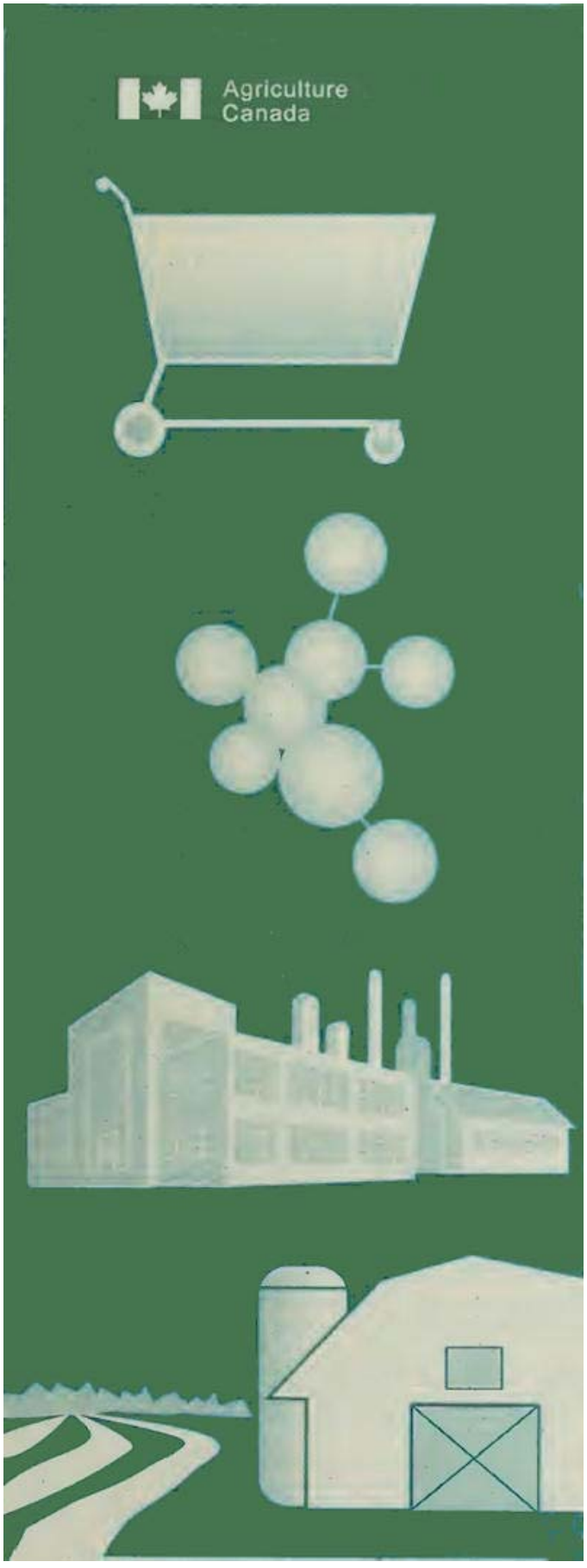

Research Branch
Technical Bulletin 1993-1E

Clay mineralogical database of Canadian soils

Canada

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Clay mineralogical database of Canadian soils

with a clay mineralogical map of surface soils

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Base de données sur la minéralogie de l'argile des sols canadiens

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Summary

Soil mineralogical information is of primary importance in the characterization and utilization of soils. Since the first report of clay mineralogical data for Canadian soils in 1937, mineralogical data for approximately 1500 samples from 500 pedons in Canada have been obtained and recorded. All these data were assembled along with data for related bedrock samples. Criteria for mineralogical classes were defined and the existing data were classified and compiled in digital files. A part of the data were the spatial coordinates allowing the site observations to be input and manipulated within a Geographical Information System (GIS). The mineralogical data were used in conjunction with the Soil Map of Canada (1:5 million) to produce a clay mineralogical map of surface soils (1:10 million) which is attached to this monograph. When many clay mineralogical data are available such as the case in southwestern Ontario, the data were used with regional Soil Landscape Maps (1:1 million) to produce a more detailed clay mineralogical map of the region. This map is now being used as a layer of information in the GIS and also in plotted form to study the relationship between clay mineralogy and pesticide use for areas of intensive crop production in this region. During the process of compiling the existing clay mineralogical data and manipulating them in a GIS, a number of gaps in the information were identified particularly for noncrystalline and smectitic soil components. New studies are currently in progress to fill in these information gaps.

INTRODUCTION

In Canada, more than 95% of the soils used for cultivation are mineral soils. Dominant components of mineral soils are inorganic substances of sand, silt and clay sizes along with some organic matter. The inorganic substances include primary minerals inherited from parent materials, and secondary minerals which were formed syngenetically or by the transformation of the primary minerals during pedogenic processes. These substances occur in crystalline or noncrystalline form.

The clay fraction of the soil is the most important of all the mineral components, because the clay-size components have the greatest influence on the physical, chemical and biological activities of soil. Clay particles have large specific surface area, are very reactive on and between the clay surfaces, and considered to be the most active part of soil. The amount and type of clay determine the character and productivity of the soil. For this reason, soil mineralogical studies in the past several decades have focused on the clay fraction of soils.

Since the first report of clay mineralogical data for Canadian soils (Clark et al. 1937), many papers have been published on subjects related directly or indirectly to clay mineralogy of Canadian soils. Kodama (1979) summarized mineralogical data of Canadian soils from 1937 to 1977, and characterized the distribution of clay minerals in terms of physiographic region and soil type. Although a considerable amount of clay mineralogical information on Canadian soils is available, much of it pertains only to crystalline mineral components in the clay fraction and to partial profiles of scattered pedons. As public concerns grow for soil conservation and environmental quality, there is a need (a) to organize and complete a mineralogical database of Canadian soils and (b) to assess the influence of mineralogical composition on soil behaviour in actual field conditions. The most effective way to extend this information is to organize the data including their interpretation in map form and in electronic file.

As mentioned before, mineralogical data for the clay fractions are relatively abundant. Therefore, we proceeded to make a clay mineralogical map of surface soils in Canada after we completed a supplemental review of the literature from 1978 to 1990 and produced additional data by ourselves.

The purpose of this monograph is to describe (1) how the clay mineralogical data were compiled, (2) how the data were organized and selected for the map, (3) how mineral criteria were defined for grouping, (4) how the clay mineralogical map was constructed, (5) how the electronic file for the data was established, and (6) how the map and electronic file are potentially utilized. Comprehensive tabulated clay mineralogical data and indices including geographical sites, soil type and mineral type are also presented.

METHODS OF DATA COMPILATIONS

Literature Survey

References cited for the mineral file are listed chronologically and alphabetically in each year as an Appendix to this monograph. In some cases, unpublished data were used and cited as such.

Compilation

All mineralogical data available for a pedon or a soil horizon were summarized in a format represented in Table 1. In the format, clay minerals are treated in a narrow sense as phyllosilicates. Besides the identification for the pedon examined (soil series name, location, type of deposition, etc.), the format also contains columns listing a brief description of the physical nature of each horizon and geological data of rocks or sediments underlying the pedon or of parent materials from which the pedon developed. The subgroup to which the soil series belongs is given just under the soil series name in the first column of the format. Since many soil series names and their subgroups were listed in Canadian Soil Names File by CanSIS (Canadian Soil Information System, 1973), the subgroup was indicated by symbols which followed the connotative code system adopted by CanSIS. If the soils studied were not listed in the CanSIS File, original descriptions were given. Qualitative or quantitative expressions for the mineralogical data were classified into one of nine categories given in Table 2, depending upon the type of presentation of the original data. Precision of data increases with numbers of the categories. When the original data did not fit correctly, a minimum modification was applied in order to accommodate them in one of the categories. The data compiled in such a manner were grouped by province or territory. When the exact location of a sample was known, it was marked on the 1:5M scale soil map of Canada (Clayton *et al.*, 1977). The map showing the sample sites and the original data file in 12 volumes are available at the Soil Mineralogy Laboratory of the Centre for Land and Biological Resources Research in Ottawa.

Table 1. The formal for the mineral data file and examples of data description.

Soil Series (Soil Group)	Location		Underlying Rock		Soil			Particle Size (%)			Clay Minerals							Non-clay Minerals						Reference Authors Initials/ Year
	Place Long-itude	Latitude Type of Dep	Age	Type	Hor-izon	Depth	Texture	Silt	C Clay	F Clay	Fract. Studied	Mixed Layer	Smec	Verm	Mica	Chlor	Kaol	Other	Qt	Feldspar K	Feldspar Na-Ca	Amph	Carb-onate	Iron Oxide	Other	
B.C.						cm					µm															
Fitzsimmons	Site 1	50°02'N		gabbro	A_1	0.125	L	44.6	10.9		2-0.2			tr-35	10-35	35-65			tr-35							S L & F# (1972 a,b)
(O HFP)		122°51'W		qt diorite							<0.2	tr	tr	35-65	tr	tr	Tr		tr							
ONT.						in.																				
Guelph												S/M* M>> S**														W(1947)#
(BR GBL)	near Guelph Wellington Co. developed on glacial till composed largely of dolomite, limestone				B_2	17-22	CL	319	52.1		2-0.2		5		25		20		40	10						
											< 0.2	30	5		50		10		5	0						
ALTA.						in.					µm															
Cooking Lake (O GL)	Sec 12-53-21 W4				C_2	29+			19	12	2-0.2 <0.2 100-150 sp gr <2.7	tr	m M		M m	tr	m tr -m		m tr.							P(1961) #
																			60	8	32					

NOTE: Combination of component layers* & their mixing ratio **, # see Appendix, find paper with corresponding initial(s) under given year

Table 2. Various expressions for mineral quantities.

	Symbol	Expression	
CLASS 1	○	Present	
	○,○...○	If the order of approx. amounts is known, 1 > 2 > ...> n	
	●	Main, without knowing the order	
	-	Absent	
CLASS 2	●	Dominantly, Largely, Mostly present	
	○	In a considerable amount	
	⊗	In a small amount - some amount	
	ⓣ	In a trace amount	
CLASS 3	+++	Strong	
	++	Medium	peak intensity
	+	Weak	of X-ray diffraction
	ident.	Identifiable	pattern.
CLASS 4	vs	Very strong	
	s	Strong	
	ms	Medium strong	
	m	Medium	peak intensity of X-ray
	mw	Medium weak	diffraction pattern
	w	Weak	
	vw	Very weak	
	faint	Faintly	
	tr	Trace	
CLASS 5	D	Dominant	
	M	Major	amount, based on X-ray
	M-m	Moderate	peak intensity without
	m	Minor	considering intensity
	tr	Trace	factors.
CLASS 6	* * * *	Dominant	
	* * *	Major	amount, based on an
	* *	Moderate	intensity factor method.
	*	Minor	
	tr	Trace	
CLASS 7	05	100-80%	
	04	80-60%	
	03	60-40%	per total fraction studied.
	02	40-20%	
	01	20-0%	
CLASS 8	05/P	100-80%	
	04/P	80-60%	
	03/P	60-40%	per total phyllosilicates.
	02/P	40-20%	
	01/P	20-0%	
CLASS 9	0,1,2,...25...100% as it indicates		

Selection and Preparation of Data for Mapping

In order to summarize clay mineralogical data in a map form, quantitative or at least semi-quantitative data are required. There was no common standard for comparison of the data as given in the various quantitative expressions shown in Table 2, except classes 7, 8 and 9, where the amounts are given in weight percent. To facilitate the interpretation of the data on a common basis, it was necessary for a standardization process to set up for the quantification of soil minerals; this process is expressed by one of the schemes from class 2 to class 6 (Table 2). A semi-quantitative scheme consisting of four divisions: major, moderate, minor and trace was set up as a common standard and all expressions were converted to the four-division scheme by including dominant in major and combining two or three divisions into one. Then the four divisions were tentatively scaled as >35%, 10-35%, 1-10% and <1% for major, moderate, minor and trace, respectively. Based on this scale, the mineralogical data given in each one of the schemes from class 2 to class 6 were numerated.

When there was more than one mineralogical expression available for one location, the one which considered to be most appropriate was chosen. If the data were more or less comparable, they were averaged for one representation.

