Chapter 34 – Mineral Resources of the Western Canada Sedimentary Basin

Authors:
W.N. Hamilton - Alberta Geological Survey, Edmonton
R.A. Olson - R.A. Olson Consulting Ltd., Edmonton

Additional Contributors:
J.D. Bamburak - Manitoba Energy and Mines, Winnipeg
R. Gunter - Manitoba Energy and Mines, Winnipeg
P. Guliov - Saskatchewan Energy and Mines, Regina
D. MacDougall - Saskatchewan Energy and Mines, Regina
Z.D. Hora - British Columbia Ministry of Energy, Mines and Petroleum Resources, Victoria
T. Schroeter - British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver
D. Atkinson - Indian and Northern Affairs - Northwest Territories, Yellowknife
W. Gibbins - Indian and Northern Affairs - Northwest Territories, Yellowknife
D.J. Ouellette - Indian and Northern Affairs - Yukon, Whitehorse

Introduction

This chapter deals with the economic minerals, other than oil, gas and coal, that are hosted by rocks of the Western Canada Sedimentary Basin. The diversified geology of various regions and stratigraphic levels within the basin have given rise to a wide variety of minerals, more than 50 different kinds, that have an existing or potential resource value. The aim of the chapter is to provide an overview of economic minerals in the context of basin geology. It is directed primarily toward the mineral explorationist who wishes to gain a broad understanding of the metallogeny of the basin region and the resource potential for industrial and metallic minerals.

Presentation of Mineral Deposits

Minerals of the Western Canada Sedimentary Basin are presented according to the scheme outlined in Figure 34.1. The minerals are divided into industrial (or nonmetallic) minerals and metallic minerals. Under these broad categories the minerals are grouped into the various mineral types shown, with each type having common geological characteristics or elemental associations or both. The scheme is not intended as a classification of mineral deposits, merely a convenient way of grouping the various kinds of minerals by geological association.

INDUSTRIAL (NONMETALLIC) MINERALS	
Chemical and biogenic deposits	
Limestone	Magnesite
Dolomite	Phosphate
Marl and tufa	Barite
Evaporites	
Potash	Gypsum
Salt	Sodium sulphate
	Magnesium sulphate
Terrigenous clastics - fine	**Terrigenous clastics - coarse**
Bentonite	Silica sand
Clay, common (brick)	Sandstone
Clay, stoneware/refractory	Quartzite
Clay, expandable	Titanium-zirconium minerals
Shale	
Kaolin	
Others	
Sulphur	Germanium, gallium
Formation brines (Ca-Mg-Br-I-Li)	Talc
'Kimberlite' pipes (diamond)	Pumicite
Carbonatites (Nb, REE)	Leonardite
Nepheline syenite	Gemstones (ammolite, sodalite)
Fluorspar	Vanadium
METALLIC MINERALS	
Precious metals	**Base metals**
Gold	Copper
Silver	Lead
	Zinc
	Nickel
Ferrous metals	**Uranium deposits**
Iron - magnetite or iron silicate minerals	Uranium
Manganese	
Others	
'Kimberlite' pipes (diamond)	Mercury
Carbonatites (Nb, REE)	Vanadium
Germanium, gallium	

Figure 34.1 Classification scheme for the presentation of mineral deposits and occurrences in the Western Canada Sedimentary Basin.

All known deposits and occurrences are presented on geological base maps: Figures 34.5 and 34.7, for the nonmetallic and metallic minerals, respectively. These maps indicate, in most cases, the geological setting for the deposit. In some cases however, the deposit is hosted by a rock unit that exists at depth beneath the unit that crops out. The mineral deposits are displayed in two ways: 1) spot symbols, which are colour-coded according to the scheme of mineral groupings outlined in Figure 34.1, with each symbol representing an individual deposit or cluster of deposits, the actual area of which is too small to show at the map scale; and 2) line symbols, for deposits large enough to be outlined in their true dimensions. The deposits represented by spot symbols are further categorized as to 'status' as follows: 1) producers or past producers, 2) prospects, or undeveloped potential ore deposits, and 3) showings, or significant mineral occurrences. For the metallics, because of the fewer numbers of mineral occurrences displayed on the map (Fig. 34.7), an additional category (anomalies) is included. Definitions for the different 'status' categories are given in Figure 34.2.

Numerical listings of all deposits and occurrences displayed on the two maps are presented in Figures 34.6 (nonmetallics) and 34.8 (metallics). For the nonmetallics the deposits and occurrences are listed by province, first in alphabetical order by major commodity, and second (i.e., within commodities) in numerical order by NTS grid number and latitude-longitude location. For the metallics the listing is the same except that mineral commodities are arranged in the deposit-type groupings as presented in Figures 34.1 and 34.7. Each deposit or occurrence is assigned an identification number, which includes a one-letter province identifier (A, Alberta; B, British Columbia; M, Manitoba; N, Northwest Territories; S, Saskatchewan; Y, Yukon Territory) followed by a sequential number. The sequencing of ID numbers corresponds to this listing and is independent for each province.

For each deposit or occurrence displayed on the two maps, a synopsis of available data is contained in a mineral deposits master table[1]. The data include information on geological setting and resource attributes of the deposit, along with pertinent references. Summaries of data for the more important deposits selected from the master table are presented in Appendix I (nonmetallics) and Appendix II (metallics).

Economic Minerals - A Resource Perspective

More than 35 different minerals are produced now or have been produced in the Western Canada Sedimentary Basin. Some of the minerals have a long history of production, even preceding that for the fossil fuels. The oldest record of mineral production dates from 1820, when salt was being harvested from saline spring deposits in northeastern Alberta for trade with inhabitants of the region (Allan, 1920). Currently, the annual production of non-fuel minerals in the basin is valued at about $1.5 billion (Fig. 34.3), which is about 7 percent of the region's total mineral production wealth.

1. Because of space limitations the complete table is not included with this chapter, but is published separately by the Alberta Research Council (Price et al., *in press*). It is also searchable as part of the Atlas Database.

Producer/past producer
Mineral deposit from which ore is currently being mined or has been mined in the past for commercial gain. Typically, ore reserves and grade are known with some certainty and, in the case of past producers, are available from production records. For past producers, production has ceased because: (1) ore reserves have been exhausted, or (2) operations became sub-economic, because of factors such as declining grade/commodity prices, loss of markets, increasing waste to ore ratio during mining, increasing processing costs, etc.

Prospect
Mineral deposit that has sufficient size and ore mineral content to make commercial extraction a possibility. Typically, enough assessment work has been done to establish the presence of ore grade material and make at least a preliminary estimate of deposit size (i.e., reserves). Further work will enhance the accuracy of reserve estimates and may lead to definition of the deposit as an orebody and a potential producer.

Showing
Natural occurrence of valuable mineral(s) in sufficient concentration to indicate that further exploration may be warranted. Typically, insufficient work has been done to establish the size of the occurrence or the grade of the concentration of valuable mineral(s).
For nonmetallic mineral occurrences, access and recoverability are additional critical factors in distinguishing showings from prospects: e.g., a nonmetallic deposit that has unfavorable access or recoverability may be classed as a showing even though it has sufficient indication of size and grade to be a prospect.

Anomaly
Mineral occurrence that has been indicated by geological, geophysical or geochemical means to be a local abnormality from the general surroundings. This category has been applied only to the metallic minerals.

Figure 34.2 Definitions for 'status' categories of mineral deposits and occurrences in the Western Canada Sedimentary Basin.

Mineral production in the basin region for the past 26 years is shown in Figure 34.4. Since publication of the previous atlas in 1964, the importance of non-fuel minerals has grown enormously. By far the largest in both tonnage and value of production are the industrial minerals – a diverse array of more than a dozen different commodities. In the past 26 years the basin has become the world's second largest producer of potash, second largest producer and largest exporter of sulphur, and a new international supplier of magnesite. Major growth has occurred also in locally consumed minerals for the construction materials and chemical industries. These include production of limestone for cement and lime, sand and gravel for aggregate, gypsum, building stone, brick clay and expandable clay, bentonite, silica, and salt.

The metallic mineral deposits are much less developed in the Western Canada Sedimentary Basin, but also are much less explored. Because of its mainly sedimentary rock regime the basin region has long been regarded as unfavorable for metallics, with the notable exception of lead-zinc from such past-producers as the Pine Point and Monarch-Kicking Horse mines. More recently, recognition of a variety of geological anomalies and some igneous rocks in the basin has touched off new interest in the resource potential for metallics. The main contribution of metallic minerals shown in Figure 34.4 is for lead-zinc production from Devonian strata at Pine Point, N.W.T. This graph records the complete cycle of Pine Point production from its beginning in 1965 to cessation in 1988. Current production of metallic minerals from Phanerozoic basin rocks is limited to minor amounts of placer gold. Two other metallic producers, Spruce Point and Namew Lake in Manitoba, lie within the basin region, but their production is from Precambrian basement rocks beneath the Phanerozoic cover.

x 1000		Yukon and Northwest Territories	British Columbia	Alberta	Saskatchewan	
Metals						
Gold	g			34		
	$	–	–	453	–	–
Other metals [1]		–	–	2,568	–	–
Nonmetals						
Sulphur	t		413	5,550	64	
	$	–	40,650	200,269	3,032	–
Potash	$	–	–	–	747,000 [7]	–
Salt [2]	t			1,237	534	
	$	–	–	15,410	26,759	–
Sodium sulphate	$	–	–	1,212	20,589	–
Magnesite	$	–	24,000 [7]	–	–	–
Other nonmetals [3]	$	–	4,800 [8]	14,237	2,400 [8]	8,245
Structural Materials						
Cement	$	–	–	98,200 [7]	10,300 [7]	23,800 [7]
Lime	t			219		x
	$	–	–	20,488	–	7,199
Sand and gravel [4]	t	x	x	35,663	7,924	10,537
	$	750 [6]	8,600 [6]	106,584	17,597	35,203
Stone	$	–	–	2,892	–	7,946
Other structural materials [5]	$	–	–	10,000 [8]	3,400 [8]	1,200 [8]
TOTAL	$	750	78,054	469,292	831,077	83,593

Source: Statistics Canada Catalogue 26 - 202, 1991. Legend: g - grams, t - tonnes, x - unavailable.
[1] Includes magnesium and vanadium
[2] Includes calcium chloride
[3] Includes gypsum and peat (Man.); peat (Sask. and Alta.); gypsum and barite (B.C.)
[4] Includes silica (except Yukon and N.W.T.)
[5] Includes clay products; bentonite (Sask. and Alta.)
[6] Estimated, as percentage (5%) of total reported for entire province/territory; estimate for B.C. includes additional value for silica
[7] Estimated, by difference from total of nonmetals/structural materials reported
[8] Estimated, by comparison with previous reported production

Figure 34.3 Industrial and metallic mineral production in the Western Canada Sedimentary Basin: preliminary estimate 1991.

Industrial (Nonmetallic) Minerals

The industrial minerals that occur in the Western Canada Sedimentary Basin are shown in Figure 34.1. They are widely distributed throughout the basin (Fig. 34.5) and are found in rock units from every geological period in the Phanerozoic. At least 480

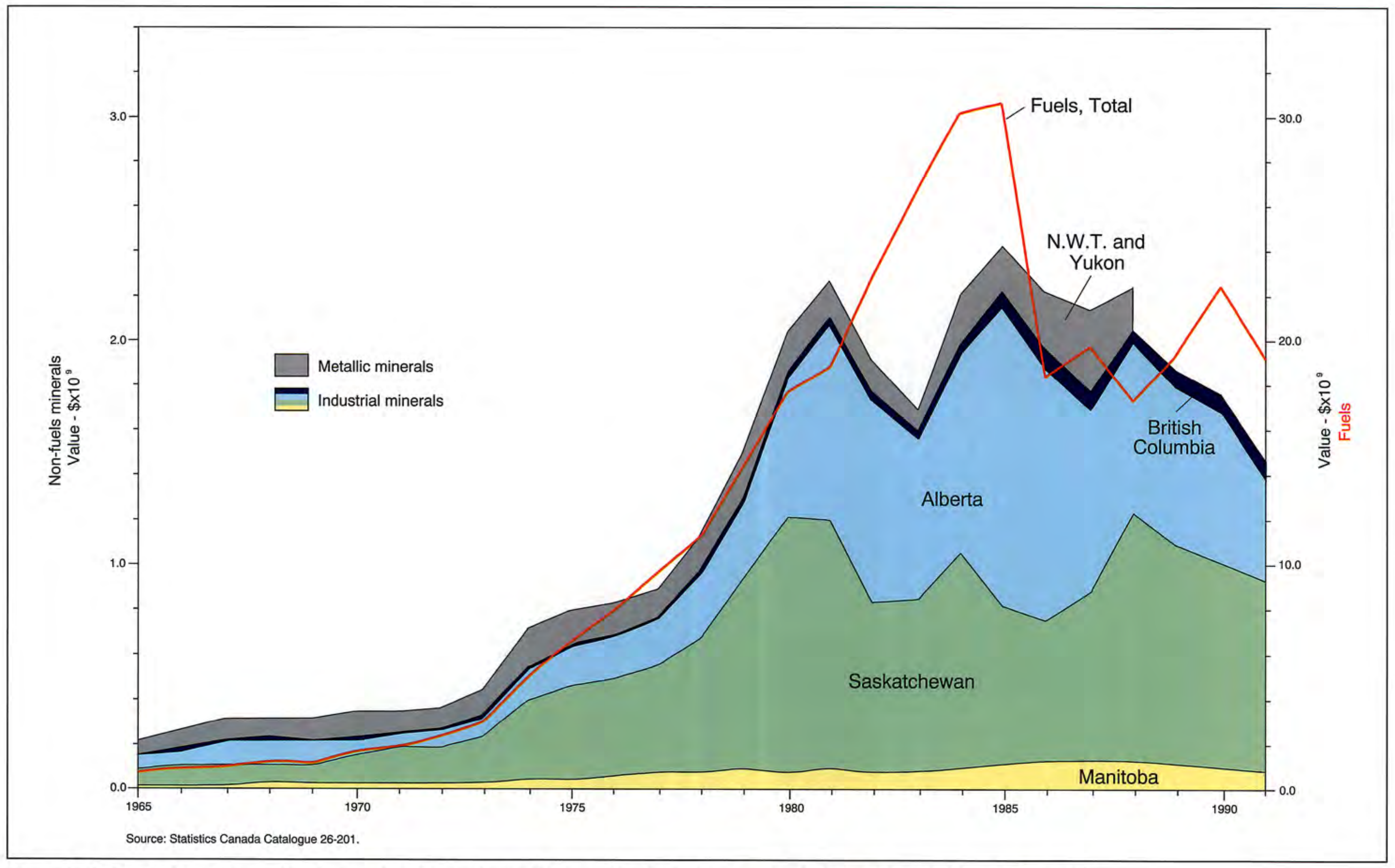

Figure 34.4 Graph showing the value of mineral production for the Western Canada Sedimentary Basin during the period from 1965 to 1991.

deposits and occurrences of these minerals are known (Fig. 34.6). Appendix I summarizes available data for deposits that are current or past producers in the region. Data for all deposits and occurrences shown in Figure 34.5 are given in the mineral deposits master table (Price et al., *in press*).

