 Brown Chernozemic A 2 Dark Brown Chernozemic No Canadian unit A 1 Brown Chernozemic A 2 Dark Brown Chernozemic
C Chernozems Ch Haplic Ck Calcic Cl Luvic	M 4 Cryoboroll M 5 Haploboroll M 1 Calciaquoll M 3 Argiboroll	No Canadian unit A 3 Black Chernozemic A 3 Black Chernozemic
H Phaeozems Hg Gleyic Hl Luvic Hh Haplic	M 2 Haplaquoll M 6 Argiudoll M 15 Argixeroll M 7 Hapludoll M 16 Haploxeroll	No Canadian unit No Canadian unit No Canadian unit
M Greyzems Mo Orthic	M 3 Argiboroll	A 4 Dark Gray Chernozemic
B Cambisols Bd Dystric Be Eutric Bh Humic Bx Gelic Bk Calcic Bc Chromic	I 8 Dystrochrept I 10 Fragiochrept I 7 Cryochrept I 9 Eutrochrept I 11 Ustochrept I 13 Cryumbrept I 14 Haplumbrept No United States unit I 9 Eutrochrept I 9 Eutrochrept	E 3 Dystric Brunisols E 2 Eutric Brunisol E 1 Melanic Brunisol No Canadian unit E 3 Cryic Dystric Brunisols No Canadian unit No Canadian unit

CLASSIFICATION AND SYMBOLS

FAO/Unesco Soil Map of North America	Map of Soils, 1 : 7 500 000, National Atlas of the United States	Soil Map of Canada 1 : 5 000 000
L Luvisols	A 6 Fragiudalf A 7 Hapludalf A 9 Haplustalf A 4 Eutroboralf A 3 Cryoboralf A 2 Ochraqualf A 8 Paleudalf A 9 Haplustalf A 10 Paleustalf A 11 Durixeralf A 12 Haploxeralf A 13 Palexeralf	C 1 Brunisolic Gray Brown Luvisol <i>No Canadian unit</i> C 1 Gray Brown Luvisol C 2 Gray Wooded (Gray Luvisol) <i>No Canadian unit</i> <i>No Canadian unit</i>
D Podzoluvisols	A 5 Glossoboralf	<i>No Canadian unit</i>
P Podzols	S 2 Cryorthod S 3 Fragiorthod S 4 Haploorthod S 4 Haploorthod S 1 Haplaquod	D 3 Humo-Ferric Podzol <i>No Canadian unit</i> <i>No Canadian unit</i>
W Planosols	A 1 Albaqualf	<i>No Canadian unit</i>
A Acrisols	U 4 Fragiudult U 6 Paleudult U 1 Ochraqualf U 2 Haplohumult U 5 Hapludult	<i>No Canadian unit</i> <i>No Canadian unit</i> <i>No Canadian unit</i> <i>No Canadian unit</i>
O Histosols	H 2 Histosols H 1 Histosols <i>No United States unit</i> <i>No United States unit</i> <i>No United States unit</i>	<i>No Canadian unit</i> <i>No Canadian unit</i> H 1 Fibrisol H 1 Fibrisol H 3 Cryic Fibrisol
Glaciers and Snow Caps	<i>No United States unit</i>	I Icefields

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