Definition of Mineral Classes

A mineral class for the clay fraction of a soil is defined by the name of a single dominant mineral whose amount is >35% which was determined in the preceding section as the highest scaled one of the four divisions. For example, when a soil contains mica as such a dominant mineral constituent, the soil is grouped into a micaceous class. However, in the case where none of minerals are dominant (<35%), such a soil is grouped as a mixed mineral class. Of the Canadian soils more than half belong to either micaceous class (28%) or smectitic class (23%). Most of the remainder (44%) are grouped in a mixed mineral class. The last small portions of all soils selected (5%) belong to three mineral classes; vermiculitic, chloritic and carbonatic. Since these classes represent only 5% of the whole

soils, the classes are combined together in a major class called "others".

Canadian soils, thus, may be classified by four major groups: micaceous, smectitic, mixed and others, and these major classes are expressed by symbols of large capitals as shown in Table 3. This expression can also be extended by adding subordinate symbols of small capitals for constituent minerals of moderate amounts (10-35%) in order to add more information about the mineral composition of soil. Since only the mineralogy of the clay fraction is considered, it was important to include soil textural information along with clay mineralogical data. Three texture groups were set up: sandy (S), loamy (L) and clayey (C) and these were defined by their clay contents, that is: <10%, 10-35% and >35%, respectively. The symbols for expressing texture group are placed at the end of the description after a slash sign (/), as shown by examples given in Table 3. In practice, however, to avoid crowded descriptions in the limited space of a map, coding numbers were set up for all 67 varieties of mineral composition which were observed in surface soils of Canada (see Appendix I). The coding numbers within the general classes were followed by textural expressions S, L and C to simplify the full description (Table 4).

Transformation of Point Data into Area Data

All clay mineral point data (461) were plotted on a 1:5 million (M) base map of soils of Canada (Canada Department of Agriculture, 1977), according to their sampling locations. The base map has a total of 756 soil polygons. When all mineral data were plotted, 150 of the total 756 soil polygons contained at least one data point. Most of the point data were located on agricultural land. As a consequence, a soil polygon in a prairie agricultural region and in southern Ontario usually contained several data points while there were few data available in northern regions of the provinces and in the territories. If there is only one data point within a soil polygon, the whole polygon is to be classified to a mineral class according to this mineral data point. If there are two or more data points within a soil polygon, the mineral class of this polygon has to represent the majority of the data points contained within this polygon.

Table 3. Major mineral classes, mineral groups, defined soil texture and their abbreviated symbols, with an example of short description for clay mineral composition along with soil texture information.

Mineral Class		Symbol	Mineral Group	Symbol
Micaceous		M	Smectite	S
			Vermiculite	V
Smectitic		S	Chlorite	Ch
			Mica	M
Mixed		X	Kaolinite	K
			Quartz	Q
	Chloritic	Ch	Feldspar	F
			Amphibole	Am
Others	Vermiculitic	V	Carbonate	Ca
			Noncrystalline Phases	A
	Carbonatic	Ca		

Texture Group	Symbol	Definition (clay content)
Sandy	S	<10%
Loamy	L	10-35%
Clayey	C	>35%

Example

Subordinate mineral component

↓

$M_{S, V}$ /S

↑ ↑

Mineral Class Texture Group

In a sandy soil, its clay fraction has mica as the dominant mineral component (>35%) associated with a moderate amount (10-35%) of smectite and vermiculite. The mineralogy of this clay fraction is classified as micaceous.

Table 4. List of all sub-mineral classes combined with soil texture information for map codings.

Micaceous Classes (>35% Mica)			Mixed Classes (All <35%)		
Map Coding	Other minerals (>15%)	Texture	Map Coding	Other minerals (>15%)	Texture
			30 C	Ch, M, S	Clayey
01 S	Ch, Ca	Sandy	31 L	Ch, S, Am	Loamy
02 L	Ch, K	Loamy	32 L	Ch, V, K	Loamy
02 S	Ch, K	Sandy	33 S	F, M, Ch	Sandy
03 L	Ch, V	Loamy	34 L	M, Am, Ch	Loamy
04 L	Ch	Loamy	35 S	M, Am, V	Sandy
04 S	Ch	Sandy	36 L	M, Ch, K	Loamy
05 L	K, Ch	Loamy	36 S	M, Ch, K	Sandy
06 L	K, V	Loamy	37 L	M, Ch, K	Loamy
07 C	Q	Clayey	37 S	M, Ch, Q	Sandy
08 L	S, K	Loamy	38 L	M, Ch, V	Loamy
09 L	S, Q	Loamy	39 L	M, Ch	Loamy
09 S	S, Q	Sandy	39 S	M, Ch	Sandy
10 L	S, V	Loamy	40 L	M, K	Loamy
10 S	S, V	Sandy	41 L	M, Q, F	Loamy
11 C	S	Clayey	42 L	M, S, Ch	Loamy
11 L	S	Loamy	42 S	M, S, Ch	Sandy
11 S	S	Sandy	43 S	M, S, Q	Sandy
12 L	V, Am	Loamy	44 C	M, S, V	Clayey
13 L	V, K	Loamy	45 C	M, S	Clayey
14 L	V, Q	Loamy	46 C	M, V, K	Clayey
15 C	V, S	Clayey	46 L	M, V, K	Loamy
16 C	V	Clayey	47 L	M, V, S	Loamy
16 S	V	Sandy	48 L	Q, Ca	Loamy
17 C	--	Clayey	49 L	S, Ch, M	Loamy
17 L	--	Loamy	50 S	S, Ch, V	Sandy
17 S	--	Sandy	51 S	S, Ch	Sandy
			52 L	S, M, Ch	Loamy
Smectitic Classes (>35% Smectite)			53 L	Sm, M, K	Loamy
			54 C	S, M, Q	Clayey
18 L	Ca, M	Loamy	55 C	S, M, V	Clayey
19 L	Ch, M	Loamy	56 C	S, M	Clayey
20 S	Ch	Sandy	56 L	S, M	Loamy
21 L	M, Ch	Loamy	56 S	S, M	Sandy
22 L	M, K	Loamy	57 L	S, V, M	Loamy
23 L	M, Q	Loamy	58 C	V, K, M	Clayey
24 C	M, V	Clayey	59 L	V, M, Ch	Loamy
24 L	M, V	Loamy	60 L	V, M	Loamy
25 C	M	Clayey	61 L	--	Loamy
25 L	M	Loamy			
25 S	M	Sandy	Others (Underlined >35%)		
26 S	Q, M	Sandy	62 L	Ca, Q	Loamy
27 L	Q, V	Loamy	63 S	Ch, M	Sandy
28 C	Q	Clayey	64 S	Ch, V, K	Sandy
28 L	Q	Loamy	65 L	Ch, V, S	Loamy
29 C	--	Clayey	66 C	V, M, K	Clayey
29 L	--	Loamy	67 C	V, M	Clayey
29 S	--	Sandy	67 S	V, M	Sandy

Mineral Abbreviations

Am= Amphibole; Ca= Carbonate; Ch= Chlorite; F= Feldspar; K= Kaolinite; M= Mica;

Q= Quartz; S= Smectite; V= Vermiculite.

The 1:5 M clay mineralogical map was further reduced to 1:10 M according to standard cartographic procedures. For reasons of map clarity, the area of the smallest polygon on the 1:10 M mineralogical map is approximately 0.2 cm^2. The reduction processes from 1:5 M to 1:10 M did not result in significant reduction of mineralogical information. This is due mainly to the nature of clay mineral distribution in Canada. The mineral classes are highly geographically dependent. For example the smectitic mineral class is dominant in the prairies, the micaceous is most common in Quebec and in the Atlantic region, while the mixed mineral class is most frequently found in southern Ontario. As a result, most of the mineral class polygons in 1:5 M map are very large in size. The reduction to 1:10 M scale still leaves the area of me3f these polygons well above the minimum of 0.2 cm^2. In a few cases, the reduced polygon was less than 0.2 cm^2 in size and had to be integrated with other polygons. In such cases, the dominant mineral class in an integrated polygon is used to represent this new polygon.

Compilation of Digital Files

The computerized mineralogy database was developed on Arc/Info, a geographic information system (GIS) developed by Environment Systems Research Institute, Toronto, Canada[1], operating on a VAX 8650 computer. Records were compiled and associated with a known location (as given by some geographical coordinate system), a particular sample site and layer and was recorded in tabular form. This information was stored in its original format as a bibliographical file.

In order to provide a standard efficient format manipulation and analysis, the data have been reorganized into three files and a file of literature citations as shown below (Table 5). The mineral kind and content information was converted to a common, ordinal system of measurement.

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[1] The mention of a trademark, proprietary product or vendor does not imply endorsement by Agriculture Canada to the exclusion of other products or vendors.

Table 5. Record structure for the mineralogy database.

Datafile	Field	Description
XXSITE.DAT	PROVINCE	province code
	PEDON	pedon number
	STATUS	year of data publication (code)
	REF	reference link to PUBREF.DAT
	LATDD	latitude in dec. deg of pedon
	LONDD	longitude " "
	LOCEST	flag if location is estimate
XXLAYER.DAT	PROVINCE	province code
	PEDON	pedon number
	LAYER	pedon soil layer (surface or sub)
	UDEPTH	upper depth of soil layer
	LDEPTH	lower depth os soil layer
	HZN-DESIG	horizon designation of layer
	TEXTURE	texture of layer
XXLAYMIN.DAT	PROVINCE	province code
	PEDON	pedon number
	LAYER	pedon soil layer
	CLAY-FRAC	clay fraction
	MIN	mineral code
	AMT	standardized value for mineral
PUBREF.DAT	REF	reference number
	YEAR	year of publication
	TITLE	title of publication
	AUTHOR	author(s) of publication
	JOURNAL	journal of publication
	PAGE_NO	page number

where 'XX' represents the provincial/territorial code and highlighted fields identify data file key

In order to achieve a common data format, some of the original information was significantly generalized and in some instances, information about a sample was ignored. If specific information for a particular record or group of records is required, the original data has been retained (MINAL.DAT) and can be linked to the more practical data model.

There are 967 clay mineral layer records linked to 461 reference records. Of these records, 59 were flagged during the data quality check due to the lack of accurate location information.

The 905 records with geographic location information were used to produce an Arc/Info point coverage which was overlayed by provincial boundaries [taken from the Soil Landscapes of Canada (Shields *et al.*, 1991)]. The province of origin of the sample as recorded in the data was considered to be correct and compared to the plotted location; the location data has been rounded to the nearest 5 minutes. Only 2 sample sites that did not fall within the correct provincial boundaries (including the 5 minute margin of error). These should be rejected from further GIS analysis.

UTILIZATION OF THE MONOGRAPH

Use of Appendices

This monograph contains several Appendices and a clay mineralogical map of surface soils (1:10 million). Although all necessary data have been compiled in electronic files which are incorporated in a Geographical Information System (GIS), a book-form presentation is still convenient and useful for a quick overview of the mineralogical information available for Canadian soils. Thus, it was decided to prepare the following lists in order to facilitate such a search and make the available information as useful as possible.

1. Provincially listed sample locations with their longitudes and latitudes along with soil type and polygon number for soils of Canada.
2. Soil types and polygons grouped by type of clay mineral assemblage.
3. Sample locations grouped by major soil types.

These lists are given in Appendices II, III and IV, respectively, at the end of this monograph. List 1 (Appendix II) describes sample locations in an ascending order of their longitudes. Therefore, the list may also be used to find mineralogical data available for a soil sample from a location which is closest to the location in question. List 2 (Appendix III) can be used to correlate between clay mineral assemblage and soil type, and list 3 (Appendix IV) facilitates finding sample locations [where mineralogical data available] under a given major soil type. These are only a few examples for use of the lists.

Interpretations and Use of the Clay Mineralogical Map

As mentioned earlier, after criteria for mineralogical classes were defined, a part of the data denoted the spatial coordinates allowing the site observations to be input and manipulated within a Geographical Information System. The mineralogical data were combined with the Soil Map of Canada (1:5 million) to produce a clay mineralogical map of surface soils. Due to size limitation, the map attached to this monograph is given in 1:10 M scale. In some geographical regions, the data are sufficient to produce a more detailed clay mineralogical map in conjunction with regional Soil Landscape Maps (1:1 M). Recently, we prepared a detailed clay mineralogical map of Southwestern Ontario (Kodama *et al.* 1991). This map is now being used as a layer of information (texture, parent material precipitation etc.) in GIS and in plotted form to study the relationship between clay mineralogy and pesticide use and soil interaction for areas of intensive crop production in this region.