In the following sections a brief description of geological setting and resource attributes is given for each mineral represented. Reference to specific deposits is given by means of the identification number assigned to the deposit.

Chemical and Biogenic Deposits

This group includes industrial mineral deposits that originated by chemical or biochemical processes within a sedimentary succession, but excludes evaporites. Although evaporites are a type of chemical sediment, they are treated separately because of their unique geological characteristics and economic importance.

Limestone and Dolomite

Limestone is found in all provinces in the Western Canada Sedimentary Basin and is or was produced in all but Saskatchewan. In terms of its primary product usage (cement and lime), limestone is one of the most valuable industrial minerals of the region.

In Manitoba, limestone production from the Devonian Elm Point Formation occurs near Steep Rock (M18)[2] and Faulkner (M17), for use in a cement plant near Winnipeg and a lime plant at Faulkner (Bannatyne, 1984). Another Devonian source of limestone is the Souris River Formation, which is quarried near Mafeking (M20) for cement production at Regina. Devonian limestones extend into Saskatchewan as well, but not in economically quarriable situations, with the possible exception of near-surface deposits near Pinehouse Lake (S51) (Guliov, 1992).

Huge reserves of limestone are exposed in Cambrian, Devonian and Mississippian formations in the Rocky Mountains of Alberta (Holter, 1976). Limestone is exploited currently at six localities. The two largest quarries are at Cadomin (A121) and Exshaw (A111), both producing limestone for cement from the Devonian Palliser Formation. Two other quarries, at Canmore (A112) and Crowsnest Lake (A108), produce from the Carboniferous Livingstone Formation for use in lime making. Two smaller operations, at Nordegg (A116) and at Corkscrew Mountain near Rocky Mountain House (A114), utilize equivalent Carboniferous strata of the Pekisko Formation for a broad range of agricultural and industrial limestone products. Formerly, the Cambrian Eldon Formation was a source of limestone for lime making at Kananaskis (A113). In the Alberta Plains, limestone exposed near the shield margin in the northeast has had no exploitation. Some good grades are reported for Devonian Waterways Formation limestones that crop out along the Athabasca and Clearwater rivers, but quarriable reserves appear limited.

British Columbia has no current limestone production from its part of the basin, although production did occur for a short time from the Carboniferous Rundle Group at Sukunka River (B18) in northeastern B.C. Plentiful resources of chemical-grade limestone remain at this locality.

Dolomite crops out extensively in the Rocky Mountains of Alberta and British Columbia, and in the shield-marginal lowlands of Manitoba, east-central Saskatchewan and northeastern Alberta. Although vast resources of high-purity material are available, little exploitation for chemical use has taken place. Small production of dolomite for use as smelter flux took place at one time from Devonian Fairholme Group strata at Crowsnest Lake, Alberta (A80). The main use of dolomite in the basin has been for building stone and crushed aggregate. One of Canada's most famous building stones is produced from the Ordovician Red River Formation in Manitoba, from quarries at Garson (M14), northeast of Winnipeg. Known as 'Tyndall Stone', the rock is a dolomitic limestone valued for its tapestry-mottled appearance and large fossil forms. It is widely used as facing stone in public buildings.

Other exposures of the Red River and overlying Stony Mountain Formation dolomites occur throughout the Interlake region of Manitoba and parts of east-central Saskatchewan. They have considerable potential as dimension stone. Limited quarrying of the Red River dolomite has occurred in the Limestone Lake area (S41) of Saskatchewan. The dolomites exposed in the mountains of Alberta and British Columbia have little dimension stone potential because of severe jointing and fracturing.

Marl and Tufa

Marl and tufa deposits are numerous in central and northwestern Alberta (Macdonald, 1982), and probably are common in other parts of the basin as well, although not as extensively mapped. The Alberta deposits are generally small, of post-glacial or Recent age, and associated with groundwater discharge areas. A few have sizeable reserves (1 000 000 t) with grades of 65 percent $CaCO_3$ or better. Two of these, at Halfway Lake near Clyde (A142) and at Marlboro (A134), were exploited in the past for cement making, and at least three others (A136, A143 and A148) have had sporadic production for local agricultural liming.

Magnesite

Carbonate-hosted magnesite deposits are known at two localities in the Rocky Mountains in British Columbia (Grant, 1987), including the only producer at Mount Brussilof (B19). This deposit, reputed to be the largest and purest magnesite deposit in the western world, is hosted in Middle Cambrian Cathedral Formation dolomite. It is part of a 15-km long magnesite belt that follows the Cathedral Escarpment (Simandl and Hancock, 1991). Magnesite quarried at Mount Brussilof is shipped to Exshaw, Alberta for processing to caustic calcined magnesia and fused magnesia. Some of the magnesite produced was used also as ore feed for magnesium metal extraction at High River, Alberta (Wheeler, 1992) prior to closure of the plant in 1991.

Phosphate

Phosphates and phosphatic rocks are common in the Rocky Mountains of Alberta and British Columbia. No less than ten formations, ranging from Devonian to Jurassic in age, are phosphate-bearing in the area (Macdonald, 1987; Butrenchuk, *in press*). However, deposits with grades approaching commercial levels are few, and are limited to the Permian Johnston Canyon and Ranger Canyon formations, the Triassic Whistler Member of the Sulphur Mountain Formation, and the Jurassic Fernie Formation. Best potential lies with deposits in the Fernie Formation in southeastern British Columbia, where large reserves with grades of 18 to 26 percent P_2O_5 have been identified. No commercial production has occurred to date, except for limited test production at the abandoned Crow mine in Crowsnest Pass (B34). Triassic phosphates in the Monkman Pass-Wapiti Lake area of northeastern British Columbia are comparable in grade and thickness to the phosphates in the Fernie Basin.

Barite

Barite is found in Western Canada Sedimentary Basin strata only in British Columbia. Known deposits include both vein and bedded replacement types in Cambrian, Ordovician and Devonian rocks (Butrenchuk, 1989a). In southeastern British Columbia barite is found as veins, pods and lenses in Cambrian Jubilee Formation dolomites (B1). In northeastern British Columbia the occurrences are in Devonian strata. At Muncho Lake (B3), for example, barite beds up to 33 m thick occur in a zone between Wokkpash Formation sandstone and overlying Stone Formation dolomite.

Production of barite has occurred in southeastern British Columbia intermittently since 1940, mostly from vein deposits at Parson and Brisco, but with some from replacement deposits near Spillimacheen and Invermere (Hora, 1983). These deposits lie west of the western structural boundary of the Rocky Mountains, outside the study area for this Atlas, though their host rocks are equivalents or extensions of sedimentary units in the Western Canada Sedimentary Basin.

Evaporites

Evaporites are of major importance in the Western Canada Sedimentary Basin as economic mineral source rocks, giving rise directly to deposits of potash, salt and gypsum, and having indirect implications in the presence of sulphur deposits. Although evaporites abound stratigraphically in the basin, the Middle Devonian Elk Point Group and equivalents stand out as the most important. Jurassic evaporites are important in the eastern region (for gypsum). Recent evaporites give rise to surficial deposits of sodium and magnesium sulphates.

Potash

Potash underlies an extensive area of southern Saskatchewan, with projections into southwestern Manitoba and eastern Alberta (Fig. 34.5). All current production is in Saskatchewan, where its annual value in recent years has exceeded that of any other industrial mineral product for the entire country. The potash occurs in the Prairie Evaporite Formation, the uppermost evaporite unit of the Elk Point Group. This formation is extensive throughout the plains region, with thicknesses of up 200 m. It consists primarily of salt (halite) in Alberta, but is richly mineralized with potash in the central part of the evaporite basin (in Saskatchewan).

The potash occurs in the upper 60 m of the formation, in four members separated by salt beds (Holter, 1969). The members range from 6 to 15 m in thickness and contain individual potash beds up to 7 m thick. They extend more or less continuously across the basin in Saskatchewan, although interruptions due to solution channeling occur. Depths to the uppermost potash member range from 885 m in the northeast to more than 1500 m in the Regina-Moose Jaw area. The principal minerals are halite, sylvite and carnallite.

Potash mining is conducted at ten sites in Saskatchewan, eight of which are conventional underground mines and two of which are solution mines (Guliov, 1992). Three of the conventional mines are located in the Esterhazy-Rocanville area near the eastern border (S56, S57, S58), exploiting the lowermost Esterhazy Member. In the Saskatoon-Lanigan area, five conventional mines (S61, S64, S65, S66, S68) and one solution mine (S67) exploit the uppermost Patience Lake Member. At Belle Plaine (S60) near Regina, solution mining is used to exploit a third potash member, the Belle Plaine, which underlies the Patience Lake Member. The potash beds at this site are too deep (1500 m) for conventional underground recovery, which in practice is limited to a depth of about 1100 m.

2. Deposit identification numbers for industrial minerals comprise a one-letter Province identifier (A, Alberta; B, British Columbia; M, Manitoba; N, Northwest Territories; S, Saskatchewan; Y, Yukon Territory) followed by a sequential number. A complete listing of ID numbers with deposit locations is given in Figure 34.6.

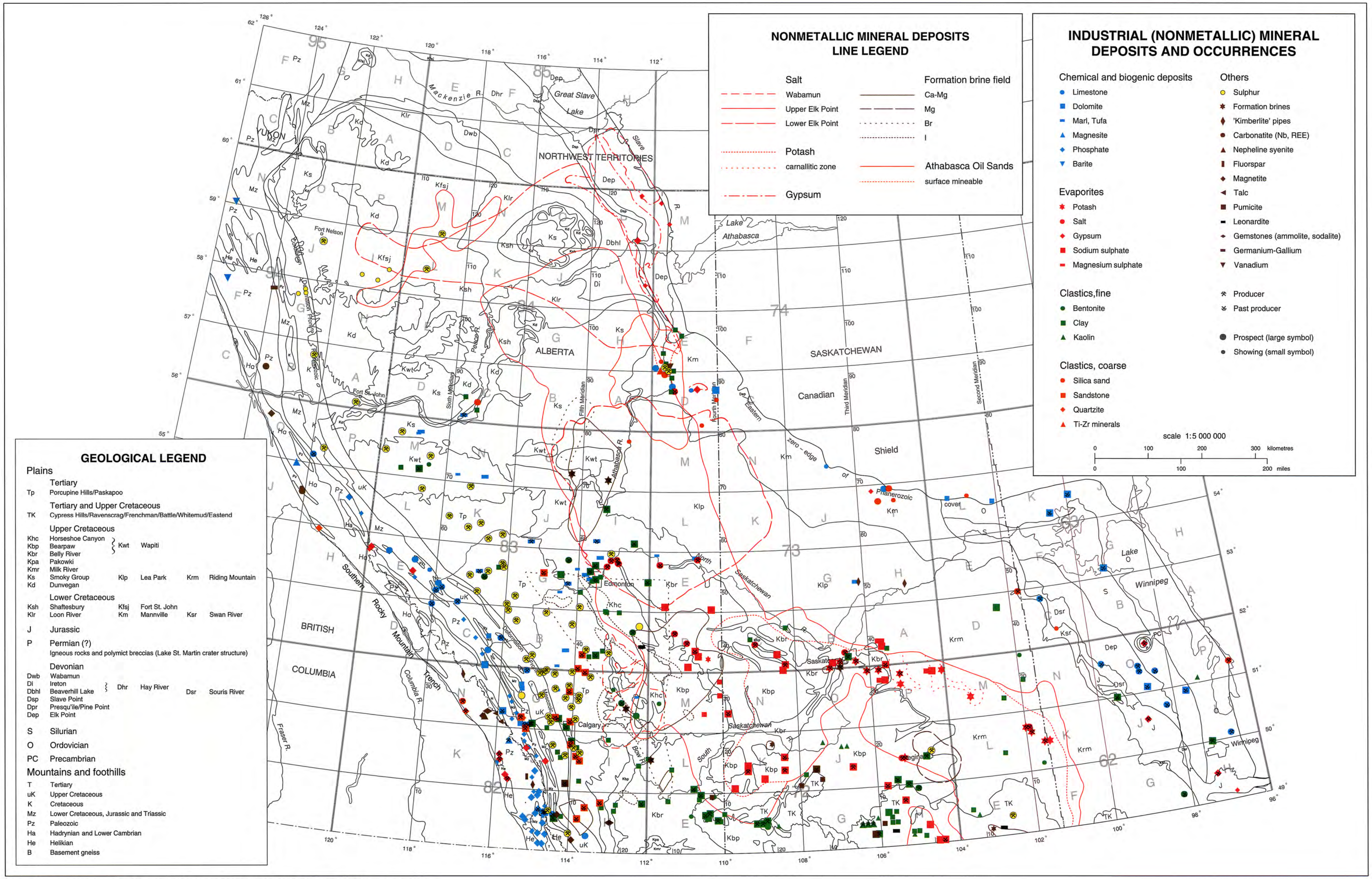

Figure 34.5 Industrial (nonmetallic) mineral deposits and occurrences in the Western Canada Sedimentary Basin.