During the process of compiling the existing clay mineralogy and manipulating them in a GIS, a number of gaps in the information were identified particularly for noncrystalline and smectitic soil components. New studies are currently in progress to fill in these information gaps. (Kodama and Ross, 1991; Ross and Kodama, 1992; Ross *et al.* 1992).

The clay mineralogical map can be used to determine soil family mineralogy classes in Soil Taxonomy (Soil Survey Staff 1990) and in The Canadian System of Soil Classification, (Agriculture Canada Expert Committee on Soil Survey 1987).

It is particularly useful for clayey and fine loamy soils. For sandy and coarse loamy soils, the whole soil mineralogy should be more suitable to determine mineralogy classes (Lietzke 1985).

The clay mineralogical map can be used to locate areas in which potassium and ammonium fixation may occur by the presence of significant amounts of vermiculite in discrete or interstratified forms (Ross and Cline, 1984; Ross *et al.* 1985).

Strong retention of phosphorous can be expected in areas with soils containing appreciable amounts of iron and aluminum oxides, kaolinite and amorphous material (such as allophane) (Parfitt 1978; Kimble *et al.* 1990). Such soils would also have high pH-dependent cation exchange capacity (Ross, 1980). Soils containing smectite as a dominant component, as indicated in the prairie provinces, are characterized by considerable swelling and shrinking, high water retention, high liquid and plastic limits, high cation exchange capacities, and high specific surface areas (Yong and Warkentin, 1975; Ross *et al.* 1991).

The presence of carbonate minerals, particularly in the upper profile, indicates young *soils,* poor drainage conditions and/or low intensity weathering as well as abundant though sometimes excessive supply of plant-available calcium and magnesium with associated neutral or alkaline pH (Protz *et al.* 1984; Protz *et al.* 1988).

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REFERENCES

Agriculture Canada Expert Committee on Soil Survey. 1987. The Canadian System of Soil Classification. 2nd ed. Agriculture Canada. Publ. 164, Ottawa, Ont.164 pp.

Canadian Information System (CANSIS). 1973. Canadian Soil Names File. Canada Soil Survey Committee. 285 pp.

Clark, G.L., Riecken, F.F. and Reynolds, D.H. 1937. X-ray diffraction studies of two micron fractions of some genetic soil profiles Z. Kristallogr. A96, 273-286.

Clayton, J.S., Ehrlich, W.A., Cann, D.B., Day, J.H. and Marshall, I.B. Soils of Canada, Canada Department of Agriculture, Research Branch, Soil Research Institute - Canada Soil Survey Committee. 2 volumes with a Glossary and a map.

Kimble, J., Eswaran, H. and Cook, T. 1990. Spodosols transitions with other soils. Proc. 5th International Soil Correlation Meeting (ISCOM) Characterization, classification and utilization of Spodosols. J.M. Kimble and R.D. Yeck eds. 171-180.

Kodama, H. 1979. Clay minerals in Canadian soils: Their origin, distribution and alteration. Can. J. Soil Sci. 59, 37-58.

Kodama, H. and Ross, G.J. 1991. Tiron dissolution method used to remove and characterize inorganic components in soils. Soil Sci. Soc. Am. J. 55, 1180-1187.

Kodama, H., Ross, G.J., Wang, C., Shen, G. and MacDonald, K.B. 1991. Clay mineralogical database of soils and its use in Canada. 83rd Annual Meeting (Denver, Colorado) of ASA-CSSA-SSSA. Abstract p. 366.

Lietzke, D.A. 1985. Whole soil mineralogy - criteria for mineralogical families in Soil Taxonomy. In Mineral Classification of Soils. (J.A. Kittrick, Ed.) SSSA Special Publication Number 16. 17-40.

Parfitt, R.L. 1978. Anion adsorption by soils and soil minerals. Adv. Agron. 30, 1-50.

Protz, R., Ross, G.J., Martini, I.P. and Terasmae, J. 1984. Rate of podzolic soil formation near Hudson Bay, Ontario. Can. J. Soil Sci. 64, 31-49.

Protz, R., Ross, G.J., Shipitalo, M.J. and Terasmae, J. 1988. Can. J. Soil Sci. 68, 287-305.

Ross, G.J. 1980. Mineralogical, physical, and chemical characteristics of amorphous constituents in some Podzolic soils from British Columbia. Can. J. Soil Sci. 60, 31-43.

Ross, G.J. and Cline, R.A. 1984. Potassium exchange characteristics in relation to mineralogical properties and potassium uptake by grapes of selected soils in the Niagara peninsula of southern Ontario. Can. J. Soil Sci. 64, 87-98.

Ross, G.J. and Kodama, H. 1992. X-ray diffraction characteristics of soil smectites. Can. J. Soil Sci. (in press).

Ross, G.J., Phillips, P.A. and Culley, J.L.R. 1985. Transformation of vermiculite pedogenic mica by fixation of potassium and ammonium in a six-year field manure application experiment. Can. J. Soil Sci. 65, 599-603.

Ross, G.J., Wang, C. and Kodama, H. 1991. Soil surface areas. An indicator of soil mineralogical and soil water sorption properties. 83rd Annual Meeting (Denver, Colorado) of ASA-CSSA-SSSA. Abstract p. 367.

Shields, J.A., Tarnocai, C., Valentine, K.W.G. and MacDonald, K.B. 1991. Soil landscapes of Canada. Procedures Manual and User's Handbook, Agriculture Canada Publication. 1868/E. Ottawa. 74 pp.

Soil Survey Staff. 1990. Keys to Soil Taxonomy. SMSS Tech. mono. No. 19. Virginia Polytechnic Institute and State University.

Yong, R.N. and Warkentin, B.P. 1975. Soil Properties and Behaviour. Developments in Geotechnical Engineering. Vol. 5 Elsevier Scientific Publishing Co. New York. 449 pp.

APPENDICES

APPENDIX I

List of References (marked with *) cited for the Mineral Data File

References without the mark carry additional mineralogical information including the mineralogy of bedrocks.

1937

* Clark, G.L., Riecken, F.F. and Reynolds, D.H. X-ray diffraction studies of two micron fractions of some genetic soil profiles. Z. Kristallogr. A96: 273286.

1943

Richard, J.A. and Chandler, R.F. Jr. Some physical and chemical properties of mature Podzol profiles. Soil Sci. Soc. Amer. Proc. 8: 379-383.

1946

McLelland, J.E. A chemical and mineralogical study of Saskatchewan boulder clay. M. Sc. Thesis. University of Saskatchewan.

1947

Leahey, A. Characteristics of soils adjacent to the Mackenzie River in the Northwest Territories of Canada. Soil Sci. Soc. Amer. Proc. 12: 458-461.

* Willis, A.L. Mineral content of five representative Ontario soils. M. Sc. Thesis. University of Wisconsin.

Willis, A.L., Pennington, R.P. and Jackson, M.L. Mineral standards for quantitative X-ray diffraction analysis of soil clays: 1. Abridgement of component percentage based on weathering sequence. Soil Sci. Soc. Amer. Proc. 12: 400-406.

1948

* Jackson, M.L., Tyler, S.A., Willis, A.L. Bourbeau, G.A. and Pennington, R.P. Weathering

sequence of clay-size minerals in soils and sediments. J. Phys. Chem. 52: 1237-1260.

1949

* Warder, F.G. The nature of clay minerals in some Saskatchewan soils. M.Sc. Thesis. University of Saskatchewan.

* Willis, A.L. Clay minerals present in eight representative Ontario soils. Ph.D. Thesis. University of Wisconsin.

1951

Rice, H.M. and Atkinson, H.J. Soil mineralogy: II. Preliminary results in mineralogical investigation of Canadian soils. Chem. Can. 3: 38-40.

1952

* Warder, F.G. and Dion, H.G. The nature of the clay minerals in some Saskatchewan soils. Sci. Agric. 32:535-547.

1953

Atkinson, H.J., Giles, G.R. and MacLean, A.J. The physical and chemical composition of soils from Carleton and Grenville counties in Ontario. Can. J. Agric. Sci. 33: 116-124.

Brady, J.G., Humphrys, J.M. and Eager, R.L. Differential thermal analysis of some Saskatchewan clays. J. Can. Ceram. Soc. 22: 7-28.

Lambe, T.W. and Martin, R.T. Composition and engineering properties of soil. Highway Research Board. Proc. 32 Annual Meeting. pp. 576-590.

* Webber, L.R. and Shivas, J.A. The identification of clay minerals in some Ontario soils. 1. Parent materials. Soil Sci. Soc. Proc. Amer. 17: 96-99.

1955

Ehrlich, W.A. and Rice, H.M. Postglacial weathering of Mankato till in Manitoba. J. Geol. 63: 527-537.

* Ehrlich, W.A. and Rice, H.M. and Ellis, J.H. Influence of the composition of parent materials on soil formation in Manitoba. Can. J. Agric. Sci. 35: 407-421.

Lambe, T.W. and Martin, R.T. Composition and engineering properties of soil (IV). Highway Research Board. Proc. 34th Annual Meeting. pp. 661-677. Penner, E. Compositional analysis of Leda Clay. NRC Division of Building. DBR Report No. 75.

1956

* Reeder, S.W. Mineralogy of the sand and clay fractions of two New Brunswick Podzols. The Queen's series. M.Sc. Thesis. McGill University.

1957

Dreimanis, A., Realvely, G.H., Cook, R.J.B., Knox, K.S. and Moretti, F.J. Heavy mineral studies in tills of Ontario and adjacent areas. J. Sediment. Petrol. 27: 148-161.

1958

* Brydon, J.E. Mineralogical analysis of the soils of the Maritime Provinces. Can. J. Soil Sci. 38: 155-160

Brydon, J.E. and Heystek, H. A mineralogical and chemical study of the dikeland soils of Nova Scotia. Can. J. Soil Sci. 38: 171-186.

Millette, J.F.G. and Higbee, H.W. Periglacial loesses. I. Morphological properties. Amer. J. Sci. 256: 284-293.

1959

* Brydon, J.E and Sowden. F.J. A study of the clay-humus complexes of a Chernozemic and a Podzol soil. Can. J. Soil Sci. 39: 136-143.

Byrne, P.J.S. and Farvolden, R.N. The clay mineralogy and chemistry of the Bearpaw formation of southern Alberta. Res. Council Alberta (Can.) Geol. Div. Bull. 4: 1-44.

Christiansen, E.A. Glacial geology of the Swift Current area Saskatchewan. Department of Mineral Resources, Regina, Saskatchewan. Rep. no. 32.

Dell, Carol I. A study of the mineralogical composition of sand in southern Ontario. Can. J. Soil Sci. 39: 185-196.

Forman, S.A. and Rice, H.M. A mineralogical study of some core samples from the Bearpaw formation. Can. J. Soil Sci. 39: 178-184.

* Rice, H.M., Forman, S.A. and Patry, L.M. A study of some profiles from major soil zones in Saskatchewan and Alberta. Can. J. Soil Sci. 39: 165-177.

* Theisen, A.A., Webster, G.R. and Harward, M.E. The occurrence of chlorite and vermiculite in the clay fraction of three British Columbia soils. Can. J. Soil Sci. 39: 244-251.

* Wright, J.R. Leahey, A. and Rice, H.M. Chemical morphological and mineralogical characteristics of a chromosequence of soils on alluvial deposits in the northwest territories Can. J. Soil Sci. 39: 32-43.

1960

Allen, V.T. and Johns, W.D. Clays and clay minerals of New England and eastern Canada. Bull. Geol. Soc. Amer. 71: 75-86.

* Lutwick, L.E. The nature and distribution of free iron in the Grey Wooded soils of Saskatchewan. Ph.D. Thesis. University of Saskatchewan.

* Mathieu, A.L. The mineralogy of the clay fraction in relation to the genesis of solodized solonetz soils. Ph.D. Thesis. University of Saskatchewan.

* Pawluk, S. (a) Some Podzol soil of Alberta. Can. J. Soil Sci. 40: 1-14.

* Pawluk, S. (b) Characteristics of Gray Wooded soils developed from glacial till deposits in the Peace River district and north central regions of Alberta. Trans. 7th Int. Congr. Soil Sci. (Madison) 4: 315-322.