ID	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities
A1+	72E	49 37 06 110 51 04	Bentonite
A2+	72E	49 56 19 110 15 56	Bentonite
A3+	72M	51 28 54 111 42 12	Bentonite
A4+	82P	51 16 40 112 18 46	Bentonite
A5	82P	51 28 54 112 42 40	Bentonite
A6+	82P	51 41 59 112 56 40	Bentonite
A7	83A	52 39 34 112 26 20	Bentonite
A8	83F	53 27 40 116 38 35	Bentonite
A9	83G	53 49 29 114 17 09	Bentonite
A10+	83M	55 14 09 118 31 29	Bentonite
A11+	72E	49 31 52 110 06 21	Clay - brick; stoneware
A12	72E	49 32 44 110 10 25	Clay - stoneware
A13+	72E	49 35 21 110 25 19	Clay - brick; stoneware
A14	72E	49 37 58 110 29 23	Clay - stoneware
A15+	72E	49 38 51 110 00 56	Clay - stoneware
A16	72E	49 39 43 110 22 36	Clay - stoneware
A17+	72E	49 51 57 111 27 39	Clay - brick
A18+	72E	49 53 41 110 39 09	Clay - brick
A19	72E	49 58 04 110 36 25	Clay - brick
A20	72L	50 04 10 110 47 20	Clay - brick
A21+	72L	50 23 24 111 22 03	Clay - expandable
A22+	72L	50 33 52 111 59 11	Clay - expandable
A23+	74D	56 44 01 111 25 38	Clay - brick
A24+	74D	56 53 34 111 24 49	Clay - stoneware
A25+	74E	57 00 33 111 24 49	Clay - brick
A26+	74E	57 07 32 111 34 29	Clay - stoneware
A27+	74E	57 18 03 111 40 15	Clay - stoneware
A28+	74E	57 35 30 111 06 45	Clay - brick
A29+	74E	57 41 36 111 18 15	Clay - stoneware
A30+	82G	49 34 29 114 12 54	Clay - brick
A31	82G	49 36 14 114 26 27	Clay - brick
A32+	82H	49 41 28 112 51 40	Clay - brick
A33+	82H	49 47 35 112 48 58	Clay - brick
A34+	82H	49 47 35 113 10 39	Clay - brick
A35	82H	49 49 20 112 08 18	Clay - brick
A36+	82I	50 10 18 113 47 30	Clay - brick
A37+	82I	50 26 53 112 14 18	Clay - expandable
A38+	82I	50 43 29 113 52 16	Clay - brick
A39*,+	82I	50 52 13 113 02 24	Clay - brick
A40+	82J	50 33 00 114 17 14	Clay - brick
A41+	82J	50 38 15 114 22 54	Clay - brick
A42*,+	82J	50 41 44 114 14 36	Clay - brick
A43*	82J	50 45 14 114 02 08	Clay - brick
A44	82J	50 49 36 114 00 44	Clay - expandable
A45+	82O	51 01 50 114 41 13	Clay - brick
A46*	82O	51 03 34 114 09 07	Clay - brick
A47	82O	51 03 34 114 10 30	Clay - brick
A48*	82O	51 04 27 114 10 30	Clay - brick
A49*	82O	51 04 27 115 10 31	Clay - shale
A50	82O	51 05 19 115 04 56	Clay - shale
A51	82O	51 11 26 114 28 39	Clay - brick
A52*,+	82O	51 39 24 114 07 50	Clay - brick
A53*	83A	52 01 09 113 56 36	Clay - brick
A54+	83A	52 14 15 113 38 02	Clay - brick
A55	83A	52 16 00 113 27 52	Clay - brick
A56+	83A	52 20 22 113 16 43	Clay - brick
A57*,+	83A	52 21 14 113 05 12	Clay - brick
A58+	83A	52 58 47 112 50 46	Clay - brick
A59+	83A	52 58 47 113 11 05	Clay - brick
A60+	83A	52 59 39 113 13 59	Clay - expandable
A61+	83F	53 38 08 116 16 27	Clay - brick
A62+	83G	53 34 39 114 30 17	Clay - fireclay
A63*,+	83G	53 36 24 114 59 46	Clay - brick
A64+	83H	53 17 59 113 56 30	Clay - brick
A65	83H	53 29 23 112 03 25	Clay - brick
A66+	83H	53 29 23 113 37 48	Clay - expandable
A67	83H	53 31 08 113 31 54	Clay - brick
A68+	83H	53 33 45 113 23 03	Clay - expandable
A69*	83H	53 35 30 113 37 48	Clay - brick
A70*,+	83H	53 35 49 113 37 15	Clay - expandable
A71	83H	53 38 59 113 40 45	Clay - expandable
A72	83H	53 45 05 113 32 10	Clay - expandable
A73	83I	54 07 46 112 27 58	Clay - brick
A74	83I	54 41 49 113 16 07	Clay - brick
A75+	83M	55 08 03 119 20 43	Clay - brick
A76	83M	55 08 56 118 48 25	Clay - brick
A77+	84C	56 12 37 117 16 50	Clay - brick
A78+	84C	56 24 50 117 38 57	Clay - brick
A79	74D	56 41 24 110 04 17	Dolomite
A80+	82G	49 37 40 114 38 08	Dolomite
A81+	82O	51 04 27 115 24 28	Dolomite
A82	82O	51 15 48 115 53 47	Dolomite
A83+	82O	51 39 24 115 24 21	Dolomite
A84+	82O	51 43 46 115 25 46	Dolomite
A85+	83C	52 00 22 116 27 51	Dolomite
A86*,†	83C	52 29 12 116 00 14	Dolomite
A87+	83C	52 29 12 116 24 42	Dolomite
A88	72L	50 33 00 111 53 40	Formation brine - CaCl2
A89	82P	51 23 39 112 34 14	Formation brine - CaCl2
A90	83O	55 15 54 114 17 45	Formation brine - CaCl2
A91	83P	55 10 38 113 13 23	Formation brine - CaCl2
A92	82H	49 30 07 112 57 11	Gemstone
A93+	74D	56 42 09 110 37 47	Gypsum
A94+	74M	59 26 18 111 29 08	Gypsum
A95+	74M	59 47 14 111 45 44	Gypsum
A96+	82J	50 28 38 114 40 36	Gypsum
A97+	82J	50 40 52 115 11 23	Gypsum
A98+	83E	53 26 48 118 39 01	Gypsum
A99+	83E	53 46 00 119 53 41	Gypsum
A100+	84I	58 25 13 112 15 00	Gypsum
A101+	84P	59 09 43 112 31 23	Gypsum
A102+	84P	59 54 12 112 24 05	Gypsum
A103	83A	52 25 36 112 11 57	Leonardite
A104+	74D	56 41 24 110 48 57	Limestone
A105+	74D	56 44 54 111 22 27	Limestone
A106+	74E	57 03 10 111 53 48	Limestone
A107	82G	49 36 14 114 25 05	Limestone
A108	82G	49 37 59 114 40 00	Limestone
A109*,+	82G	49 38 52 114 38 38	Limestone
A110+	82H	49 16 08 113 33 31	Limestone (coquina)
A111	82O	51 03 34 115 10 31	Limestone
A112	82O	51 03 34 115 16 06	Limestone
A113	82O	51 04 47 115 07 33	Limestone
A114	82O	51 57 44 115 17 16	Limestone
A115†	83C	52 15 12 116 23 34	Limestone
A116	83C	52 28 20 116 03 07	Limestone
A117	83D	52 56 13 118 02 07	Limestone
A118+	83E	53 29 25 118 11 00	Limestone
A119+	83E	53 38 09 118 37 32	Limestone
A120+	83E	53 44 15 119 22 27	Limestone
A121	83F	53 00 38 117 19 33	Limestone
A122	83F	53 10 14 117 57 44	Limestone
A123	83F	53 13 43 117 48 57	Limestone
A124*,+	83F	53 14 35 117 47 30	Limestone
A125+	83F	53 17 13 117 54 49	Limestone
A126+	82G	49 36 14 114 18 19	Magnetite, paleoplacer
A127+	82H	49 11 46 113 55 03	Magnetite, paleoplacer
A128+	73E	53 53 48 110 42 39	Marl
A129+	73E	53 56 25 111 48 05	Marl
A130+	82O	51 39 24 114 26 15	Marl
A131+	82P	51 35 00 112 18 46	Marl
A132+	83B	52 03 52 114 29 19	Marl
A133+	83B	52 19 36 114 16 36	Marl
A134	83F	53 32 54 116 47 25	Marl
A135+	83G	53 17 13 114 30 02	Marl
A136	83G	53 25 55 114 17 00	Marl
A137+	83G	53 40 45 114 02 43	Marl
A138+	83H	53 31 08 113 40 45	Marl
A139*,+	83H	53 34 38 113 40 45	Marl
A140+	83H	53 35 30 113 48 07	Marl
A141+	83H	53 52 56 113 24 44	Marl
A142	83I	54 09 31 113 30 57	Marl
A143	83J	54 06 05 115 23 16	Marl
A144+	83M	55 43 50 118 55 03	Marl
A145+	83M	55 45 35 118 51 57	Marl
A146+	83N	55 07 10 116 51 37	Marl
A147+	83N	55 07 10 117 39 19	Marl
A148	84C	56 06 31 117 38 33	Marl
A149+	82G	49 34 00 114 40 00	Phosphate
A150*,+	82G	49 39 30 114 38 15	Phosphate
A151+	82G	49 44 00 114 38 00	Phosphate
A152+	82J	50 33 15 114 55 45	Phosphate
A153+	82J	50 41 30 115 07 30	Phosphate
A154+	82J	50 47 15 115 15 30	Phosphate
A155+	82J	50 53 58 115 16 55	Phosphate
A156+	82O	51 08 30 115 37 30	Phosphate
A157+	82O	51 14 40 115 30 40	Phosphate
A158+	82O	51 25 30 115 39 30	Phosphate
A159+	82O	51 31 00 115 43 15	Phosphate
A160+	83C	52 10 51 116 32 08	Phosphate
A161+	83C	52 26 30 116 45 30	Phosphate
A162+	83C	52 43 15 117 07 30	Phosphate
A163+	83E	53 20 30 118 35 45	Phosphate
A164+	73D	52 13 23 110 22 23	Potash
A165+	72E	49 56 12 110 16 07	Pumicite
A166	82J	50 07 36 114 08 25	Pumicite
A167+	82O	51 05 19 115 18 53	Quartzite
A168	73D	52 29 06 110 57 06	Salt (storage)
A169	73D	52 38 42 111 17 15	Salt (storage)
A170	73E	53 46 49 111 42 08	Salt
A171	73E	53 52 04 110 38 12	Salt
A172	74D	56 42 16 111 20 51	Salt
A173	83H	53 44 12 113 11 21	Salt
A174*	83H	53 45 05 113 09 52	Salt (storage)
A175	83H	53 47 35 112 52 57	Salt
A176	83H	53 48 01 112 53 41	Salt
A177*	83H	53 48 34 113 08 22	Salt (storage)
A178	83H	53 50 19 113 05 24	Salt (storage)
A179	82H	49 32 44 113 48 35	Sandstone - building stone
A180	82H	49 44 05 113 37 45	Sandstone - building stone
A181	82H	49 49 20 113 13 21	Sandstone - building stone
A182	82I	50 30 23 113 47 48	Sandstone - building stone
A183	82I	50 34 45 113 53 39	Sandstone - building stone
A184*	82I	50 36 30 113 50 53	Sandstone - building stone
A185	82J	50 46 06 114 02 08	Sandstone - building stone
A186	82O	51 01 50 115 14 42	Sandstone - dimension stone
A187*	82O	51 02 42 114 06 19	Sandstone - building stone
A188*	82O	51 03 34 114 09 07	Sandstone - building stone
A189	82O	51 07 57 115 23 05	Sandstone - dimension stone
A190	82O	51 08 49 114 04 56	Sandstone - building stone
A191*	82O	51 09 41 114 23 04	Sandstone - building stone
A192	82O	51 12 18 114 28 39	Sandstone - building stone
A193	82O	51 38 32 114 07 50	Sandstone - building stone
A194	82P	51 58 32 113 43 45	Sandstone - building stone
A195	83A	52 02 02 113 55 10	Sandstone - building stone
A196	83A	52 16 00 113 49 27	Sandstone - building stone
A197	83G	53 35 31 114 59 46	Sandstone - building stone
A198+	74D	56 06 30 110 29 16	Silica sand
A199+	74D	56 31 48 110 02 41	Silica sand
A200+	74D	56 58 48 111 34 29	Silica sand
A201+	74E	57 05 47 111 37 42	Silica sand
A202*,+	83A	52 22 07 113 44 04	Silica sand
A203	83H	53 51 11 112 55 00	Silica sand
A204+	83P	55 49 54 112 39 16	Silica sand
A205+	84C	56 20 28 117 15 15	Silica sand
A206+	72M	51 18 25 110 30 29	Sodium sulphate
A207+	72M	51 36 45 110 05 11	Sodium sulphate
A208+	72M	51 50 43 110 05 12	Sodium sulphate
A209+	73D	52 05 31 110 56 40	Sodium sulphate
A210+	73D	52 16 00 110 39 31	Sodium sulphate
A211	73D	52 21 14 110 44 9	Sodium sulphate
A212+	73E	53 02 16 110 17 06	Sodium sulphate
A213+	73E	53 04 54 111 34 37	Sodium sulphate
A214	74E	57 00 33 111 29 39	Sulphur
A215	74E	57 02 18 111 34 29	Sulphur
A216	82G	49 37 59 114 34 35	Sulphur
A217	82G	49 18 13 114 00 35	Sulphur
A218	82I	50 38 34 113 46 54	Sulphur
A219	82I	50 43 29 113 56 25	Sulphur
A220	82J	50 35 37 114 09 03	Sulphur
A221	82J	50 45 14 114 29 50	Sulphur
A222	82O	51 07 57 114 34 14	Sulphur
A223	82O	51 13 11 114 38 25	Sulphur
A224	82O	51 23 41 114 02 09	Sulphur

Figure 34.6 Index to industrial mineral deposits. Numerical listing of industrial (nonmetallic) mineral deposits and occurrences in the Western Canada Sedimentary Basin.
Note: Deposits and occurrences in this table are grouped by province, and are listed first in alphabetical order by major commodity, and second (i.e., within commodities) in numerical order by NTS grid number and latitude-longitude location. The sequencing of identification numbers corresponds to this listing, and is independent for each province. ID numbers with a cross symbol (+) indicate deposits or occurrences that are not included in the data summary table (Appendix 34.I), but are given in the mineral deposits master table (Price, et al., *in press*). ID numbers with an asterisk (*) indicate deposits or occurrences that have not been plotted in Figure 34.5 because of overcrowding of deposit symbols.

ID	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities
A225	82O	51 32 25 114 12 00	Sulphur
A226+	82O	51 32 25 115 23 43	Sulphur
A227	82O	51 34 09 114 51 22	Sulphur
A228	82O	51 41 09 114 29 06	Sulphur
A229	82O	51 44 39 114 07 50	Sulphur
A230	82O	51 53 23 114 48 56	Sulphur
A231	82O	51 56 00 114 31 56	Sulphur
A232	82O	51 58 04 114 45 00	Sulphur
A233	82O	51 58 37 114 03 37	Sulphur
A234	82O	51 59 29 114 45 02	Sulphur
A235	82P	51 11 45 113 55 35	Sulphur
A236	82P	51 30 38 113 51 34	Sulphur
A237	82P	51 35 00 113 50 10	Sulphur
A238	82P	51 54 13 113 33 30	Sulphur
A239	83A	52 18 37 113 05 11	Sulphur
A240	83A	52 21 14 113 42 38	Sulphur
A241+	83A	52 45 41 112 15 57	Sulphur
A242	83B	52 09 06 115 19 18	Sulphur
A243	83B	52 13 28 115 10 44	Sulphur
A244	83B	52 45 48 114 06 34	Sulphur
A245	83B	52 46 40 115 39 26	Sulphur
A246	83B	52 56 17 114 50 06	Sulphur
A247	83B	52 56 36 115 54 07	Sulphur
A248	83F	53 12 57 116 48 27	Sulphur
A249	83F	53 28 32 117 02 10	Sulphur
A250	83F	53 33 46 116 32 41	Sulphur
A251	83F	53 39 00 116 06 08	Sulphur
A252	83F	53 42 30 116 09 05	Sulphur
A253	83G	53 02 22 115 57 48	Sulphur
A254	83G	53 11 06 115 44 38	Sulphur
A255	83H	53 03 09 113 55 02	Sulphur
A256	83H	53 57 18 113 05 24	Sulphur
A257	83K	54 06 05 116 36 45	Sulphur
A258	83K	54 11 19 116 12 45	Sulphur
A259	83K	54 15 40 117 12 44	Sulphur
A260	83K	54 20 55 116 51 44	Sulphur
A261	83K	54 25 17 117 46 08	Sulphur
A262	83K	54 56 42 117 14 32	Sulphur
A263	83L	54 49 44 118 38 50	Sulphur
A264	83M	55 22 53 118 29 57	Sulphur
A265	83M	55 24 38 119 49 57	Sulphur
A266	83M	55 43 50 119 24 33	Sulphur
A267	84L	58 26 56 119 14 25	Sulphur
A268	84M	59 03 34 118 52 01	Sulphur
A269+	82O	51 05 20 115 54 10	Talc
A270+	74E	57 00 33 111 29 39	Ti-Zr minerals
A271+	74E	57 02 18 111 34 29	Ti-Zr minerals
A272+	74E	57 00 33 111 29 39	Vanadium, nickel
B1+	82J	50 25 51 115 53 01	Barite
B2+	94F	57 41 00 125 24 00	Barite
B3+	94N	59 03 30 125 42 18	Barite
B4*,+	82J/3E	50 12 30 115 08 00	REE, Nb, phosphate
B5+	93I; 93J	54 31 00 122 04 00	REE, Nb
B6+	93J	54 32 00 122 05 00	Nb, Rb, La, Ce
B7+	94B	56 27 00 123 44 50	Nb, REE, apatite
B8+	82J	50 12 30 115 08 00	Fluorspar
B9+	82N	51 09 35 116 21 40	Gemstone (sodalite)
B10+	94G	59 46 48 123 56 24	Germanium, gallium
B11	82J	50 09 00 115 38 00	Gypsum

ID	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities
B12+	82J	50 13 00 115 42 30	Gypsum
B13	82J	50 28 00 115 52 00	Gypsum
B14	82J	50 30 00 115 53 00	Gypsum
B15+	83E	53 43 00 119 56 00	Gypsum
B16+	82J	50 04 45 114 58 00	Kimberlite
B17+	82N	51 49 30 117 00 00	Kimberlite
B18	93P	55 09 09 121 55 02	Limestone
B19	82J	50 47 20 115 40 40	Magnesite
B20+	93J	54 58 24 122 23 06	Magnesite
B21+	82N	51 09 35 116 21 40	Magnetite, paleoplacer
B22+	93O	55 42 00 123 20 00	Magnetite, paleoplacer
B23+	82N	51 09 35 116 21 40	Nepheline syenite
B24+	82G	49 06 40 114 40 45	Phosphate
B25+	82G	49 07 00 114 46 00	Phosphate
B26+	82G	49 16 05 114 36 00	Phosphate
B27+	82G	49 16 50 114 47 40	Phosphate
B28+	82G	49 18 00 114 56 45	Phosphate
B29+	82G	49 19 00 114 55 30	Phosphate
B30+	82G	49 27 10 114 40 50	Phosphate
B31+	82G	49 29 22 115 07 40	Phosphate
B32+	82G	49 32 30 115 11 00	Phosphate
B33+	82G	49 39 15 114 44 10	Phosphate
B34	82G	49 39 45 114 42 30	Phosphate
B35+	82G	49 51 50 114 59 55	Phosphate
B36+	82G	49 54 20 114 50 55	Phosphate
B37+	82G	49 57 45 114 56 25	Phosphate
B38+	82G	49 58 00 114 48 00	Phosphate
B39+	82J	50 12 00 115 00 00	Phosphate
B40+	82J	50 18 25 114 56 05	Phosphate
B42+	93I	54 17 30 120 18 00	Phosphate
B43+	93I	54 32 00 120 42 00	Phosphate
B44	82N	51 12 40 116 51 33	Quartzite
B45+	93H	53 56 47 121 26 41	Quartzite
B46	82N	51 22 18 116 57 49	Silica sand
B47	93P	55 17 00 121 38 00	Sulphur
B48	94A	56 06 58 120 53 50	Sulphur
B49	94B	56 47 00 122 21 00	Sulphur
B50+	94G	57 44 05 123 09 15	Sulphur
B51+	94G	57 46 07 122 55 45	Sulphur
B52+	94G	57 49 52 122 57 30	Sulphur
B53+	94I	58 09 48 120 44 30	Sulphur
B54+	94I	58 13 10 121 15 15	Sulphur
B55+	94I	58 21 38 120 25 35	Sulphur
B56	94J	58 40 00 122 38 00	Sulphur
B57+	82N	51 13 00 116 04 55	Talc
B58+	82O	51 05 00 115 54 00	Talc
M1	62G	49 13 19 98 12 14	Bentonite
M2	62I	50 00 00 97 14 00	Clay - expandable
M3	62J	50 59 38 99 29 57	Clay - brick
M4+	62P	51 05 00 97 18 00	Clay - kaolin
M5	62I	50 54 20 97 40 17	Dolomite
M6	62O	51 04 57 98 39 22	Dolomite
M7	63G	53 08 51 99 17 25	Dolomite
M8	63J	54 27 25 99 57 27	Dolomite - dimension stone
M9	63K	54 11 43 100 32 10	Dolomite - dimension stone
M10+	62H	49 07 00 96 51 00	Gypsum
M11	62H	49 27 30 97 15 00	Gypsum
M12	62J	50 33 03 98 46 28	Gypsum
M13	62O	51 47 51 98 31 40	Gypsum

ID	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities
M14	62I	50 05 00 96 42 00	Limestone - dimension stone
M15	62J	50 43 43 98 13 45	Limestone
M16	62O	51 19 09 98 22 34	Limestone
M17	62O	51 24 23 98 47 53	Limestone
M18	62O	51 26 53 98 48 03	Limestone
M19	62O	51 34 52 99 46 57	Limestone
M20	63C	52 48 13 101 09 44	Limestone
M21+	62K	50 27 45 101 24 15	Potash
M22	62P	51 15 00 96 23 00	Silica sand
M23+	63C	52 16 47 100 49 06	Silica sand
S1+	62K	50 06 28 101 38 58	Bentonite (calcium)
S2+	62N	51 55 49 101 55 34	Bentonite (calcium)
S3+	72F	49 28 48 108 53 51	Bentonite (calcium)
S4	72H	49 55 24 104 57 06	Bentonite (swelling)
S5+	62E	49 23 11 103 28 59	Clay - kaolin
S6+	62E	49 28 26 103 37 03	Clay - stoneware, brick
S7+	62L	50 21 11 102 37 28	Clay - brick
S8+	62M	51 15 15 102 29 51	Clay - brick
S9+	62N	51 31 27 101 55 20	Clay - brick
S10+	63D	52 45 11 102 22 19	Clay - shale
S11+	72F	49 26 04 108 37 53	Clay - kaolin
S12	72F	49 28 48 109 01 56	Clay - stoneware
S13	72F	49 28 48 109 10 00	Clay - stoneware
S14	72F	49 31 19 108 54 02 and 49 34 02 108 46 58	Clay - stoneware; kaolin
S15	72G	49 13 05 106 04 19	Clay - stoneware
S16	72G	49 23 34 106 12 24	Clay - kaolin, ball, stoneware
S17	72G	49 23 34 106 20 28	Clay - kaolin, ball, stoneware
S18	72G	49 23 34 106 28 33	Clay - kaolin, ball, stoneware
S19+	72G	49 28 48 106 04 19	Clay - kaolin, stoneware
S20+	72H	49 07 48 104 52 43	Clay - stoneware
S21+	72H	49 13 02 105 02 00	Clay - stoneware
S22+	72H	49 13 02 105 10 05	Clay - stoneware, ball and fireclay
S23+	72H	49 13 02 105 10 05	Clay - kaolin
S24+	72H	49 23 31 105 34 18	Clay - stoneware
S25+	72H	49 23 31 105 42 22	Clay - ball, stoneware
S26+	72H	49 28 45 105 42 22	Clay - ball
S27+	72H	49 33 39 105 47 50	Clay - ball
S28+	72H	49 33 58 105 35 49	Clay - ball and stoneware
S29	72I	50 00 13 105 12 49	Clay - refractory
S30	72I	50 05 27 105 29 11	Clay - refractory
S31	72I	50 26 26 104 41 13	Clay - expandable
S32+	72J	50 15 59 107 51 37	Clay - expandable
S33+	72J	50 42 11 106 45 57	Clay - kaolinitic sand
S34+	72J	50 42 11 106 54 16	Clay - kaolinitic sand
S35+	72J	50 47 06 107 23 10	Clay - kaolinitic sand
S36+	73A	52 16 29 105 30 19	Clay - brick
S37	73B	52 10 55 106 34 18	Clay - expandable
S38+	73C	52 32 12 109 14 32	Clay - brick, expandable
S39+	73C	52 42 40 108 15 09	Clay - brick
S40+	63L	54 31 30 102 08 45	Dolomite marble
S41	63L	54 39 30 103 25 00	Dolomite - dimension stone
S42+	62E	49 07 48 103 08 30	Formation brine - CaCl$_2$, MgCl$_2$
S43+	72K	50 47 26 108 42 18	Formation brine - CaCl$_2$, MgCl$_2$
S44	73B	52 06 00 106 47 21	Formation brine - CaCl$_2$
S45+	73I	54 53 36 105 35 28	Gypsum
S46+	73G	53 24 38 106 08 52	Kimberlite, diamondiferous
S47+	73H	53 19 20 104 51 31	Kimberlite, diamondiferous
S48+	62E	49 07 56 102 52 48	Leonardite