Sadler, A. G. The mineral constitution of Queenston shale. J. Can. Ceram. Soc. 29: 7-22.

1961

Ahmad, N. (a) Stony marine clays of the (Lower) Fraser Valley, British Columbia. I.

Description and physical characteristics of the deposits. Soil Sci. 91: 257-261.

Ahmad, N. (b) Stony marine clays of the (Lower) Fraser Valley, British Columbia. 2. Chemical characteristics of the deposits. Soil Sci. 91: 328331.

Brady, J.G. Nature and properties of some western Canadian clays. J. Can. Ceram. Soc. 30: 72-86.

* Brydon, J.E., Clark, J.S. and Osborne, V. Dioctahedral chlorite. Can. Mineral. 6: 595-609.

* Brydon, J.E. and Patry, L.M. Mineralogy of Champlain sea sediments and a Rideau clay soil profile. Can. J. Soil Sci. 41: 169-181.

* Clark, J.S., Gobin, C.A. and Sprout, P.N. Yellow mottles in some poorly drained soils of the lower Fraser Valley, British Columbia. Can. J. Soil Sci. 41: 218-227.

Forman, S.A. and Brydon, J.E. Clay mineralogy of Canadian soils. Pages 140-146 in Soils in Canada. R. Soc. Can. Spec. Publ. No. 3. University of Toronto Press, Toronto, Ont.

* Pawluk, S. Mineralogical composition of some Grey Wooded soils developed from glacial till. Can. J. Soil Sci. 41: 228-240.

* Reeder, S.W., Dion, H.G. and McAllister, A.L. Mineralogy of the Queens loam and Queens clay loam soils of eastern New Brunswick. Can. J. Soil Sci. 41: 147-159.

1962

Bayrock, L.A. Heavy minerals in till of central Alberta. J. Alta Soc. Petroleum Geologists. 10: 171-184.

Brady, J.G. The effects of the mineralogical composition of Whitemud formation clays on their utilization. Mines Branch Res. Rep. R 99.

* Clark, J.S., Brydon, J.E. and Hortie, H.J. The clay minerals in some British Columbia subsoils. Can. J. Soil Sci. 42: 296-301.

Sadler, A.G. The mineral constitution of some Ordovician shales of eastern and southern Ontario. Mines Branch Res. Rep. R 94.

Venkataraman, S. Quartz as an index mineral in pedogenic studies. M.Sc. Thesis. University of Saskatchewan.

1963

Bannatyne, B.B. Cretaceous bentonite deposits of Manitoba. Department of Mines and Natural Resources. Publ. 62-5. 44 pp.

Brady, J.G. and Dean, R.S. Ceramic clays and shales of British Columbia. J. Can. Ceram. Soc. 32: 46-70.

Campbell, F.A. and Lerbekmo, J.F. Mineralogic and chemical variations between Upper Cretaceous continental Belly river shales and marine Wapiabi shales in western Alberta, Canada. Sedimentology 2: 215-226.

* Clark, J.S. and Brydon, J.E. Characteristics and genesis of concretionary Brown soils of British Columbia. Soil Sci. 96: 410-417.

* Clark, J.S., Brydon, J.E. and Farstad, L. Chemical and clay mineralogical properties of the concretionary Brown soils of British Columbia, Canada. Soil Sci. 95: 344-352.

Dell, Carol 1. A study of the mineralogical composition of sand in northern Ontario. Can. J. Soil Sci. 43: 189-200.

Lerbekmo, J.F. Petrology of the Belly River formation, southern Alberta foothills. Sedimentology 2: 54-86.

* MacKenzie, A.F. and Campbell, C.A. The influence of metastable triple point solution of monocalcium phosphate monohydrate upon the clay separates of two Ontario soils. Can. J. Soil Sci. 43: 260-267.

* MacLean, A.J. and Brydon, J.E. Release and fixation of potassium in different size fractions of some Canadian soils as related to their mineralogy. Can. J. Soil Sci. 43: 123-134.

* Pawluk, S. Characteristics of 14 Å clay minerals in the B horizons of podzolized soils of Alberta. Clays Clay Minerals 11: 74-83.

* St. Arnaud, R.J. and Mortland, M.M. Characteristics of the clay fractions in a Chernozemic

to Podzol sequence of soil profiles in Saskatchewan. Can. J. Soil Sci. 43: 336-349.

1964

* Arshad, M.A. Characteristics of Solonetzic soils. Ph.D. Thesis. University of Alberta.

* Brydon, J.E. A reappraisal of the mixed-layer clay minerals in the marine clays near Alberni, B.C. Can. Mineral. 8: 111-113.

* Clark, J.S. and Green, A.J. Some characteristics of Gray soils of low base saturation from northeastern British Columbia. Can. J. Soil Sci. 44: 319-328.

* Day, J.H. and Rice, H.M. The characteristics of some permafrost soils in the MacKenzie Valley, N.W.T. Arctic 17: 222-236.

* Lavkulich, L.M., Pawluk, S. and Odynsky, W. Soil profile development in some Peace River soils. Can. J. Soil Sci. 44: 188-195.

* Pawluk, S. and Lindsay, J.D. Characteristics and genesis of Brunisolic soils of northern Alberta. Can. J. Soil Sci. 44: 292-303.

* Tedrow, J.C.F. and Douglas, L.A. Soil investigations on Banks Island. Soil Sci. 97: 53-65.

1965

Brady, J.G. and Dean, R.S. The composition and properties of ceramic clays and shales of Ontario. Report MP I 65-8. for Can. Ceram. Soc. Meeting.

* Brydon, J.E. Clay illuviation in some Orthic Podzols of eastern Canada. Can. J. Soil Sci. 45: 127-138.

Gardiner, R.T. Mineralogical and chemical composition of some prairie clays. A literature review. Tech. Pap. No. 201. Div. Building Research. National Research Council of Canada, Ottawa, Ont.

* Kodama, H. and Brydon, J.E. Interstratified montmorillonite-mica from subsoils of the Prairie provinces, Western Canada. Clays Clay Mineral. 13: 151-173.

Maiklem, W.R. and Campbell, F.A. A study of the clays from upper Cretaceous bentonites and shales in Alberta. Can. Mineral. 8: 354-371.

* McKeague, J.A. (a) Relationship of water table and Eh to properties of three clay soils in the Ottawa Valley. Can. J. Soil Sci. 45: 49-62.

* McKeague, J.A. (b) Properties and genesis of three members of the uplands catena. Can. J. Soil Sci. 45: 63-77.

Quigley, R.M. Soil mineralogy, Winnipeg swelling clays. Can. Geotech. J. 2: 120-122.

Soderman, L.G. and Quigley, R.M. Geotechnical properties of three Ontario clays. Can. Geotech. J. 2: 176-189.

1966

Alexiades, C.A. and Jackson, M.L. Quantitative clay mineralogical analysis of soils and sediments. Clays Clay Mineral. 14: 35-52.

* Arshad, M.A. and Pawluk, S. (a) Characteristics of some Solonetzic soils in the glacial Lake Edmonton basin of Alberta, Canada. 1. Physical and chemical characteristics. J. Soil Sci. 17: 36-47.

Arshad, M.A. and Pawluk, S. (b) Characteristics of some Solonetzic soils in glacial Lake Edmonton basin of Alberta, II. Mineralogy. J. Soil Sci. 17: 48-55.

Barnett, D.E. and Abbott, D. The evaluation of possible ceramic materials from New Brunswick. New Brunswick Research Productivity Council. Res. Note 6.

Brady, J.G. and Dean, R.S. Ceramic clays and shales of Ontario. EMR. Res. Rep. R 175.

Brady, J.G. and Dean, R.S. The composition and properties of ceramic clays and shales of Quebec. EMR Res. Rep. R 187.

* Coen, G.M., Pawluk, S. and Odynsky, W. The origin of bands in sandy soils of the stony plain area. Can. J. Soil Sci. 46: 245-254.

* Floate, M.J.S. A chemical, physical and mineralogical study of soils developed on glacial

lacustrine clays in north central British Columbia. Can. J. Soil Sci. 46: 227-236.

* Mackintosh, E. E. and Gardner, E.H. A mineralogical and chemical study of lower Fraser river alluvial sediments. Can. J. Soil Sci. 46: 37-46.

McKeague, J.A. and Day, J.H. Dithionite- and oxalate-extractable Fe and A1 as aids in differentiating various classes of soils. Can. J. Soil Sci. 46: 13-22.

Quigley, R.M. and Dreimanis, A. Secondary aragonite in a soil profile. Earth Planet. Sci. Lett. 1: 348-350.

Quigley, R.M. and Thompson, C.D. The fabric of anisotropically consolidated sensitive marine clay. Can. Geotech. J. 3: 61-73.

1967

Dean, R.S. Mineralogical examination of sandstone and siltstone, Thelon formation (Proterozoic), Northwest territories. Mines Branch Investigation Report. IR 67-28.

Guillet, G.R. The Clay products industry of Ontario. Industrial Mineral Report 22. Ontario Department of Mines, Toronto, Ont. 206 pp.

* McKeague, J.A., Bourbeau, G.A. and Cann, D. B. Properties and genesis of a bisequa soil from Cape Breton Island. Can. J. Soil Sci. 47: 101-110.

* McKeague, J.A., Schnitzer, M. and Heringa, P. K. Properties of an iron pan humic Podzol from Newfoundland. Can. J. Soil Sci. 47: 23-32.

* Quigley, R.M. Research report on soil mineralogy in Winnipeg and Tuxedo, Manitoba. Soil Engineering Division. Res. Rep. SM-1-67, University of Western Ontario.

Smith, D.G.W. The petrology and mineralogy of some lower Devonian bentonites from Gaspe, P.Q. Can. Mineral. 9: 141-165.

* Yatsu, E. Some problems on mass movements. Geografiska Annaler. 49A: 396-401.

1968

* Brydon, J.E., Kodama, H. and Ross, G.J. Mineralogy and weathering of the clay in Orthic Podzols and other podzolic soils in Canada. Trans. 9th Int. Congr. Soil Sci. (Adelaide, 1968) III: 41-51.

Christiansen, E.A. Pleistocene stratigraphy of the Saskatoon area, Saskatchewan, Canada. Can. J. Earth Sci. 5: 1167-1173.

* Kodama, H. and Brydon, J.E. A study of clay minerals in Podzol soils in New Brunswick, eastern Canada. Clay Mineral. 7: 295-309.

Ledoux, R. Étude de la composition minéralogique et de l'altération de minéraux dans un profil de sol de la série des sables St. Jude compté de St-Hyacinthe. Nat. Can. 95 1301-1326.

* Pawluk, S., Peters, T.W. and Carson, J. Soils of the Porcupine Hills region of Alberta. Can. J. Soil Sci. 48: 77-88.

Quigley, R.M. Discussion: Landslide on the Toulnustouc river, Quebec by R.J. Conlon. Vol. III, no. 3. pp 113-144. Can. Geotech. J. 5.

1969

Byers, P.N. Mineralogy and origin of the upper Eastend and Whitemud formations of south central and southwestern Saskatchewan and southeastern Alberta. Can. J. Earth Sci. 6: 317-334.

Dean, R.S. Mineralogical examination of two clays from the Musquodoboit River Valley, Nova Scotia. Mines Branch Investigation Report. pp. 69-70.

* Dudas, M.J. and Pawluk, S. Chernozem soils of the Alberta Parklands. Geoderma 3: 19-36.

* Gillespie, J.E. and Protz, R. Evidence for the residual character of two soils, one on granite, the other on limestone in Peterborough County. Can. J. Earth Sci. 6: 1217-1225.

* Huang, P.M. and Lee, S.Y. Effect of drainage on weathering transformations of mineral

colloids of some Canadian prairie soils. Proc. Int. Clay Conf. (Tokyo, 1969) 1: 541-551.

* Lee, P.K. A study of the engineering properties of Waterloo county surficial soils. M. Appl. Sci. Dep. Civil Eng. University of Waterloo.

MacDougall, J.D. and Harriss, R.C. The geochemistry of an Arctic watershed. Can. J. Earth Sci. 6: 305-315.

Pawluk, S. and Bayrock, L.A. Some characteristics and physical properties of Alberta tills. Res. Counc. Alta. Bull. 26. 72 pp.

Quigley, R.M. Soil mechanics research problems caused by aluminum and iron adsorption on clay minerals. Proc. Int. Clay Conf. (Tokyo) 1: 793-803.