ID	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities
S49+	72H	49 02 34 105 16 46 to 49 28 45 105 58 31	Leonardite
S50+	73I	54 55 00 105 12 30	Limestone
S51+	73O	55 21 33 106 50 00	Limestone
S52+	72P	51 45 04 105 37 10	Magnesium sulphate
S53+	72P	51 50 18 104 20 39	Magnesium sulphate
S54+	73A	52 24 14 105 40 06	Magnesium sulphate
S55+	73G	53 24 38 106 08 52	Marl
S56	62K	50 27 45 101 32 33	Potash
S57	62K	50 38 25 101 51 18	Potash
S58	62K	50 43 43 101 59 40	Potash
S59+	62M	51 20 33 103 21 03	Potash - carnallite
S60	72I	50 26 26 105 14 13	Potash
S61	72O	51 55 32 106 04 28	Potash
S62+	72P	51 39 49 105 11 40	Potash - carnallite
S63+	72P	51 50 18 104 03 39	Potash - carnallite
S64	72P	51 50 18 105 11 40	Potash
S65	72P	51 55 32 105 45 40	Potash
S66	73B	52 00 46 107 04 29	Potash
S67	73B	52 06 00 106 21 39	Potash
S68	73B	52 06 00 106 47 21	Potash
S69+	72G	49 13 05 106 04 19	Pumicite, bentonite
S70+	72H	49 23 11 105 54 18	Pumicite, bentonite
S71+	72J	50 05 30 107 59 01	Pumicite
S72+	72J	50 10 44 107 26 15	Pumicite
S73	72J	50 21 13 107 35 07	Pumicite
S74	62K	50 38 25 101 51 18 and 50 43 43 101 59 40	Salt
S75	72I	50 26 26 105 14 13	Salt
S76	73B	52 11 14 106 38 47	Salt (NaCl)
S77	73C	52 26 57 109 05 54	Salt
S78	63C	52 58 42 101 44 34	Silica sand
S79+	63L	54 40 00 102 50 30	Silica sand
S80+	73I	54 43 08 104 57 21	Silica sand
S81+	73I	54 43 08 105 24 34	Silica sand
S82+	73I	54 55 00 105 03 00	Silica sand
S83	72H	49 02 14 104 24 29	Sodium sulphate
S84+	72H	49 02 14 104 32 30	Sodium sulphate
S85+	72H	49 18 16 104 45 51	Sodium sulphate
S86	72H	49 44 27 105 19 34	Sodium sulphate
S87	72I	50 00 13 105 45 34	Sodium sulphate
S88	72J	50 21 13 106 37 23	Sodium sulphate
S89+	72K	50 04 11 109 43 25	Sodium sulphate
S90+	72K	50 13 14 108 56 31	Sodium sulphate
S91	72K	50 21 13 108 24 37	Sodium sulphate
S92	72K	50 21 13 109 22 22	Sodium sulphate
S93+	72K	50 26 28 109 22 22	Sodium sulphate
S94	72K	50 34 12 108 24 47	Sodium sulphate
S95	72N	51 18 52 109 52 15	Sodium sulphate
S96+	72P	51 45 04 105 37 10	Sodium sulphate
S97+	72P	51 50 18 104 20 39	Sodium sulphate
S98	73A	52 00 27 105 34 24	Sodium sulphate
S99+	73A	52 19 00 105 38 20	Sodium sulphate
S100+	73B	52 05 41 107 00 00	Sodium sulphate
S101+	73C	52 00 46 108 21 36	Sodium sulphate
S102	73C	52 06 06 108 17 07	Sodium sulphate
S103+	73C	52 16 29 108 30 10	Sodium sulphate
S104	62E	49 18 42 102 37 21	Sulphur
S105	72I	50 31 40 104 32 58	Sulphur (by-product)

Figure 34.6 *(continued)*

Saskatchewan potash resources are among the largest and richest known in the world. Estimates range upward from 56 billion tonnes with grades of 25 percent K_2O equivalent or better, counting conventional and solution mining recoverable reserves (Guliov, 1992).

Salt

Salt deposits have enormous extent in the Western Canada subsurface (Fig. 34.5). The major deposits belong to the Elk Point Group, a succession of strata composed dominantly of thick salt beds which reach an aggregate thickness of 430 m in one area of the basin (Hamilton, 1971). Two distinct types of salt deposits are found in the Elk Point Group, corresponding to well defined upper and lower subdivisions. The Upper Elk Point contains the Prairie Evaporite salt, by far the most extensive deposit, which underlies half of Alberta, most of the southern third of Saskatchewan and part of southwestern Manitoba, in thicknesses up to 200 m. The salt varies considerably in purity within the basin, in a manner reflecting 'normal' marine evaporite deposition (progressing to the potash phase in the basin centre).

Salt in the Lower Elk Point is more restricted in distribution, although it too is very thick and extensive in east-central Alberta. It occurs in three separate deposits: Lower Lotsberg, Upper Lotsberg and Cold Lake salts. These deposits differ from Prairie Evaporite salt in their chemical and mineralogical makeup, reflecting an 'abnormal' history of solution and redeposition that has resulted in extraordinarily pure beds of salt.

Salt beds dip homoclinally across the plains, from a depth of 210 m at Fort McMurray in the northeast, to 1820 m at Edmonton. Salt production presently occurs at eight sites in the basin, and all but one involve solution mining. Four of the producing areas are in Saskatchewan, one of which is a potash mine at Esterhazy (S74) that supplies by-product salt for ice control. The others are brining operations: at Unity (S77) and at Belle Plaine (S75), which produce evaporated salt for domestic and agriculture use; and at Saskatoon (S76), which produces brine for chloralkali chemicals manufacture. These operations all exploit the Prairie Evaporite deposit.

In Alberta, salt is brined from the Upper Lotsberg at three sites in the Fort Saskatchewan-Bruderheim area (A173, A175, A176) for chemicals manufacture, and from the Prairie Evaporite at Lindbergh (A171) to produce evaporated salt for domestic and industrial markets. Elk Point salts are also used at several localities in Alberta and Saskatchewan for underground storage of petroleum products in artificial caverns (A168, A169, A174, A177, A178). Previously in Alberta, salt was produced from the Prairie Evaporite at Fort McMurray (A172) and from the Upper Lotsberg at Duvernay (A170), but these operations ceased some years ago.

Gypsum

Gypsum occurs in all provinces in the Western Canada Sedimentary Basin, but is exploited only in Manitoba and British Columbia. In Manitoba, surface deposits are quarried at localities near Amaranth (M12) and at Gypsumville (M13), from the Jurassic Amaranth Formation (Bannatyne, 1984). At Amaranth, the gypsum beds are about 6 m thick under 6 m of glacial overburden. At Gypsumville, the deposits are preserved within an impact crater 25 km in diameter (Lake St. Martin structure) and occur as isolated ridges rising above swamp. Previously, gypsum was mined underground at Silver Plains (M11), and also from the Jurassic Amaranth Formation at a depth of 50 m. Manitoba gypsum supplies wallboard plants in Winnipeg, Saskatoon and, at times, Edmonton. Some of the production is used also in cement manufacture at plants in Winnipeg and Regina.

British Columbia production comes from the Windermere-Canal Flats area of the Rocky Mountains (Butrenchuk, 1989b). The gypsum deposits are in the Middle Devonian Burnais Formation and are equivalent in age to evaporites of the Lower Elk Point subgroup, although depositionally quite separate and distinct. The deposits are structurally disturbed, occurring as sections of steeply dipping, contorted, gypsiferous strata 200 m or more in thickness. Quarrying takes place at two sites: the Elkhorn quarry near Windermere (B13) and the Lussier River quarry near Canal Flats (B11). Production is shipped to wallboard plants in Vancouver, Calgary and Edmonton, and to cement plants in Exshaw and Edmonton.

Alberta has a number of gypsum deposits of Devonian and Triassic ages (Hamilton, 1982). These are undeveloped, owing to their remote locations or difficult accessibilities, but at least two have future development potential. The prospective deposits are near-surface projections of Elk Point and associated Fort Vermilion Formation evaporites in northeastern Alberta, near Fort McMurray (A93) and at Peace Point on the Peace River (A101).

Sodium and Magnesium Sulphates

Sodium sulphate deposits are numerous in southern Saskatchewan and southeastern Alberta (Broughton, 1984), and have been commercially exploited for many years. They are alkali lake deposits of Recent age, formed by evaporation in enclosed drainage basins under fairly arid conditions. The deposits occur as lake brines and as intermittent or permanent crystal beds comprised dominantly of sodium sulphate, with lesser amounts of magnesium salts. Mirabilite ($Na_2SO_4 \cdot 10H_2O$) is the most abundant mineral to form in the crystal beds, which are normally interlayered with silt, clay, and organic matter. The beds typically are 1 to 5 m thick, although some greater than 30 m are known, and have grades in excess of 90 percent mineral salts. Many of the deposits are small, but 22 have indicated reserves of 500 000 t or greater, the largest at Ingebright Lake South (S92) having 9 million tonnes.

Seven sodium sulphate production plants were in operation in 1991, six of these in Saskatchewan (S86, S88, S92, S94, S95, S102). The product is used primarily in kraft pulp mills, with a small proportion going to the manufacture of detergents. These markets are declining, and two of the Saskatchewan plants (S94, S95) and the lone Alberta plant (A211) ceased operation during 1991.

No production of magnesium sulphate has occurred from alkali lakes in either Saskatchewan or Alberta. However, some of the Saskatchewan lake brines are enriched in magnesium salt, at the expense of sodium sulphate, and contain substantial resources. Most notable of these is Big Quill Lake (S53), with reserves of 2 million tonnes of magnesium sulphate (Guliov, 1992).

Terrigenous Clastics

This group of industrial minerals is divided in Figure 34.1 into fine and coarse, to correspond to the major rock-type distinction between clay-size and sand-size clastic rocks. The distinction relates also to major differences in physical properties of the industrial minerals derived from these rock types.

Bentonite

Bentonite is common in Upper Cretaceous rocks throughout the basin region, but economic deposits are rare. Only three localities are currently producing. Sodium (swelling) bentonite is produced near Rosalind, Alberta (A7) from the non-marine Horseshoe Canyon Formation, and near Truax, Saskatchewan (S4) from the marine Bearpaw Formation. The bentonite is used in foundries, drilling muds, for pelletizing, and for sealing reservoirs. Calcium (non-swelling) bentonite is produced at Thornhill (M1) near Morden, Manitoba, from the Pembina Member of the Vermilion River Formation. It is used as a decolorizing and absorbing agent for mineral and vegetable oils, and as a binder in feed pellets and foundry sand. Other deposits of swelling bentonite are known in the Bearpaw and Horseshoe Canyon formations of central Alberta, and of non-swelling bentonite in the Ravenscrag and Battle formations in southern Saskatchewan.

Clay and Shale

Clay and shale occur in virtually all of the Mesozoic and Cenozoic formations exposed in the basin region. The clay rocks have been widely exploited at various times in the past for structural clay products, cement, and lightweight (expanded clay) aggregate manufacture. All provinces except British Columbia are producing or have recently produced clay from basin rocks.

In general, the better grades of ceramic clay in Western Canada are found in non-marine bedrock formations, among which the Upper Cretaceous Whitemud Formation has been the principal source. The Whitemud is a thin (up to 30 m) but extensive unit that underlies a large area of southern Saskatchewan and part of southeastern Alberta in the Cypress Hills area. Clays in this formation are kaolin based and include plastic, stoneware, ball and china clay. Ceramic products derived from these clays include flue linings, sewer pipe, refractory brick, common and face brick, and pottery. The Whitemud Formation is also a potential source of filler-grade kaolin.

In Saskatchewan, clay production from the Whitemud Formation occurs near Eastend (S14), for use in structural clay products and pottery making at Medicine Hat, Alberta; in the Wood Mountain-Flintoft area (S15, S16, S17, S18), for brick making at Estevan; and in the Dirt Hills-Cactus Hills area near Claybank (S29), for brick making at Regina. Other sources of clay include the Paleocene Ravenscrag Formation and certain glacial lacustrine deposits. Production from the Ravenscrag in the Willow Bunch-Rockglen area (S15) is used in the Estevan brick plant and also for earthenware and stoneware products. Local glacial clays are used for lightweight aggregate production at Regina (S31) and Saskatoon (S37), and for cement making at Regina.

In Alberta, Whitemud Formation clay is quarried in the Cypress Hills area (A12, A16) for use mainly in brick making at Medicine Hat. At Edmonton, local glacial clays are combined with similar clays from Athabasca (A74) for brick making. Clays from the Upper Cretaceous Scollard Formation near Wabamun (A62), and from the Battle Formation in the Cypress Hills area, have had limited trial use for low-alkali cement manufacture. Shales from the Upper Cretaceous Wapiabi (A50) and Belly River formations are quarried for cement manufacture at Exshaw. Shale from the Paleocene Porcupine Hills Formation is quarried from pits at DeWinton just south of Calgary (A44) for lightweight aggregate production. Other significant past exploitation of Alberta clay rocks includes the use of glacial clays for expanded aggregate in Edmonton (A71), and the use of dolomitic shale from the Carboniferous Banff Formation for mineral wool production near Exshaw (A49).

In Manitoba, Jurassic and Cretaceous shales have been quarried in the Pembina Mountain and Ste. Rose du Lac areas (M3) for use in a brick plant at Lockport, which closed in 1990. Glacial lake clays are used for cement and expanded aggregate production in plants near Winnipeg (M2).

Kaolin

Deposits of kaolin in the Western Canada Sedimentary Basin are found principally in the Upper Cretaceous Whitemud Formation. No production of kaolin in the 'pure commodity' sense has occurred, although many of the produced industrial ceramic clays are kaolin-rich. In southern Saskatchewan, the Whitemud Formation comprises a lower kaolinized sand member and an upper plastic clay member (Guliov, 1992). In the Wood Mountain area (S17), the lower member contains 50 to 60 percent kaolin. Research and development work has shown the kaolin component to be potentially separable and upgradable to a commercial filler-grade product. The kaolin reserves in the area are large, close to 200 million tonnes (Master, 1987).

Silica Sand and Quartzite

Silica deposits are widely scattered in Western Canada in rocks of Ordovician, Cretaceous and Recent ages, and production of silica occurs in all provinces (Collings and Andrews, 1989). In Manitoba, silica sand is quarried on Black Island in Lake Winnipeg (M22), from the Ordovician Winnipeg Formation. The sand is a high-purity product and was used until recently for glass manufacture in Redcliff, Alberta; its current uses include foundry and filter-bed sand, and sandblasting. Another high-purity deposit near Beausejour, Manitoba has been produced periodically for use in glass making, sand-lime brick and other constructional uses. This is a post-glacial deposit and is believed to have been derived from Ordovician Winnipeg Formation sand. Other potential deposits are present in the Lower Cretaceous Swan River Formation near Swan River (M23).

In Saskatchewan, the Lower Cretaceous Mannville Formation (Swan River equivalent) contains high-purity silica deposits in the Red Deer River area (S78) and near Wapawekka Lake (S82). Only in the Red Deer River deposit has production occurred, the product for use as golf course sand. Another deposit in the same area, at Hanson Lake (S79), is in the Ordovician Winnipeg Formation. This sand has had limited use as flux for nonferrous metal smelting at Flin Flon, Manitoba, and has been investigated as a hydraulic fracturing sand.

Alberta's lone silica producer is a Recent dune sand deposit near Bruderheim (A203). The sand is relatively low-grade material derived from reworked glacial deposits and is used mainly for fibreglass manufacture. Higher grade resources are known in northern Alberta, in deposits of Early Cretaceous age, but are undeveloped. These include the McMurray Formation sands that arise as tailings from oil sands processing (A200), and highly quartzose marine sands in the Peace River (A205) and Pelican (A204) formations.

The Ordovician Mount Wilson Formation is the source of high-grade silica at two production sites near Golden in British Columbia. The formation crops out along a narrow, 50 km long belt in southeastern B.C. and for most of its length comprises massive white quartzite. At Nicholson (B44), the quartzite is quarried and crushed to produce lump silica for ferrosilicon manufacture in Washington state. At Mount Moberly (B46), on the northern end of the belt, the quartzite unit includes a friable sandstone phase that allows for the production of granular silica. The product is used for glass manufacture at Vernon, B.C. and for various silica sand markets in Western Canada, including golf course sand. Another high-grade silica resource, albeit undeveloped, occurs near Longworth in northeastern B.C., in quartzite of the Silurian Nonda Formation (B45).

Sandstone

Sandstones in the Western Canada Sedimentary Basin have had limited industrial use. Most have poor durability for use as a building stone, or even for riprap. The only sandstone currently exploited in the basin is found in the Triassic Spray River Formation. It is fine grained and grades to siltstone. This rock is quarried near Canmore in the Alberta Rocky Mountains (A186, A189), where it is known as 'Rundle Rock'. The rock is dark gray and flaggy, and is used primarily for rough building stone and patio stone. Another Alberta sandstone, which had significant past use, is known as 'Paskapoo Sandstone'. The rock is a weak, friable sandstone from the Paleocene Paskapoo and Porcupine Hills formations. As many as 20 quarries of this stone were once operated (Godfrey, 1986). Limited use is still made of Paskapoo Sandstone for restoration of historic Alberta buildings originally constructed of this material, particularly in Calgary.

Titanium-zirconium Minerals

Heavy minerals that exist in trace amounts in Lower Cretaceous McMurray Formation oil sands are rich in titanium minerals and zircon. The 'heavies' become concentrated in the secondary tailings stream during oil sands processing at Fort McMurray. The concentration level is such that these tailings are comparable in tonnage and grade to world-scale mineral sands deposits worked commercially for titanium and zirconium minerals recovery (Trevoy, 1984). However, commercial development has not yet occurred for the oil sands tailings.

Sand and Gravel

Construction sand and gravel rate among the most important industrial minerals in the Western Canada Sedimentary Basin in terms of total production value. Deposits are widely dispersed in all provinces and production occurs at hundreds of sites. Because of the abundance of sand and gravel deposits and operations throughout the region, they are not presented in Figure 34.5.

Sand and gravel are hosted primarily in the surficial mantle of the basin region. They occur in three main geological categories: preglacial, glacial, and Recent alluvial (Edwards, 1992). By far the most common are the glacial deposits, which comprise mainly outwash but also include ice-contact and glacio-lacustrine deposits. The latter are important aggregate sources in southern Manitoba and eastern Saskatchewan, where they occur as extensive beach deposits. Preglacial deposits are of local importance in Alberta and Saskatchewan. They are found both as channel fill in bedrock channels (e.g., at Villeneuve, Alberta), and as Tertiary gravel cappings on bedrock uplands (e.g., at Hand and Wintering hills in Alberta, at Cypress Hills in Alberta and Saskatchewan, and in the Swift Current and Wood Mountain areas in Saskatchewan). Recent alluvial deposits are less common, but are worked in many places, generally on river terraces, and account for a major share of the production.

Other Industrial Minerals

This category includes minerals of various geological origins that are not classifiable in any of the previous categories. Some are the result of fluid-rock interactions (sulphur, formation brines); some are metamorphic (talc), pyroclastic (pumicite), and alteration products (leonardite); and some are commodity specialties (gemstones).

Other industrial minerals that belong to this category but have strong overlapping ties with the metallics are discussed under Metallic Minerals. These are mostly minerals that are the result of igneous emplacement (diamondiferous 'kimberlites'; niobium-, rare earth- or fluorspar-bearing carbonatites; nepheline syenite; germanium-gallium; and some magnetite deposits); they also include a paleoplacer (magnetite) and a bitumen byproduct (vanadium).

Sulphur

Sulphur is widespread in the Western Canada Sedimentary Basin, primarily in the form of hydrogen sulphide dissolved in natural gas in subsurface reservoir formations. The basin is the world's second largest producer of sulphur; most of it as by-product or co-product of sour gas production from Devonian and Carboniferous carbonate reservoirs. The sulphur is recovered in more than 50 sulphur extraction plants in Alberta (A216 to A268), four in northeastern British Columbia (B47, B48, B49, B56), and one in Saskatchewan (S104). A small but significant proportion (about 9 percent) is recovered from synthetic crude oil extracted from the Athabasca oil sands (A214, A215).

Sulphur production from sour gas has declined from the peak years of 1980-85 because of depletion of 'conventional' resources (i.e., gas fields with H_2S concentrations less than 50 percent and mostly in the range of 3-20 percent). However, potential new resources exist in the form of 'ultra sour' gas (70-90 percent H_2S), and the technology for extraction of these resources is under pilot plant development at the Bearberry field in the southern Alberta Foothills (A230). If the recovery technology proves feasible, reserves from the Bearberry field alone could double the recoverable sulphur reserves in Western Canada, which are estimated currently at about 100 million tonnes.

A prospective future source of sulphur in Western Canada is native sulphur found in carbonate-evaporite successions of Devonian, Carboniferous and Triassic ages in Alberta and British Columbia (Hora and Hamilton, 1992). Several intersections of native sulphur in Middle Devonian rocks are recorded in wells of northeastern B.C. (B50 to B55), and one occurrence in the Upper Devonian Wabamun Group near Camrose, Alberta (A241) has been intensively prospected.

Formation Brines

Formation waters enriched in calcium, magnesium, bromide, iodide and lithium have been mapped in the Alberta subsurface (Hitchon, 1984), and are known to exist elsewhere in the basin region (Fig. 34.5). Formation brines in Devonian reservoirs (Keg River and Beaverhill Lake formations) are currently exploited at four localities in Alberta for calcium chloride production: two near Slave Lake (A90, A91), one at Drumheller (A89), and one at Brooks (A88). In Saskatchewan, calcium chloride brine seeping into the PCS potash mine near Saskatoon (S44) is recovered and marketed (Buchinski, 1988). The source of this Ca- and Mg-enriched brine is believed to be the Middle Devonian Dawson Bay Formation. Similar brines are found in Middle Devonian carbonate reservoirs elsewhere in the Elk Point Basin in Saskatchewan (Guliov, 1992).

Talc

Talc in the Western Canada Sedimentary Basin was reported by Spence (1940) in Cambrian Cathedral Formation strata at three localities west of Banff, Alberta. All are within National Park territory. The Silver Moon deposit (B57), just west of Vermilion Pass in British Columbia, was worked to a small extent before 1930. The Gold Dollar (B58) and Red Mountain (A269)[3] deposits lie near the B.C.-Alberta boundary in the vicinity of Redearth Pass. Red Mountain was prospected in 1944 as a wartime strategic material source, but was never developed.

Pumicite

Pumicite deposits are reported in numerous localities in Saskatchewan and Alberta, and range in age from Upper Cretaceous to Quaternary. Most are too thin and limited in extent to be of economic interest, but at least three of the Saskatchewan deposits appear large enough for commercial development (Guliov, 1992). These are the Rockglen (S69) and Duncairn (S71) deposits of Eocene-Oligocene age, and the St. Victor (S70) deposit of the Paleocene Ravenscrag Formation. Only one Alberta deposit has any sizeable extent. This deposit is in the Upper Cretaceous Bearpaw Formation near Irvine in the Cypress Hills area (A165). Reported past development of pumicite in the basin relates to small tonnages mined during the 1930s and 1940s from localized deposits at Waldeck, Saskatchewan (S73) and at Willow Creek near Nanton, Alberta (A166), for use in abrasive cleansers.

Leonardite

Deposits of leonardite, which comprises humic acid-rich material formed from oxidation of low-rank coal, are found extensively in southern Saskatchewan and, to a lesser extent, in central Alberta. The Saskatchewan deposits are associated with Paleocene Ravenscrag Formation lignites in the Estevan (S48) and Willow Bunch (S49) coal fields. There is no commercial production from these deposits, but small-scale production has occurred at the Paintearth mine (A103) in the Battle River area of Alberta, from deposits associated with Upper Cretaceous Horseshoe Canyon Formation coals. The main use has been for drilling mud conditioning.

Gemstones

Gemstones are not common in rocks of the Western Canada Sedimentary Basin. Nonetheless, a thriving industry exists in Alberta based on production of 'ammolite', a gem-quality material extracted from the shells of ammonites (specifically, *Placenticeras*). Production is from a richly fossiliferous zone in the Upper Cretaceous Bearpaw Formation that crops out along St. Mary River in southern Alberta (A92).

Gem-quality sodalite is found in British Columbia in nephelene syenites that have intruded basin rocks. No production occurs, but at least one prospect exists in the Ice River complex south of Field (B9).

Resource Aspects of Industrial Minerals

Major industrial mineral products for the different provinces in the Western Canada Sedimentary Basin region are summarized in Figure 34.3. By far the bulk of the production value comes from four primary commodities: potash, sulphur, limestone (in cement and lime), and construction aggregates (mainly sand and gravel). These four commodities accounted for 90 percent of the total industrial mineral production value in 1991, with potash and sulphur together accounting for almost 70 percent. The balance is spread among the many minerals[4] discussed in the foregoing sections.

3. Studies published since this chapter was prepared indicate that the Red Mountain talc deposit described by Spence (1940) and MacLean (1988) as an Alberta occurrence actually lies within British Columbia (Benvenuto, 1992).

4. Included in mineral production statistics is peat moss - not presented in this chapter because it does not relate directly to the rocks or geological processes associated with the Western Canada Sedimentary Basin.

The total value of industrial mineral production for the region is about one third of that for all of Canada. This high proportion is misleading, however, because the region is one of relative industrial immaturity. Potash and sulphur, which account for the bulk of the total value, are both sold largely on the export market. Most of the other commodities are dependent on industrial markets within the region, and accordingly are only minimally developed. Potential for expanded production exists for practically all the minerals, but the realization must await further industrial growth within the region or the securing of markets without.

In addition to the above, there are minerals in the basin that have been produced in the past but are not currently produced, and minerals that have been prospected but not yet developed. Some of the more important of these, in terms of 'value added' and competitive marketing potential, include: potash in Manitoba; kaolin, Mg brines, leonardite, and diamonds in Saskatchewan; Ti-Zr minerals, native sulphur, and diamonds in Alberta; and phosphate, native sulphur and carbonatite-hosted Nb-rare earth elements-fluorspar in British Columbia.

Metallic Minerals

There are at least 97 metallic mineral occurrences in Phanerozoic strata of the Western Canada Sedimentary Basin or in underlying Precambrian basement rocks (Figs. 34.7 and 34.8). A synopsis of the available data for each metallic mineral occurrence is given in the mineral deposits master table (Price et al., *in press*). Appendix II presents an extract of these data for deposits that have current or past production and for occurrences that are classed as prospects. Figure 34.9 summarizes the occurrences by province or territory, by major commodity, and by whether the host is Phanerozoic strata or Precambrian basement rocks.

The following discussion of the characteristics of the mineral occurrences uses the report by Eckstrand (1984) as a guide to deposit type.

Precious Metals

Seven of the ten precious metal occurrences are placer gold in Recent or Pleistocene river gravels in Alberta, Saskatchewan and the Northwest Territories (A2, A3, S1 to S4, N1)[5]. Past production typically consists of a few tens of kilograms of gold or less at a few occurrences. The bedrock sources of the placer gold are unknown.

The other precious metal occurrences comprise: 1) gold-bearing quartz veins that cut Lower Cambrian quartzitic rocks near Athabasca Pass, British Columbia (B1); 2) anomalous concentrations of up to 0.21 g Au/t in Lower Cretaceous volcanic rocks in southwestern Alberta (A1); and 3) silver-bearing galena-tetrahedrite-quartz veins in southeastern British Columbia (B2).

Base Metals

Base metals make up the most abundant type of metallic occurrences in the Western Canada Sedimentary Basin. There are at least 59 such occurrences: eight occur in Precambrian basement rocks underlying Phanerozoic strata in either Saskatchewan or Manitoba, ten are in Precambrian sedimentary rocks that crop out in the Cordillera of British Columbia and Alberta, and the remaining 41 are hosted by Phanerozoic strata (Fig. 34.9).