1970

Bayliss, P. and Levinson, A.A. Clay-mineralogy and boron determinations of the shales from the Reindeer Well, MacKenzie river delta, N.W.T. Canada. Bull. Can. Petrol. Geol. 18: 80-83.

Bayliss, P., Levinson, A.A. and Klovan, J.E. Mineralogy of bottom sediments, Hudson Bay, Canada. Can. Petro. Geol. Bull. 18. pp. 469-473.

* DeKimpe, C. Chemical, physical and mineralogical properties of a podzol soil with fragipan derived from glacial till in the province of Quebec. Can. J. Soil Sci. 50: 317-330.

Gillot, J.E. Fabric of Leda clay investigated by optical, electron-optical and X-ray diffraction methods. Eng. Geol. 4: 133-153.

* McKeague, J.A. and Brydon, J.E. Mineralogical properties of ten reddish Brown soils from the Atlantic provinces in relation to parent materials and pedogenesis. Can. J. Soil Sci. 50: 47-55.

* Pettapiece, W.W. Pedological investigations in the Front Ranges of the Rocky Mountains along the North Saskatchewan River Valley. Ph.D. Thesis (University of Alberta).

Quigley, R.M. and Vogan, R.W. Black shale heaving at Ottawa, Canada. Can. J. Earth Sci.

7: 106-112.

Rostad, H.P.W. and St. Arnaud, R.J. Nature of carbonate minerals in two Saskatchewan soils. Can. J. Soil Sci. 50: 65-70.

Rutherford, G.K. and Sullivan, D.K. Properties and geomorphic relationships of soils developed on a quartzite ridge near Kingston, Ont. Can. J. Soil Sci. 50: 419-429.

Tank, R.W. and McNeely, L. Clay minerals associated with the Precambrian Gowganda formation of Ontario. Clay Min. 8: 471-477.

* Vaguers, V.J. Mineral distribution in tills in central and southern Ontario. Ph.D. Thesis. University of Western Ontario.

1971

* Beke, G.J. and Pawluk, S. Pedogenic significance of volcanic ash layers in the soils of an East slopes (Alberta) Watershed basin. Can. J. Earth Sci. 8: 664-675.

Beke, G.J. and Zwarich, M.A. Chemical and mineralogical characteristics of cutans from B horizons of three Manitoba soils. Can. J. Soil Sci. 51: 221-228.

Dean, R.S. Clay mineralogy of a sample of sylvite ore from the Duval Corporation mine, Saskatoon, Saskatchewan. Mines Br. Investig. Rep. IR 71-19. Gillot, J.E. Mineralogy of Leda clay. Can. Mineral. 10: 797-811.

* Lavkulich, L.M., Bhoojedhur, S. and Rowles, C.A. Soils with Placic horizons on the west coast of Vancouver Island, British Columbia. Can. J. Soil Sci. 51: 439-448.

* MacLean, A.J. and Brydon, J.E. Fixation and release of potassium in relation to the mineralogy of the clay fraction of some selected soil horizon samples. Can. J. Soil Sci. 51: 449-459.

McKeague, J.A., Brydon, J.E. and Miles, N.M. Differentiation of forms of extractable iron and aluminum in soils. Soil Sci. Soc. Amer. Proc. 35: 33-38.

* McKeague, J.A., Nowland, J.L., Brydon, J.A. and Miles, N.M. Characterization and classification of five soils from eastern Canada having prominently mottled B horizons.

Can. J. Soil Sci. 51:483-497.

* Pawluk, S. Characteristics of fera eluviated Gleysols developed from acid shales in northwestern Alberta. Can. J. Soil Sci. 51: 113-124.

Quigley, R.M., Matich, M.A.J., Horvath, R.G. and Hawson, H.H. Swelling clay in two slope failures at Toronto, Canada. Can. Geotech. J. 8: 417-424.

* Rutherford, G.K. The properties, genesis and geomorphological relationships of a sequence of soils on a limestone plain in southeast Ontario, Canada. Geoderma 5: 179-196.

Somasiri, S., Lee, S.Y. and Huang, P.M. Influence of certain pedogenic factors on potassium reserves of selected Canadian prairie soils. Soil Sci. Soc. Amer. Proc. 35: 500-505.

Somarisi, S. and Huang, P.M. The nature of K-feldspars of a Chernozemic soil in the Canadian Prairies. Soil Sci. Soc. Amer. Proc. 35: 810-815.

Sudom, M.D. and St. Arnaud, R.J. Use of quartz, zirconium and titanium as indices in pedological studies. Can. J. Soil Sci. 51: 385-396.

Zwarich, M.A. and Mills, J.G. An evaluation of three methods for the quantitative determination of calcite and dolomite in soils and geological sediments. Can. J. Earth Sci. 8: 967-972.

1972

* Bourgeois, W.W. and Lavkulich, L.M. A study of forest soils and leachates on sloping topography using a tension lysimeter. Can. J. Soil Sci. 52: 375391.

* Brydon, J.E. and Shimoda, S. Allophane and other amorphous constituents in a Podzol from Nova Scotia. Can. J. Soil Sci. 52: 465-475.

* DeKimpe, C.R., Baril, R.W. and Rivard, R. Characterization of a toposequence with fragipan: The Leeds-Ste. Marie-Brompton series of soils, Province of Quebec. Can. J. Soil Sci. 52: 135-150.

* McKeague, J.A., Day, J.H. and Clayton, J.S. Properties and development of hydromorphic mineral soils in various regions of Canada. Trans. of Commissions V and VI of the Int.

Soc. Soil Sci. Pseudogley and Gley. pp. 207-218 (1972) Verlag Chemie, GimbH, Weinheim/Bergstr.

* McKeague, J.A., Miles, N.M., Peters, T.W. and Hoffman, D.W. A comparison of Luvisolic soils from three regions in Canada. Geoderma 7: 49-69.

Mills, J.G. and Zwarich, M.A. Recognition of interstratified clays. Clays Clay Mineral. 29: 169-174.

* Pawluk, S. Measurement of crystalline and amorphous iron removal in soils. Can. J. Soil Sci. 52: 119-123.

* Pettapiece, W.W. and Pawluk, S. Clay mineralogy of soils developed partially from volcanic ash. Soil Sci. Soc. Amer. Proc. 36: 616-619.

Quigley, R.M. and Dreimanis, A. Weathered interstadial green clay at Port Talbot, Ontario. Can. J. Earth Sci. 9: 991-1000.

Rutherford, G.K. The clay mineralogy and some properties of bottom sediments of the St. Lawrence River near Kingston, Ontario. Can. J. Earth Sci. 9: 1670-1676.

* Sneddon, J.I., Lavkulich, L.M. and Farstad, L. (a) The morphology and genesis of some Alpine soils in British Columbia, Canada. 1. Morphology, classification and genesis. Soil Sci. Soc. Amer. Proc. 36: 100-104.

* Sneddon, J.I., Lavkulich, L.M. and Farstad, L. (b) The morphology and genesis of some Alpine soils in British Columbia, Canada. II. Physical, chemical and mineralogical determination and genesis. Soil Sci. Soc. Amer. Proc. 36: 104-110.

1973

* Laflamme, G., Baril, R. and DeKimpe, C.R. Caractérisation d'un Podzol Humo-ferrique, Luvisolique, et lithique à Esprit-Saint, Compte de Rimouski, Québec. Can. J. Soil Sci. 53: 145-154.

* Laverdière, M.R. and Cescas, M.P. Some characteristics of La Pocatière and St. Pascal soils developed on marine sediments in Quebec. Can. J. Soil Sci. 53: 155-162.

* McKeague, J.A., MacDougall, J.I. and Miles, N.M. Micromorphological, physical, chemical and mineralogical properties of a catena of soils from Prince Edward Island in relation to their classification and genesis. Can. J. Soil Sci. 53: 281-295.

* Pawluk, S. and Dumanski, J. Ferruginous concretions in a poorly drained soil of Alberta. Soil Sci. Soc. Amer. Proc. 37: 124-127.

Scafe, D.W. Bentonite characteristics from deposits near Rosalind, Alberta, Clays Clay Mineral. 21: 437-449.

* Somasiri, S. and Huang, P.M. The nature of K-feldspars of selected soils in the Canadian prairies. Soil Sci. Soc. Amer. Proc. 37: 461-464.

1974

* DeKimpe, C.A. and McKeague, J.A. Micromorphological, physical and chemical properties of a Podzol soil with a fragipan. Can. J. Soil Sci. 54: 29-38.

* DeKimpe, C.R., McKeague, J.A. and Topp, G. C. Soil properties in relation to water regime at a site near Quebec City. Can. J. Soil Sci. 54: 427-446.

Foscolos, A.E. and Kodama, H. Diagenesis of clay minerals from Lower Cretaceous shale of northeastern British Columbia. Clays Clay Mineral. 22: 319-335.

* Madden, J. Clay mineralogy and heavy metals in soils and geological sediments of Manitoba. Proc. 18th Annual Meeting of Soil Science Society of Manitoba. pp. 27-41.

* Pettapiece, W.W. A hummocky permafrost soil from the subarctic of northwestern Canada and some influence of fire. Can. J. Soil Sci. 54: 343-355.

* Twardy, A.G., Pawluk, S. and Lindsay, J.D. Comparative study of four tills in west-central Alberta. Can. J. Soil Sci. 54: 69-80.

* Wang, C., Nowland, J.L. and Kodama, H. Properties of two fragipan soils in Nova Scotia including scanning electron micrographs. Can. J. Soil Sci. 54: 159-170.

1975

* Brewer, R. and Pawluk, S. Investigations of some soils developed in hummocks of the Canadian sub-arctic and southern-arctic regions. 1. Morphology and micromorphology. Can. J. Soil Sci. 55: 301-319.

Dean, R.S. Mineralogy of the ceramic clays and shales of the Atlantic provinces. CANMET. Scientific Bulletin CM 75-8.

Foscolos, A.E. and Stott, D.F. Degree of diagenesis, stratigraphic correlations and potential sediment sources of Lower Cretaceous shale of northeastern British Columbia. Geol. Surv. Canada Bull. 250. 46 pp.

* McKeague, J.A. and Sprout, P.N. Cemented subsoils (Duric horizons) in some soils of British Columbia. Can. J. Soil Sci. 55: 189-203.

* Mutwewingabo, B., DeKimpe, C.R., Bourbeau, G.A., Baril, R. W. and Lajoie, P. Etude comparative de sols des Laurentides, Quebec. Can. J. Soil Sci. 55: 363-379.

* Pawluk, S. and Brewer, R. (a) Investigation of some soils developed in hummocks of the Canadian sub-arctic and southern-arctic regions. 2. Analytical characteristics, genesis and classification. Can. J. Soil Sci. 55: 321-30.

* Pawluk, S. and Brewer, R. (b) Micromorphological and analytical characteristics of some soils from Devon and King Christian Islands, N.W.T. Can. J. Soil Sci. 55: 349-361.

* Pawluk, S. and Brewer, R. (c) Micromorphological, mineralogical and chemical characteristics of some Alpine soils and their genetic implications. Can. J. Soil Sci. 55: 415-437.

* Yong, R.N. and Warkentin, B.P. Soil Properties and Behaviour Developments in Geotechnical Engineering 5. Elsevier Scientific Publishing Co. New York. 449 pp.

1976

* Brunelle, A., Pawluk, S. and Peters, T.W. Evaluation of profile development of some Solonetzic soils of south central Alberta. Can. J. Soil Sci. 56: 149-58.

* DeKimpe, C.R. Influence of parent material and moisture regime on soil genesis in the Appalachian highlands, Quebec. Can. J. Soil Sci. 56: 271-283.

Kodama, H., Miles, N.M., Shimoda, S. and Brydon, J.E. Mixed-layer kaolinite-montmorillonite from soils near Dawson, Yukon Territory. Can. Mineral. 14: 159-163.

1977

Clayton, J.S., Ehrlich, W.A., Cann, D.B., Day, J.H. and Marshall, I.B. Soils of Canada, Canada Department of Agriculture, Research Branch, Soil Research Institute - Canada Soil Survey Committee.2 volumes with a Glossary and a map.

Guillet, G.R. Clay and shale deposits of Ontario. Ontario Geological Survey. Mineral Deposits Circular. MDS 15. 117 pp.