5. Deposit identification numbers for metallic minerals comprise a one-letter Province identifier (A, Alberta; B, British Columbia; M, Manitoba; N, Northwest Territories; S, Saskatchewan; Y, Yukon Territory) followed by a sequential number. A complete listing of ID numbers with deposit locations is given in Figure 34.8.

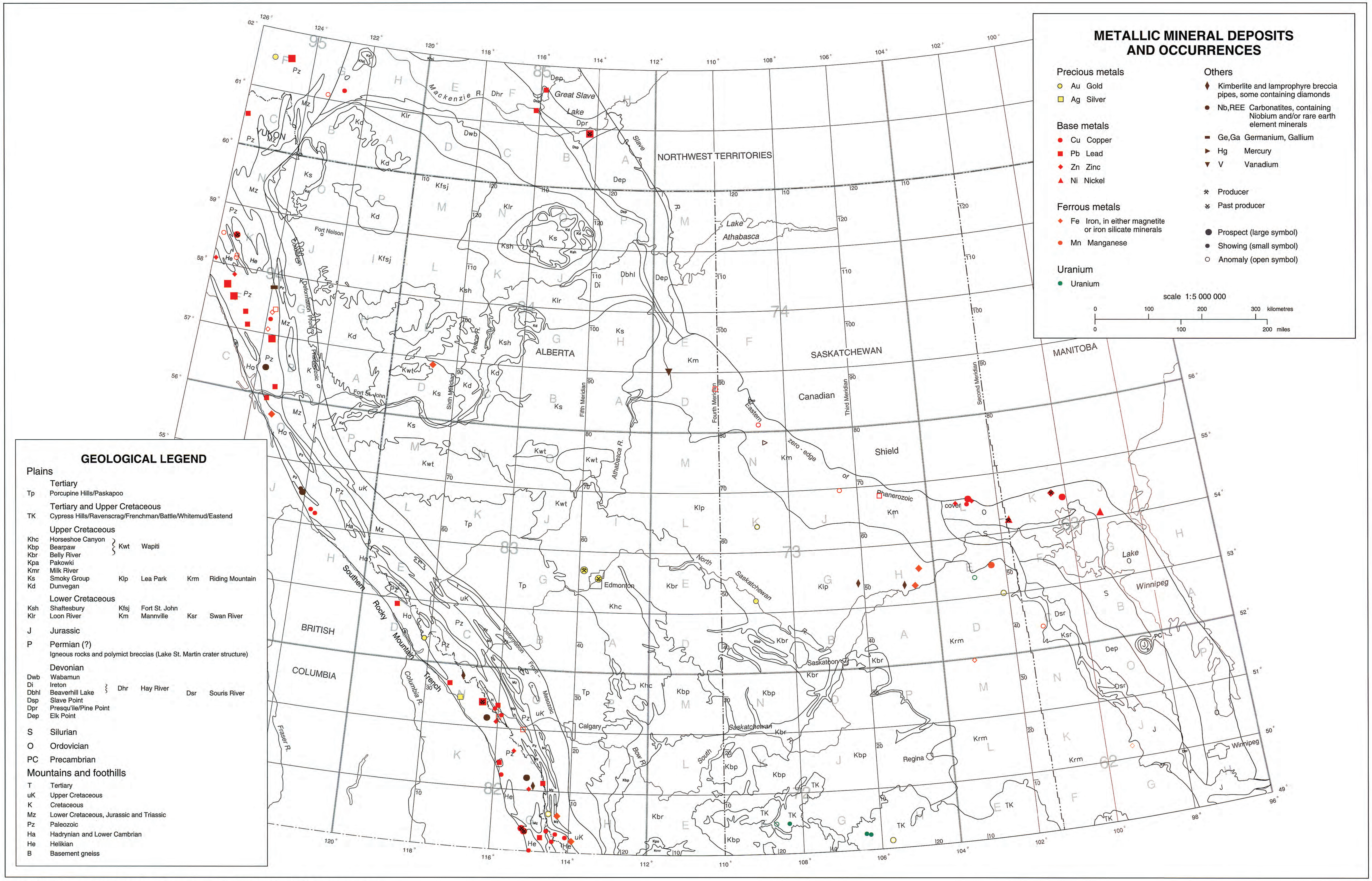

Figure 34.7 Metallic mineral deposits and occurrences in the Western Canada Sedimentary Basin.

ID	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities
A1+	82G	49 37 59 114 31 52	Au
A2	83H	53 33 45 113 26 00	Au (placer)
A3	83H	53 41 37 113 51 04	Au (placer)
A4+	82G	49 15 00 114 05 00	Cu
A5+	82G	49 18 00 114 20 00	Cu
A6+	82N/8	51 19 00 116 05 00	Cu, Pb, Zn
A7+	82O/4	51 13 00 115 54 00	Cu
A8+	74D	56 43 35 110 05 05	Pb, Zn
A9+	82J	50 07 42 114 43 02	Pb, Zn
A10+	82O	51 00 05 115 18 53	Pb, Zn
A11+	82N/8	51 22 30 116 01 10	Pb, Cu
A12+	82O/4	51 11 00 115 59 00	Pb, Ag
A13	82G	49 36 14 114 18 19	Fe, Ti - magnetite
A14	82H	49 11 46 113 55 03	Fe, Ti - magnetite
A15	84D	56 54 04 118 43 26	Fe
A16	74E	57 00 33 111 29 39	V, Ni
B1+	83D/8	52 23 00 118 09 00	Au
B2+	82N	51 27 48 117 02 24	Ag,Pb,Cu,Au
B3+	82G	49 00 45 114 58 49	Cu, Zn, Ba
B4+	82G	49 10 40 114 24 51	Cu, Au, Ag, Mo
B5	82G	49 19 38 115 07 45	Cu, Ag, Au
B6+	82G	49 20 45 114 34 05	Cu
B7	82G	49 22 20 115 12 00	Cu, Ag
B8+	82J	50 14 00 115 48 00	Cu, Pb, Zn, Ag
B9+	93I	54 12 10 121 37 30	Cu
B10+	93I	54 15 23 121 45 36	Cu, Ag
B11+	94G	57 15 12 123 52 06	Cu, Pb, Zn, Ba
B12+	94K	58 08 24 125 16 48	Cu
B13+	94K	58 09 54 125 16 18	Cu
B14+	94K	58 30 00 125 50 00	Cu
B15	94K	58 30 42 125 24 06	Cu
B16+	82G	49 114 08 14 43 44	Pb, Zn, Au, Cu, Ba
B17+	82J	50 25 51 115 53 01	Pb, Zn, Ba
B18	82N	51 24 50 116 26 10	Pb, Zn, Ag, minor Cd
B19+	82N	51 41 00 117 21 00	Pb, Zn, Ag, Cu, Au
B20+	83D	52 54 12 118 59 54	Pb, Zn, Ag
B21+	93O	55 57 12 123 34 30	Pb, Zn
B22+	94B	56 09 30 123 23 05	Pb, Zn
B23	94B	56 56 06 123 44 00	Pb, Zn
B24+	94F	57 05 42 124 33 06	Pb, Zn, Ba
B25+	94F	57 18 00 124 41 00	Pb, Zn, Ba
B26	94F	57 30 30 125 07 54	Pb, Zn, Ag, Ba
B27	94F	57 41 00 125 24 00	Pb, Zn, Ag, Ba
B28+	94G	57 25 30 123 46 48	Pb, Zn
B29+	82J	50 01 24 115 04 03	Zn, Pb
B30+	82J	50 38 20 115 30 40	Zn, Pb
B31+	82N	51 06 12 116 02 12	Zn, Pb
B32+	94F	57 51 45 125 14 00	Zn, Ba, minor V
B33+	94G	57 04 54 123 53 54	Zn, Pb
B34+	94G	57 22 12 123 51 30	Zn, Pb, Ba, Fl
B35+	94K	58 04 12 125 54 54	Zn, Pb, Ba
B36	82N	51 09 35 116 21 40	Fe, Ti
B37	93O	55 42 00 123 20 00	Fe

ID	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities
B38	82J/3E	50 12 30 115 08 00	REE, Nb, phosphate.
B39+	93J	54 32 00 122 05 00	Nb, Rb, La, Ce
B40	93I/5; 93J/8,9	54 31 00 122 04 00	REE, Nb
B41	94B/5	56 27 00 123 44 50	Nb, REE, apatite
B42+	82J/2	50 04 45 114 58 00	Kimberlite
B43+	82N/14,15	51 49 30 117 00 00	Kimberlite
B44	94G	57 46 48 123 56 24	Germanium, gallium
M1	63K/8	54 24 25 100 08 57 and 54 29 06 100 02 45	Cu, Zn
M2	63K/9	54 32 40 100 24 40	Zn, Cu
M3	63J/3	54 05 18 99 11 12	Ni, Cu, minor PGE
M4	63K/4	54 11 42 101 44 54	Ni, Cu, PGE
M5+	62J	50 11 47 99 18 50	Fe
M6+	63C	52 23 00 101 10 00	Mn, Fe
N1+	95F/11	61 32 00 125 21 00	Au (placer)
N2+	95G/3	61 05 00 123 19 00	Cu
N3+	95G/2	61 11 30 122 46 35	Cu, minor Zn, Pb
N4	85B/16	60 40 00 115 00 00 to 61 00 00 114 00 00	Pb, Zn
N5+	85F/1,8	61 15 00 116 08 00	Pb, Zn
N6+	85G/12	61 36 00 115 50 00	Pb, Zn
N7	95F/7,10	61 33 30 124 47 30	Pb, Zn, Ag, Cu, Cd
S1+	63E,D	53 01 00 102 08 00	Au (placer)
S2+	72H	49 14 45 105 49 00 to 49 11 30 105 46 30	Au (placer)
S3+	73B,C,F	53 12 00 109 02 00	Au (placer)
S4+	73K	54 25 00 108 42 00 to 54 26 00 109 11 00	Au (placer)
S5+	63L/10	54 33 03 102 52 01	Cu, Zn, Ag, Au
S6	63L	54 38 00 102 48 30	Cu, Zn, Pb, Ag, Au
S7+	74C	56 07 00 108 48 00	Cu
S8+	73I, P	54 39 30 105 17 30 to 55 13 00 106 47 00	Pb, Zn, Cu
S9+	63L/11	54 34 58 103 11 40	Zn, Cu, Ag, Au
S10+	63L/10	54 35 39 102 43 05	Zn, Cu, Ag, Au
S11+	62M	51 58 00 103 09 00	Fe
S12	73H	53 18 00 104 33 35	Fe
S13	73H	53 34 30 104 25 00	Fe
S14	63E	53 26 15 102 09 00 and 53 30 30 102 38 00	Mn, Fe, Ba, Cr, Ca, Cu, Au, Pb, Mo, Ni, Ag, Ti, V, Zn, Zr
S15+	73J/15	54 58 00 106 30 00	Mn
S16+	63E	53 14 05 102 57 26 to 53 24 34 102 49 03	U?
S17+	72F	49 22 00 108 30 00 to 49 25 00 108 35 00	U
S18+	72F	49 30 45 108 20 00	U
S19+	72G	49 15 00 106 16 00	U
S20+	72G	49 15 00 106 17 00 to 49 17 00 106 28 00	U
S21+	73G	53 24 38 106 08 52	Kimberlite
S22+	73H	53 17 00 104 50 30 to 53 24 00 104 53 20	Kimberlite
S23+	73N	55 49 00 108 38 00	Hg
Y1+	95C/12	60 31 00 125 53 00	Pb, Zn, Ag

Figure 34.8 Index to metallic mineral deposits. Numerical listing of metallic mineral deposits and occurrences in the Western Canada Sedimentary Basin.
Note: Deposits and occurrences in this table are grouped by province, and are listed first in order of the deposit-type groupings as presented in Figures 34.1 and 34.7; and second in numerical order by NTS grid number and latitude-longitude location. The sequencing of identification numbers corresponds to this listing, and is independent for each province. ID numbers with a cross symbol (+) indicate deposits or occurrences that are not included in the data summary table (Appendix 34.II), but are given in the mineral deposits master table (Price, et al., *in press*).

Province, Territory	Major Commodity Types										Host lithology totals		Province, territory total
	Precious Metals		Base Metals		Ferrous Metals		Uranium		Other				
	Phan.	PreC.	Phan.*	PreC.	Phan.**	PreC.	Phan.	PreC.	Phan.**	PreC.	Phan.	PreC.	
Alberta	3	0	7	2	3	0	0	0	1	0	14	2	16
British Columbia	2	0	25	8	2	0	0	0	7	0	36	8	44
Manitoba	0	0	0	4	1	1	0	0	0	0	1	5	6
Northwest Territories	1	0	6	0	0	0	0	0	0	0	7	0	7
Saskatchewan	4	0	2	4	2	3	5	0	3	0	16	7	23
Yukon	0	0	1	0	0	0	0	0	0	0	1	0	1
Subtotals	**10**	**0**	**41**	**18**	**8**	**4**	**5**	**0**	**11**	**0**	**75**	**22**	**97**
Grand total of occurrences in Phanerozoic and Precambrian rocks											**97**		

NOTE: Phan. denotes the host rock is Phanerozoic. PreC. denotes the host rock is Precambrian.
* At Pine Point district, at least 100 Pb-Zn deposits have been discovered, and 48 of these have been mined.
** For British Columbia, the ultramafic-carbonatite complex at Ice River (B36) is tabulated under "Iron-Manganese" rather than under "Other" because it includes a titaniferous magnetite deposit in a mafic phase of the intrusive.