* Kodama, H., McKeague, J.A., Tremblay, R.J., Gosselin, J.R. and Townsend, M.G. Characterization of iron oxide compounds in soils by Mössbauer and other methods. Can. J. Earth Sci. 14: 1-15.

Kodama, H., Scott, G.C. and Miles, N.M. X-ray quantitative analysis of minerals in soils. Soil Research Institute, Agriculture Canada. Special publication. 49 pp. Can. J. Earth Sci. 14: 1-15.

* Laverdière, M.R., Weaver, R.M. and D'Avignon, A. Characteristics of the mineral constituents of some Albic and Spodic horizons as related to their charge properties. Can. J. Soil Sci. 57: 349-359.

Madden, J. The clay mineralogy of some northern Manitoba soil parent material. Manitoba Soil Science Meetings. 30-37.

Nicholson, H. Margaret and Moore, T.R. Pedogenesis in a subarctic iron-rich environment: Schefferville, Quebec. Can. J. Soil Sci. 57: 35-45.

Piper, D.J.W. and Slatt, R.M. Late Quarternary clay-mineral distribution on the eastern continental margin of Canada. Geol. Soc. Amer. Bull. 88:267-272.

* Acton, C.J., Beke, G.J., Day, J.H., MacDougall, J.I. and Marcoux, R. Guidebook for a soil and land use tour of eastern Canada. Tours 1 and 10, 129-131. 11th Congress ISSS (International Society of Soil Science) D.F. Acton and L.S. Crosson (Guidebook Eds.)

* Crown, P.H. and Greenlee, G.M. Guidebook for a soils and land use tour in the Edmonton region, Alberta. Tours E1, E2 and E3. 11th Congress ISSS. D.F. Acton and L.S. Crosson (Guidebook Eds.).

* Greenlee, G.M. Guidebook for a tour of the Athabasca oil sands mining, soils, and land reclamation in the boreal forest region of northeastern Alberta. Tours 9 and 17. 11th Congress ISSS. D.F. Acton and L.S. Crosson (Guidebook Eds.).

* Kjearsgaard, A.A. and Macyk, T.M. Guidebook for a soils and land use tour in the plains, foothills, and mountain regions of Alberta from Edmonton to Red Deer and Jasper. Tours 6 and 14. 11th Congress ISSS. D.F. Acton and L.S. Crosson (Guidebook Eds.).

* Knapik, L.J. and Coen, G.M. Guidebook for a soils and land use tour in Banff and Jasper National Parks. Tours 8 and 16. 11th Congress ISSS. D.F. Acton and L.S. Crosson (Guidebook Eds.).

* Macyk, T.M., Ellis, J.G., Michalyna, W. and Smith, R.E. Guidebook for a tour across the southern portion of the interior plains of western Canada from Edmonton, Alberta to Winnipeg, Manitoba. Tour 11. 11th Congress ISSS. D.F. Acton and L.S. Crosson. (Guidebook Eds.).

* Parfitt, R.L. Anion adsorption by soils and soil materials. Adv. Agron. 30, 150.

* Peters, T.W., Shields, J.A. and Ellis, J.G. Guidebook for a tour to observe soil landscape and cropping systems in central and southern Alberta and southwestern Saskatchewan. Tours 5 and 13. 11th Congress ISSS. D.F. Acton and L.S. Crosson. (Guidebook Eds.).

Pettapiece, W.W., Tarnocai, C., Zoltai, S.C. and Oswald, E.T. Guidebook for a tour of soil, permafrost and vegetation relationships in the Yukon and Northwest territories of northwestern Canada. Tour 18. 117-158. 11th Congress ISSS. D.F. Acton and L.S. Crosson. (Guidebook Eds.).

* Sowden, F.J., MacLean, A.A. and Ross, G.J. Native clay-fixed ammonium content, and the fixation of added ammonium of some soils of eastern Canada. Can. J. Soil Sci. 58, 27-38.

1979

* DeKimpe, C.R., Laverdiere, M.R. and Martel, Y.A. Surface area and exchange capacity of clay in relation to the mineralogical composition of gleysolic soils. Can. J. Soil Sci. 59, 341-347.

* Evans, L.J. and Cameron, B.H. A chronosequence of soils developed from granitic morainal material, Baffin Island, N.W.T. Can. J. Soil Sci. 59, 203-210.

1980

* Ross, G.J. Mineralogical, physical and chemical characteristics of amorphous constituents in some podzolic soils from British Columbia. Can. J. Soil Sci. 60, 31-43.

1981

* Smith, C.A.S., Coen, G.M. and Pluth, D.J. Podzolic soils with Luvisolic-like morphologies in the upper subalpine subzone of the Canadian Rockies 2. Genesis. Can. J. Soil Sci. 61, 337-350.

1982

* Pawluk, S. and Dudas, M.J. Pedological investigation of a Gray Luvisol. Can. J. Soil Sci. 62, 49-60.

* Ross, G.J., Wang, C., Ozkan, A.I. and Rees, H.W. Weathering of chlorite and mica in a New Brunswick Podzol developed on till derived from chlorite-mica schist. Geoderma 27, 255-267.

1983

* Doran, D.R. and Evans, L.J. Native fixed ammonium and fixation of added ammonium in relation to clay mineralogy in some Ontario soils. Can. J. Soil Sci. 63, 631-639.

* Evans, L.J. and Cameron, B.H. The Brookston series in southwestern Ontario. Characteristics, classification and problems in defining a soil series. Can. J. Soil Sci. 63, 339-352.

1984

* Al-Kanani, T., Ross, G.J. and Mackenzie, A.F. Mineralogy of surface soil samples of some Quebec soils with reference to K status. Can. J. Soil Sci. 64, 107-113.

* Protz, R., Ross, G.J., Martini, I.P. and Terasmae, J. Rate of Podzolic soil formation near Hudson's Bay, Ontario. Can. J. Soil Sci. 64, 31-49.

* Ross, G.J. and Cline, R.A. Potassium exchange characteristics in relation to mineralogical properties and potassium uptake by grapes of selected soils in the Niagara Peninsula of southern Ontario. Can. J. Soil Sci. 64, 87-98.

* Spiers, G.A., Pawluk, S. and Dudas, M.J. Authigenic mineral formation by solodization. Can. J. Soil Sci. 64, 515-532.

1985

* Protz, R., Ross, G.J. and Shipitalo, M.J. The influence of texture on clay weathering and soil formation in mid-northern Ontario. Appl. Clay Sci. 1, 43-55.

* Ross, G.J., Hoyt, P.B. and Neilsen, G.H. Soil Chemical and mineralogical changes due to acidification in Okanagan apple orchards. Can. J. Soil Sci. 65, 347-355.

* Ross, G.J., Phillips, P.A. and Culley, J.L.R. Transformation of vermiculite to pedogenic mica by fixation of potassium and ammonium in a six-year field manure application experiment. Can. J. Soil Sci. 65, 599-603.

* Spiers, G.A., Dudas, M.J., Muehlenbachs, K. and Pawluk, S. Isotopic evidence for clay mineral weathering and authigenesis in cryoboralfs. Soil Sci. Soc. Am. J. 49, 467-474.

1986

* Wang, C., Stea, R.R., Ross, G.J. and Holmstrom, D. Age estimation of the Shulie Lake and Eatonville tills in Nova Scotia by pedogenic development. Can. J. Earth Sci. 23,

115-119.

1987

* Ross, G.J., Eilers, R.G. and Ivarson, K.C. Influence of acid sulfate weathering on chemical and mineralogical properties of an acid sulfate soil of Manitoba. Can.J. Soil Sci. 68, 629-644.

* Ross, G.J., Wang, C. and Hill, R.G. Mineralogical variability of the clay in a map delineation of Brandon soil. Can. J. Soil Sci. 67, 83-93.

1988

* Protz, R., Ross, G.J., Shipitalo, M.J. and Terasmae, J. Podzolic soil development in the southern James Bay Lowlands, Ontario. Can. J. Soil Sci. 68, 287-305.

1990

* Kimble, J., Eswaran, H. and Cook, T. Spodosols transitions with other soils. Proc. of 5th International Soil Correlation Meeting (ISCOM). Characterization, classification and utilization of Spodosols. J.M. Kimble and R.D. Yeck (Eds.) Soil Conservation Service USDA. 171-180.

1991

* Ross, G.J., Wang, C. and Kodama, H. Soil surface area: An indicator of soil mineralogical and soil water sorption properties. Agron. Abstracts: 1991 Annual Meetings. Denver, Colorado. p. 367.

1992

* Ross, G.J. and Kodama, H. X-ray diffraction characteristics and related properties of smectites in some Canadian soils. Can. J. Soil Sci. (In press).

ABBREVIATIONS

(For Appendices II, III and IV)

Long.	Longitude
Lat.	Latitude
Polygon No.*	Expressed in combination with symbol for soil classification.
	The first letter and number(e.g.A1, B1, C2, D3 etc.) correspond to respective soil classifications as described in Appendix IV.
Mineral Symbols	See Table 3
M, S, X etc.	
(M, V, Q) etc.	Subordinate minerals are in parenthesis
Symbols for Texture Group	See Table 3
AL	Alberta
BC	British Columbia
MN	Manitoba
NB	New Brunswick
NF	Newfoundland
NS	Nova Scotia
NW	Northwest Territories
ON	Ontario
PE	Prince Edward Island
QU	Quebec
SK	Saskatchewan
YU	Yukon

* Same as used in "Soils of Canada" by Clayton *et al.* (1977).

APPENDIX II

NEWFOUNDLAND

	Long.	Lat.	Soil Classification	Polygon No.
1.	52°20'	47°41'	Humo-Ferric Podzol	D3076
2.	52°33'	47°03'	Humo-Ferric Podzol	D3077

PRINCE EDWARD ISLAND

	Long.	Lat.	Soil Classification	Polygon No.
1.	62°07'	46°29'	Humo-Ferric Podzol	D3062
2.	62°56'	46°30'	Humo-Ferric Podzol	D3054
3.	63°31'	46°30'	Humo-Ferric Podzol	D3065
4.	64°19'	46°55'	Humo-Ferric Podzol	D3061

NOVA SCOTIA

	Long.	Lat.	Soil Classification	Polygon No.
1.	60°03'	46°22'	Humo-Ferric Podzol	D3083
2.	60°31'	45°30'	Gray Luvisol	C2111
3.	62°01'	45°29'	Humo-Ferric Podzol	D3075
4.	62°42'	45°30'	Humo-Ferric Podzol	D3047
5.	62°51'	45°30'	Gray Luvisol	C2117
6.	63°05'	45°21'	Gray Luvisol	C2114
7.	63045'	45°29'	Humo-Ferric Podzol	D3067
8.	63°51'	44°23'	Humo-Ferric Podzol	D3053
9.	64°01'	45°30'	Cumulic Regosol	F2016
10.	64°28'	44°54'	Humo-Ferric Podzol	D3141
11	64°33'	44°53'	Humo-Ferric Podzol	D3146

NEW BRUNSWICK

	Long.	Lat.	Soil Classification	Polygon No.
1.	65°10'	46°31'	Gray Luvisol	C2110
2.	65°13'	45°29'	Humo-Ferric Podzol	D3048
3.	66°08'	47°03'	Humo-Ferric Podzol	D3082
4.	66°38'	46°21'	Humo-Ferric Podzol	D3072
5.	67°00'	47°29'	Humo-Ferric Podzol	D3030
6.	67°22'	46°17'	Humo-Ferric Podzol	D3073
7.	67°37'	48°01'	Humo-Ferric Podzol	D3133
8.	68°06'	48°11'	Humo-Ferric Podzol	D3060

QUEBEC

	Long.	Lat.	Soil Classification	Polygon No.
1.	69°30'	49°50'	Humo-Ferric Podzol	D3126
2.	69°56'	56°39'	Rockland	R1014
3.	70°30'	46°20'	Humo-Ferric Podzol	D3066
4.	71°17'	46°29'	Humo-Ferric Podzol	D3058
5.	71°24'	48°29'	Orthic Gleysol	G2027
6.	71°33'	45°56'	Humo-Ferric Podzol	D3135
7.	72°45'	45°29'	Humic Gleysol	G1004
8.	73°44'	45°34'	Melanic Brunisol	E1012
9.	74°29'	45°09'	Humo-Ferric Podzol	D3007
10.	74°30'	46°15'	Dystric Brunisol	E3068
11.	78°23'	49°20'	Gray Luvisol	C2107

ONTARIO

	Long.	Lat.	Soil Classification	Polygon No.
1.	74°52'	45° 9'	Humic Gleysol	G1003
2.	75°30'	45°29'	Humic Gleysol	G1002
3.	75°42'	44°29'	Melanic Brunisol	E1013
4.	76°19'	44°29'	Melanic Brunisol	E1002
5.	76°21'	45°07'	Melanic Brunisol	E1005
6.	76°56'	44°30'	Melanic Brunisol	E1018
7.	78°20'	44°20'	Gray Brown Luvisol	C1001
8.	78°25'	42°41'	Humic Gleysol	G1005
9.	79°23'	43°30'	Gray Brown Luvisol	C1012
10.	79°29'	42°33'	Gray Brown Luvisol	C1013
11.	79°34'	43°29'	Gray Brown Luvisol	C1009
12.	80°14'	43°01'	Gray Brown Luvisol	C1002
13.	80°21'	44°30'	Gray Brown Luvisol	C1003
14.	80°31'	43°53'	Gray Brown Luvisol	C1008
15.	80°37'	42°45'	Gray Brown Luvisol	C1015
16.	81°02'	43°18'	Gray Brown Luvisol	C1014
17.	81°05'	48°58'	Orthic Gleysol	G2026
18.	81°56'	42°36'	Humic Gleysol	G1007
19.	82°13'	47°42'	Humo-Ferric Podzol	D3149
20.	85°37'	49°30'	Humo-Ferric Podzol	D3017
21.	87°16'	49°29'	Humo-Ferric Podzol	D3018
22.	94°48'	53°40'	Fibrisol	H1026

MANITOBA

	Long.	Lat.	Soil Classification	Polygon No.
1.	94°48'	53°40'	Fibrisol	H1031
2.	95°43'	50°30'	Fibrisol	H1027
3.	95°46'	51°58'	Fibrisol	H1032
4.	96°52'	49°30'	Humic Gleysol	G1014
5.	97°00'	49°51'	Black Chernozemic	A3107
6.	97°42'	51°07'	Dark Gray Chernozemic	A4135
7.	97°44'	51°55'	Gray Luvisol	C2075
8.	98°46'	56°10'	Fibrisol	H1030
9.	99°05'	49°33'	Black Chernozemic	A3072
10.	99°06'	50°57'	Black Chernozemic	A3106
11.	99°17'	49°29'	Black Chernozemic	A3090
12.	100°00'	50°19'	Black Chernozemic	A3087
13.	101°16'	49°46'	Black Chernozemic	A3108
14.	101°43'	49°29'	Black Chernozemic	A3089

SASKATCHEWAN

	Long.	Lat.	Soil Classification	Polygon No.
1.	101°31'	50°29'	Dark Gray Chernozemic	A4125
2.	102°38'	49°29'	Dark Brown Chernozemic	A2049
3.	103°28'	49°29'	Brown Solonetz	B1006
4.	103°40'	51°30'	Black Chernozemic	A3095
5.	104°16'	53°30'	Gray Luvisol	C2055
6.	104°21'	52°50'	Black Chernozemic	A3098
7.	104°39'	50°16'	Dark Brown Chernozemic	A2055
8.	105°15'	52°23'	Black Chernozemic	A3092
9.	105°45'	53°49'	Gray Luvisol	C2071
10.	105°50'	51°26'	Dark Brown Chernozemic	A2039
11.	107°23'	49°29'	Brown Chernozemic	A1018
12.	107°34'	51°30'	Dark Brown Chernozemic	A2044
13.	108°23'	51003'	Brown Chernozemic	A1019
14.	108°24'	52°26'	Dark Brown Chernozemic	A2037
15.	108°28'	50°30'	Brown Chernozemic	A1014
16.	108°52'	51°30'	Brown Solonetz	B1002
17.	109°15'	53°22'	Black Chernozemic	A3113

ALBERTA

	Long.	Lat.	Soil Classification	Polygon No.
1.	110°10'	51°30'	Brown Chernozemic	A1021
2.	110°50'	52°29'	Dark Brown Chernozemic	A2030
3.	110°58'	53°15'	Black Chernozemic	A3083
4.	111°03'	50°59'	Brown Solonetz	B1001
5.	111°06'	56°59'	Fibrisol	H1008
6.	111°18'	49°45'	Brown Chernozemic	A1023
7.	111°22'	56°06'	Fibrisol	H1017
8.	111°32'	52°04'	Brown Solonetz	B1008
9.	112°02'	59°29'	Fibrisol	H1034
10.	112°20'	54°15'	Black Chernozemic	A3070
11.	112°28'	53°30'	Gray Luvisol	C2036
12.	112°42'	52°17'	Black Chernozemic	A3115
13.	112°42'	58°29'	Fibrisol	H1014
14.	112°46'	51°30'	Dark Brown Chernozemic	A2035
15.	112°48'	50°14'	Dark Brown Chernozemic	A2060
16.	113°04'	49°30'	Black Chernozemic	A3079
17.	113°32'	49°49'	Black Chernozemic	A3080
18.	114°23'	57°13'	Fibrisol	H1025
19.	114°36'	52°49'	Gray Luvisol	C2027
20.	116°40'	55°47'	Black Solod	B4022
21.	117°41'	53°42'	Gray Luvisol	C2061
22.	117°58'	56°46'	Orthic Regosol	F1008
23.	118°06'	56°33'	Black Solod	B4020
24.	118°09'	52°59'	Rockland	R1023
25.	118°44'	55°29'	Black Solonetz	B2011
26.	118°48'	55°44'	Black Solod	B4021
27.	118°56'	49°36'	Dark Brown Chernozemic	A2052
28.	119°10'	55°26'	Gray Luvisol	C2051

BRITISH COLUMBIA

	Long.	Lat.	Soil Classification	Polygon No.
1.	118°29'	51°14'	Humo-Ferric Podzol	D3106
2.	118°38'	50°01'	Gray Luvisol	C2100
3.	118°40'	49°30'	Eutric Brunisol	E2033
4.	119°28'	52°36'	Rockland	R1033
5.	120°31'	49°36'	Dystric Brunisol	E3079
6.	120°41'	49°46'	Gray Luvisol	C2102
7.	121°43'	57°16'	Gray Luvisol	C2058
8.	122°02'	49°53'	Rockland	R1036
9.	122°02'	50°14'	Humo-Ferric Podzol	D3114
10.	122°05'	53°43'	Gray Luvisol	C2054
11.	122°35'	49°29'	Humic Gleysol	G1017
12.	122°41'	49°34'	Humo-Ferric Podzol	D3117
13.	123°54'	54°29'	Gray Luvisol	C2053
14.	123°55'	48°50'	Dystric Brunisol	E3066
15.	123°58'	54°19'	Gray Luvisol	C2099
16.	124°13'	54°25'	Gray Luvisol	C2103
17.	124°25'	49°14'	Humo-Ferric Podzol	D3009
18.	125°15'	54°13'	Gray Luvisol	C2060
19.	125°31	49°30'	Humo-Ferric Podzol	D3006
20.	125°31'	49°30'	Humo-Ferric Podzol	D3014
21.	128°19'	54°30'	Dystric Brunisol	E3070

YUKON TERRITORY

	Long.	Lat.	Soil Classification	Polygon No.
1.	136°39'	60°54'	Eutric Brunisol	E2045

NORTHWEST TERRITORIES

	Long.	Lat.	Soil Classification	Polygon No.
1.	71°44'	67°31'	Cryic Orthic Regosol	F3075
2.	87°53'	75°18'	Cryic Orthic Regosol	F3063
3.	99°48'	65°45'	Cryic Orthic Regosol	F3079
4.	101°40'	77°30'	Cryic Orthic Regosol	F3033
5.	116°17'	61°18'	Eutric Brunisol	E2050
6.	121°22'	61°30'	Eutric Brunisol	E2036
7.	122°12'	73°12'	Cryic Orthic Regosol	F3064
8.	123°42'	68°07'	Cryic Orthic Regosol	F3069
9.	129°07'	69°29'	Cryic Orthic Regosol	G3043
10.	130°17'	69°53'	Cryic Orthic Regosol	G3042
11.	134°38'	68°16'	Cryic Orthic Regosol	F3070

APPENDIX III

Clay Mineral Assemblage	Polygon number including coding for soil classification
M,	C1008, C1013, C1014, D3133, D3135, H1008
M, (Ch)	C2117, D3030, D3061, D3066
M, (Ch, K)	D3067, D3072, D3073, D3126, D3141
M, (Ch, V)	C2114
M, (K, Ch)	D3047
M, (K, V)	D3075
M, (Q)	G1005, G2027
M, (S)	C1003, G1002, G2026, H1014, H1025, H1034, R1033
M, (S, K)	D3146
M, (S, Q)	A2044, A3108, E2050
M, (S, V)	G3042, G3043
M, (V)	C1012, F3063, F3075, F3079
M, (V, Am)	A2052
M, (V, K)	D3083
M, (V, Q)	C1009
M, (V, S)	G1007
S,	B2011, C2055, C2071
S, (Ca, M)	C2061
S, (Ch)	D3114
S, (Ch, M)	E3079
S, (M)	A2030, A2049, A3070, A3079, A3080, A3089, A3090, A3092, A3098, A3115, A4125, B1001, B1002, B4021, C2051, F1008
S, (M, Ca)	A2060
S, (M, K)	A3106, B1008
S, (M, Q)	A1018, C2027, C2036
S, (M, V)	B1006, G1014
S, (Q)	A1021, A1023, A2035
S, (Q, M)	H1017
S, (Q, V)	A3083
X, (Ch, M, S)	E2045
X, (Ch, S, Am)	G1017
X, (Ch, V, K)	D3014
X, (F, M, Ch)	C2107

X, (M, Am, Ch)	E2033
X, (M, Am, V)	E2036
X, (M, Ch)	D3018, D3058, D3082
X, (M, Ch, Ca)	R1023
X, (M, Ch, K)	C2110, D3048, D3054, D3062, D3065, R1014
X, (M, Ch, Q)	D3017, D3076, D3149
X, (M, Ch, V)	C2111
X, (M, K)	F3033
X, (M, Q, F)	D3060, E1013
X, (M, S, Ch)	C1002, C2058, E1018, E3068
X, (M, S)	E3070
X, (M, S, Q)	F3064
X, (M, S, V)	G1003, G1004
X, (M, V, K)	D3053, F2016
X, (M, V, S)	E1012
X, (Q, Ca)	A1019
X, (S, Ch)	R1036
X, (S, Ch, M)	C2102
X, (S, Ch, V)	D3009
X, (S, M)	A2037, A2039, A3072, A3087, A3107, A4135, B4020, B4022, F3069, F3070, H1026, H1027, H1030, H1031,H1032
X, (S, M, Ch)	C2100
X, (S, M, K)	C2060
X, (S, M, Q)	A1014, A2055
X, (S, M, V)	C2054
X, (S, V, M)	A3095, C2103, D3106
X, (V, K, M)	C2099
X, (V, M)	C1001, C1015
X, (V, M, Ch)	E1002, E1005

OTHERS

Ch, (M)	D3117
Ch, (V, K)	D3006
Ch, (V, S)	E3066
V, (M)	D3007
V, (M, K)	C2053
Ca, (Q)	A3113

APPENDIX IV

A1 Orthic Brown Chernozemic Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	107°23'	49°29'	SK	S, (M, Q)	/L	A1018
2.	108°23'	51°03'	SK	X, (Q, Ca)	/L	A1019
3.	108°28'	50°30'	SK	X, (S, M, Q)	/C	A1014
4.	110°10'	51°30'	AL	S, (Q)	/L	A1021
5.	111°18'	49°45'	AL	S, (Q)	/L	A1023

A2 Orthic Dark Brown Chernozemic Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	102°38'	49°29'	SK	S, (M)	/L	A2049
2.	104°39'	50°16'	SK	X, (S, M, Q)	/C	A2055
3.	105°50'	51°26'	SK	X, (S, M)	/L	A2039
4.	107°34'	51°30'	SK	M, (S, Q)	/L	A2044
5.	108°24'	52°26	SK	X, (S. M)	/L	A2037
6.	110°50'	52°29'	AL	S, (M)	/L	A2030
7.	112°46'	51°30'	AL	S, (Q)	/C	A2035
8.	112°48'	50°14'	AL	S, (M, Ca)	/L	A2060
9.	118°56'	49°36'	AL	M, (V, Am)	/L	A2052

A3 Black Chernozemic Great Group

	Long.	Lat.	Prov.	Soil Subgroup	Short Mineral Description	Texture	Polygon No.
1	97°00'	49°51'	MN	R. BL*	X, (S, M)	/C	A3107
2	99°05'	49°33'	MN	O. BL**	X, (S, M)	/S	A3072
3	99°06'	50°57'	MN	R. BL	S, (M, K)	/L	A3106
4	99°17'	49°29'	MN	O. BL	S, (M)	/L	A3090
5	100°00'	50°19'	MN	O. BL	X, (S, M)	/L	A3087
6	101°16'	49°46'	MN	R. BL	M, (S, Q)	/L	A3108
7	101°43'	49°29'	MN	O. BL	S, (M)	/L	A3089
8	103°40'	51°30'	SK	O. BL	X, (S, V, M)	/L	A3095
9	104°21'	52°50'	SK	O. BL	S, (M)	/C	A3098
10	105°15'	52°23'	SK	O. BL	S, (M)	/L	A3092
11	109°15'	53°22'	SK	O. BL	Ca, (Q)	/L	A3113
12	110°58'	53°15'	AL	O. BL	S, (Q, V)	/L	A3083
13	112°20'	54°15'	AL	O. BL	S, (M)	/S	A3070
14	112°42'	52°17'	AL	O. BL	S, (M)	/L	A3115
15	113°04'	49°30'	AL	O. BL	S, (M)	/L	A3079
16	113°32'	49°49'	AL	O. BL	S, (M)	/L	A3080

* R. BL: Rego Black Chernozemic
** O. BL: Orthic Black Chernozemic

A4 Orthic Dark Gray Chernozemic Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	97°42'	51°07'	MN	X, (S, M)	/L	A4135
2.	101°31'	50°29'	SK	S, (M)	/L	A4125

B1 Brown Solonetz Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	103°28'	49°29'	SK	S, (M, V)	/L	B1006
2.	108°52'	51°30'	SK	S, (M)	/L	B1002
3.	111°03'	50°59'	AL	S, (M)	/L	B1001
4.	111°32'	52°04'	AL	S, (M, K)	/L	B1008

B2 Black Solonetz Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	118°44'	55°29'	AL	S	/C	B2011

B4 Black Solod Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	116°40'	55°47'	AL	X, (S, M)	/C	B4022
2.	118°06'	56°33'	AL	X, (S, M)	/C	B4020
3.	118°48'	55°44'	AL	S, (M)	/C	B4021

C1 Gray Brown Luvisol Great Group

	Long.	Lat.	Prov.	Soil Subgroup	Short Mineral Description	Texture	Polygon No.
1.	78°20'	44°20'	ON	BR. GBL*	X, (V, M)	/L	C1001
2.	79°23'	43°30'	ON	O. GBL**	M, (V)	/C	C1012
3.	79°29'	42°33'	ON	O. GBL	M,	/C	C1013
4.	79°34'	43°29'	ON	BR. GBL	M, (V, Q)	/L	C1009
5.	80°14'	43°01'	ON	BR. GBL	X, (M, S, Ch)	/S	C1002
6.	80°21'	44°30'	ON	O. GBL	M, (S)	/L	C1003
7.	80°31'	43°53'	ON	BR. GBL	M	/L	C1008
8.	80°37'	42°45'	ON	O. GBL	X, (V, M)	/C	C1015
9.	81°02'	43°18'	ON	O. GBL	M	/C	C1014

* BR. GBL: Orthic Gray Brown Luvisol

** O. GBL: Brunisolic Gray Brown Luvisol

C2 Orthic Gray Luvisol Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	60°31'	45°30'	NS	X, (M, Ch, V)	/L	C2111
2.	62°51'	45°30'	NS	M, (Ch)	/L	C2117
3.	63°05'	45°21'	NS	M, (Ch, V)	/L	C2114
4.	65°10'	46°31'	NB	X, (M, Ch, K)	/L	C2110
5.	78°23'	49°20'	QU	X, (F, M, Ch)	/S	C2107
6.	97°44'	51°55'	MN	X	/L	C2075
7.	104°16'	53°30'	SK	S	/S	C2055
8.	105°45'	53°49'	SK	S	/L	C2071
9.	112°28'	53°30'	AL	S, (M, Q)	/L	C2036
10.	114°36'	52°49'	AL	S, (M, Q)	/L	C2027
11.	117°41'	53°42'	AL	S, (Ca, M)	/L	C2061
12.	118°38'	50°01'	BC	X, (S, M, Ch)	/L	C2100
13.	119°10'	55°26'	AL	S, (M)	/L	C2051
14.	120°41'	49°46'	BC	X, (S, Ch, M)	/L	C2102
15.	121°43'	57°16'	BC	X, (M, S, Ch)	/L	C2058
16.	122°05'	53°43'	BC	X, (S, M, V)	/C	C2054
17.	123°54'	54°29'	BC	V, (M, K)	/C	C2053
18.	123°58'	54°19'	BC	X, (V, K, M)	/C	C2099
19.	124°13'	54°25'	BC	X, (S, V, M)	/L	C2103
20.	125°15'	54°13'	BC	X, (S, M, K)	/L	C2060

D3 Orthic Humo-Ferric Podzol Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	52°20'	47°41'	NF	X, (M, Ch, Q)	/L	D3076
2.	52°33'	47°03'	NF	X	/L	D3077
3.	60°03'	46°22'	NS	M, (V, K)	/L	D3083
4.	62°01'	45°29'	NS	M, (K, V)	/L	D3075
5.	62°07'	46°29'	PE	X, (M, Ch, K)	/S	D3062
6.	62°42'	45°30'	NS	M, (K, Ch)	/L	D3047
7.	62°56'	46°30'	PE	X, (M, Ch, K)	/S	D3054
8.	63°31'	46°30'	PE	X, (M, Ch, K)	/L	D3065
9.	63°45'	45°29'	NS	M, (Ch, K)	/L	D3067
10.	63°51'	44°23'	NS	X, (M, V, K)	/L	D3053
11.	64°19'	46°55'	PE	M, (Ch)	/S	D3061
12.	64°28'	44°54'	NS	M, (Ch, K)	/S	D3141
13.	64°33'	44°53'	NS	M, (S, K)	/L	D3146
14.	65°13	45°29'	NB	X, (M, Ch, K)	/L	D3048
15.	66°08'	47°03'	NB	X, (M, Ch)	/L	D3082
16.	66°38'	46°21'	NB	M, (Ch, K)	/L	D3072
17.	67°00'	47°29'	NB	M, (Ch)	/L	D3030
18.	67°22'	46°17'	NB	M, (Ch, K)	/L	D3073
19.	67°37'	48°01'	NB	M	/S	D3133
20.	68°06'	48°11'	NB	X, (M, Q, F)	/L	D3060
21.	69°30'	49°50'	QU	M, (Ch, K)	/S	D3126
22.	70°30'	46°20'	QU	M, (Ch)	/L	D3066
23.	71°17'	46°29'	QU	X, (M, Ch)	/S	D3058
24.	71°33'	45°56'	QU	M	/L	D3135
25.	74°29'	45°09'	QU	V, (M)	/S	D3007
26.	82°13'	47°42'	QU	X, (M, Ch, Q)	/S	D3149
27.	85°37'	49°30'	QU	X, (M, Ch, Q)	/S	D3017
28.	87°16'	49°29'	QU	X, (M, Ch)	/S	D3018
29.	118°29'	51°14'	BC	X, (S, V, M)	/L	D3106
30.	122°02'	50°17'	BC	S, (Ch)	/S	D3114
31.	122°41'	49°34'	BC	Ch, (M)	/S	D3117
32.	124°25'	49°14'	BC	X, (S, Ch, V)	/S	D3009
33.	125°31'	49°30'	BC	Ch, (V, K)	/S	D3006
34.	125°31'	49°30'	BC	X, (Ch, V, K)	/L	D3014

E1 Melanic Brunisol Great Group

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	73°44'	45°34'	QU	X, (M, V, S)	/L	E1012
2.	75°42'	44°29'	ON	X, (M, Q, F)	/L	E1013
3.	76°19'	44°29'	ON	X, (V, M, Ch)	/L	E1002
4.	76°21'	45°07'	ON	X, (V, M, Ch)	/L	E1005
5.	76°56'	44°30'	ON	X, (M, S, Ch)	/L	E1018

E2 Eutric Brunisol Great Group

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	116°17'	61°18'	NW	M, (S, Q)	/S	E2050
2.	118°40'	49°30'	BC	X, (M, Am, Ch)	/L	E2033
3.	121°22'	61°30'	NW	X, (M, Am, V)	/S	E2036
4.	136°39'	60°54'	YU	X, (Ch, M, S)	/C	E2045

E3 Dystric Brunisol Great Group

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	74°30'	46°15'	QU	X, (M, S, Ch)	/S	E3068
2.	120°31'	49°36'	BC	S, (Ch, M)	/L	E3079
3.	123°55'	48°50'	BC	Ch, (V, S)	/L	E3066
4.	128°19'	54°30'	BC	X, (M, S)	/C	E3070

F1 Orthic Regosol Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	117°58'	56°46'	AL	S, (M)	/L	F1008

F2 Cumulic Regosol Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	64°01'	45°30'	NS	X, (M, V, K)	/C	F2016

F3 Regosolic Static Cryosol Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	71°44'	67°31'	NW	M, (V)	/S	F3075
2.	87°53'	75°18'	NW	M, (V)	/C	F3063
3.	99°48'	65°45'	NW	M, (V)	/S	F3079
4.	101°40'	77°30'	NW	X, (M, K)	/L	F3033
5.	122°12'	73°12'	NW	X, (M, S, Q)	/S	F3064
6.	123°42'	68°07'	NW	X, (S, M)	/L	F3069
7.	134°38'	68°16'	NW	X, (S, M)	/C	F3070

G1 Humic Gleysol Great Group

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	72°45'	45°29'	QU	X, (M, S, V)	/C	G1004
2.	74°52'	45°09'	ON	X, (M, S, V)	/C	G1003
3.	75°30'	45°29'	ON	M, (S)	/C	G1002
4.	78°25'	42°41'	ON	M, (Q)	/C	G1005
5.	81°56'	42°36'	ON	M, (V, S)	/C	G1007
6.	96°52'	49°30'	MN	S, (M, V)	/C	G1014
7.	122°35'	49°29'	BC	X, (Ch, S, Am)	/L	G1017

G2 Orthic Gleysol Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	71°24'	48°29'	QU	M, (Q)	/C	G2027
2.	81°05'	48°58'	ON	M, (S)	/C	G2026

G3 Gleysol Turbic Cryosol Subgroup

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	129°07'	69°29'	NW	M, (S, V)	/L	G3043
2.	130°17'	69°53'	NW	M, (S, V)	/S	G3042

H1 Fibrisol (Mineral Subsoil)

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	94°48'	53°40'	MN	X, (S, M)	/C	H1031
2.	94°52'	49°38'	ON	X, (S, M)	/S	H1026
3.	95°43'	50°30'	MN	X, (S, M)	/C	H1027
4.	95°46'	51°58'	MN	X, (S, M)	/C	H1032
5.	98°46'	56°10'	MN	X, (S, M)	/C	H1030
6.	111°06'	56°59'	AL	M	/S	H1008
7.	111°22'	56°06'	AL	S, (Q, M)	/S	H1017
8.	112°02'	59°29'	AL	M, (S)	/S	H1034
9.	112°42'	58°29'	AL	M, (S)	/S	H1014
10.	114°23'	57°13'	AL	M, (S)	/S	H1025

R Rockland

	Long.	Lat.	Prov.	Short Mineral Description	Texture	Polygon No.
1.	69°56'	56°39'	QU	X, (M, Ch, K)	/S	R1014
2.	118°09'	52°59'	AL	X, (M, Ch, Ca)	/S	R1023
3.	119°28'	52°36'	BC	M, (S)	/S	R1033
4.	122°02'	49°53'	BC	X, (S, Ch)	/S	R1036