Figure 34.9 Summary of the metallic mineral deposits and occurrences in the Phanerozoic and underlying Precambrian basement rocks of the Western Canada Sedimentary Basin.

Six of the eight base metal occurrences that exist in Precambrian basement rocks comprise stratiform volcanic-associated massive sulphide deposits (S5, S6, S9, S10, M1 and M2). The other two are magmatic ultramafic-associated nickel-copper deposits with minor amounts of platinum group elements (M3 and M4). The Spruce Point mine (M2) and the Namew Lake mine (M4) in Manitoba were in production as of 1990, and the McIlvenna Bay deposit (S6) at Hanson Lake South in Saskatchewan is awaiting a decision to take it into production.

With respect to the ten base metal occurrences in Precambrian rocks in the Cordillera, four of these (B5, B7, B13 and B15) comprise copper-bearing quartz-carbonate veins in Helikian limestone and dolostone in southeastern and northeastern British Columbia. Five occurrences (A4, A5, B3, B4 and B6) comprise stratabound sediment-hosted disseminated chalcocite, chalcopyrite and bornite in Helikian arenites in southeastern British Columbia and southwestern Alberta. The other occurrence (B20), east of Valemount, British Columbia, consists of galena-sphalerite-quartz veins in quartz conglomerate of unknown, but probable Proterozoic age. The most important past-producer is the now closed Churchill Copper mine (B15) in northeastern British Columbia, which produced 14 670 000 kg of copper between 1970 and 1975. A small amount of copper has been produced also from the Peacock Copper (B7) and Burton (B5) deposits in southeastern British Columbia.

Phanerozoic rocks host at least 41 base metal occurrences in the Western Canada Sedimentary Basin. These occurrences are of several diverse types, including: 1) stratabound Mississippi Valley type lead-zinc deposits, 2) stratiform sediment-hosted sulphide-barite deposits, and 3) vein-type and breccia-fill sulphide showings. Mississippi Valley type Pb-Zn deposits have been the most economically important base metal occurrences. Examples of this type include the past-producers, Pine Point (N4) and Monarch-Kicking Horse mines (B18), the undeveloped prospect at Robb Lake (B23), and numerous small occurrences in Alberta, British Columbia, the Northwest Territories and Saskatchewan. All the Mississippi Valley type Pb-Zn occurrences exist in Cambrian to Devonian carbonate rocks, and they range in size from minor occurrences to major past-producers, with the largest being Pine Point (N4). Between 1964 and 1988 about 62 million tonnes of ore with an average grade of 2.7 percent Pb and 6.4 percent Zn were mined from 48 separate deposits in Middle Devonian strata in the Pine Point district, generating in excess of $334 million in dividends (W.A. Gibbins, *pers. comm,* 1991). All of these 48 deposits, with the exception of two underground operations, were mined by open-pit methods.

The stratiform sediment-hosted ('Sedex') sulphide-barite deposits in Phanerozoic strata are an important potential source of lead-zinc-silver. At the Cirque deposit (B26) in northeastern British Columbia, for example, reserves are reported to be at least 22 million tonnes grading 2.8 percent Pb, 9.4 percent Zn and 60 g Ag/t. The Cirque deposit is in Devonian Gunsteel Formation shale. There are several other occurrences of possible Sedex type in northeastern British Columbia, including Mt. Alcock (B27), Ern (B24), Elf (B25), Spa (B32) and D, P, G, Goof (B35). These deposits are also potential sources of barite as a co-product.

Vein-type and breccia-fill base metal occurrences are the most common type of base metal occurrences in Phanerozoic strata. The largest resource of this type is in the Prairie Creek area (N7) of the southwestern Northwest Territories. At Prairie Creek there are at least 15 Pb-Zn-Ag deposits and showings associated with a shear zone that cuts Ordovician to Devonian carbonate rocks. Reserves at the No. 3 zone at Prairie Creek were reported in 1984 to be about 1 450 000 tonnes grading 11.2 percent Pb, 12.2 percent Zn, 0.44 percent Cu, 0.1 percent Cd and 190 g Ag/t.

Most of the base metal occurrences in Phanerozoic strata in the Western Canada Sedimentary Basin are not reported to be important. However, many of the occurrences are either inadequately evaluated or detailed descriptions are lacking; hence it is difficult to determine whether they have further exploration potential.

Ferrous Metals

There are a total of twelve Fe, Fe-Ti or Mn-Fe deposits in the Western Canada Sedimentary Basin. Four of these are in Precambrian basement rocks; one is associated with an ultramafic intrusive complex; one is in Hadrynian metasedimentary rocks; and six are hosted by Phanerozoic strata (Fig. 34.9). The four deposits in Precambrian rocks are associated with iron formation or other such iron-rich sedimentary rocks and their metamorphosed equivalents (M5, S11, S12 and S13). The largest deposits are at Choiceland (S12) and Kelsey Lake (S13) in central Saskatchewan, where Algoman-type magnetite-bearing iron formation in the Precambrian basement is overlain by several hundred metres of Phanerozoic strata. Reserves are substantial, but the depth of burial makes these deposits currently uneconomic.

The deposits that occur in ultramafic intrusive complexes and in Hadrynian rocks are both in British Columbia (B36, B37). The intrusive prospect is in southeastern B.C. and is associated with the ultramafic-carbonatite Ice River Complex (B36); the Fe deposit occurs as a mafic phase rich in titaniferous magnetite. The Hadrynian prospect is in northeastern B.C., about 40 km northwest of Mackenzie (B37). It is a large taconite-style iron formation in schistose argillite and greywacke of the Misinchinka Formation. The iron-bearing minerals consist of magnetite, with some hematite, in a resource that totals 5 million tonnes with an average grade of about 37.8 percent Fe. Both prospects have been investigated as magnetite-heavy media sources for coal beneficiation.

With one exception, the six prospects that occur in Phanerozoic rocks (A13, A14, A15, S14, S15 and M6), are in Upper Cretaceous sedimentary strata. The exception is manganese-rich sands of Recent origin at Little Emmeline Lake (S15) in Saskatchewan. The largest of the Upper Cretaceous prospects is at Clear Hills (A15) north of Peace River, Alberta. This deposit comprises a Minette-type, oolitic iron-rich bed up to 6.7 m thick in Upper Cretaceous Bad Heart sandstone, and resources are substantial. Another large Fe-Mn resource is in east-central Saskatchewan near Pasquia Hills (S14), where Mn- and Fe-rich nodular concretion-bearing beds occur in the basal 100 m of the Upper Cretaceous Riding Mountain Formation. Both the Clear Hills and Pasquia Hills deposits are believed to be the result of sedimentary chemical precipitation. In contrast, the two Fe-Ti prospects in southwestern Alberta are thought to be of paleoplacer origin. These two prospects, one near Burmis (A13) and the other near Dungarvan Creek (A14), both comprise titaniferous magnetite in thin lenses within iron-rich zones at the top of the basal sandstone member of the Upper Cretaceous Belly River Formation. Combined resources at these two prospects are about 6.6 million tonnes averaging 30 percent Fe (Mellon, 1961). Both prospects have been investigated as potential sources of magnetite for coal beneficiation.

Uranium

Five uranium occurrences are reported in the Western Canada Sedimentary Basin. Four of the occurrences (S17 to S20, inclusive) comprise stratabound sediment-hosted uranium associated with lignite or other organic matter in the Upper Cretaceous and Paleocene Frenchman and Ravenscrag formations in southern Saskatchewan. None of these occurrences is believed to be economic; however, in the northern United States of America, geologically similar uranium deposits in rocks of equivalent age have been mined.

The other uranium occurrence is a uraniferous anomaly associated with Upper Cretaceous strata near Red Earth Indian Reserve (S16) in east-central Saskatchewan.

Other Metallic Minerals

There are eleven mineral occurrences in the Western Canada Sedimentary Basin that do not fall readily into a metallic mineral classification scheme (Fig. 34.9). These include: three occurrences of diamondiferous 'kimberlite' pipes; five carbonatite intrusions, four of which are niobium-and rare-earth bearing; and an occurrence of germanium-gallium, of mercury, and of vanadium. These occurrences, except that of mercury, may be considered as belonging to either the industrial or metallic mineral groups, hence they are presented under both categories in Figures 34.5 and 34.7 and in the master table (Price, *in press*). However, the discussion of these mineral occurrences is given here with the Metallic Minerals.

'Kimberlite' Pipes

Alkaline ultrabasic diatremes, some of which are diamondiferous, are known to occur at several localities in the Western Canada Sedimentary Basin. Their presence is confirmed in Saskatchewan and British Columbia (Gent, 1991; Pell, 1987), and is suspected in Alberta from the activities of private company exploration[6]. A kimberlite composition characterizes some, but not all, of the known intrusives.

The Saskatchewan occurrences are found at two localities in the vicinity of Prince Albert. Near Sturgeon Lake (S21), two kimberlite bodies are reported to intrude Lower Cretaceous Joli Fou Formation or later sediments. One of the bodies is reported as being diamondiferous. In the Fort-à-la-Corne area (S22), seven kimberlite pipes have been identified, with at least one confirmed to be diamondiferous. Exploration between 1987 and 1990 is reported to have resulted in the discovery of a number of kimberlite pipes and indicators at several other places in central and southwestern Saskatchewan are known (Gent, 1992).

In British Columbia, the intrusives occur in at least three areas in the Western and Main Ranges of the Rocky Mountains: at Crossing Creek near Bull River-Elk River (B42), near Golden (B43), and at Ospika River (B41) near the Aley carbonatite complex. The intrusives near Golden and at Ospika River are hosted in Upper Cambrian to Ordovician-Silurian miogeoclinal sequences, whereas in the Bull River-Elk River area the host is the Carboniferous-Permian Spray Lakes and Ishbel groups. This latter occurrence, the Crossing Creek diatreme (B42), is the only one in British Columbia of true kimberlite composition, the others having affinities to ultramafic lamprophyres. All were emplaced prior to the Jurassic-Cretaceous Columbian Orogeny, in at least three distinct time periods: Ordovician-Silurian; Devono-Carboniferous (Rb/Sr dates of 334 and 348 Ma); and Permo-Triassic (Rb/Sr dates of 240 and 244 Ma) (Pell, 1987). Two of the diatremes in the Golden area (B43), of Devono-Mississippian emplacement, are reported to be diamondiferous.

Carbonatites

Carbonatites and alkali syenites are known in basin rocks only in British Columbia. They occur as intrusive plugs, dykes and sills at several localities in the Main and Western Ranges of the Rocky Mountains (Pell, 1987). Documented occurrences include the Aley carbonatite complex northwest of Mackenzie (B41), the Prince and Wicheeda Lake carbonatite complexes northeast of Prince George (B39, B40), the Ice River ultramafic-carbonatite complex south of Field (B36), and the Rock Canyon Creek fluorite-rare earth showing east of Canal Flats (B38). This latter occurrence may be related to a buried carbonatite (Pell, 1987). The carbonatite intrusions are hosted in lower and middle Paleozoic strata and are all Devono-Carboniferous in age, hence they were emplaced during one of the main periods of kimberlitic diatreme activity. Economic commodities associated with these intrusives include niobium minerals at Aley, Prince and Wicheeda Lake; nepheline syenite, gemstone sodalite and titaniferous magnetite at Ice River; rare earth minerals at Aley, Wicheeda Lake and Rock Canyon Creek; and fluorspar at Rock Canyon Creek. No development of these commodities has occurred, although extensive prospect work at Aley has outlined 20 million tonnes of reserves grading 0.7 percent Nb_2O_5 (Mining Review, 1991).

6. From 1990 through 1992, more than 24 million hectares in western and southern Alberta were staked for mineral exploration, almost all of it for diamonds.

Germanium-gallium

Germanium and gallium occur in some lead-zinc deposits in the Robb Lake area of northeastern British Columbia. Exceptional levels of Ge (up to 6,280 ppm) and anomalous Ga (to 600 ppm) have been found within sphalerite in the Cay property (B44), a carbonate-hosted Pb-Zn prospect (Leighton et al., 1989).

Mercury

Native mercury has been found associated with bituminous sands in glacial till at Fleury Point (S23) in northwest-central Saskatchewan. Mercury occurrences have not been reported elsewhere in the Western Canada Sedimentary Basin, although Allan (1914, p. 235-236) stated that quicksilver had been discovered in gravel in the Kicking Horse Valley and a possible cinnabar occurrence exists in Upper Cambrian limestone near Field, British Columbia.

Vanadium

Trace metals in the bitumen component of the Athabasca oil sands in northeastern Alberta include vanadium and nickel. These metals accumulate in the residual bitumen coke product in the oil sands plants near Fort McMurray. Burning of the coke results in further concentration of the metals in the coke ash, reaching levels up to 3.5 percent V and 1.2 percent Ni (Hamilton and Mellon, 1973). A facility for vanadium recovery at the Suncor plant (A16) was completed in 1990, but was not put into immediate operation pending market stabilization for the V_2O_5 product.

Resource Aspects of Metallic Minerals

Other than the Pb-Zn deposits at Pine Point, no important metallic mineral deposits have been discovered in the undeformed Phanerozoic rocks of the Western Canada Sedimentary Basin. However, this may be due simply to a relative lack of metallic mineral exploration in areas underlain by these heavily glaciated Phanerozoic rocks, rather than these strata being geologically unfavorable. That such may be the case is indicated by the fact that where the Phanerozoic rocks are better exposed in the Cordillera, many important or potentially important deposits have been discovered. These include, for example, the Monarch-Kicking Horse mines (B18), Cirque (B26), Robb Lake (B23), Prairie Creek (N7) and the Aley carbonatites (B41).

Macqueen and Olson (1988) speculated that potential exists for many diverse types of metallic mineral deposits to be present in the Phanerozoic strata of the Western Canada Sedimentary Basin. These types include: 1) Mississippi Valley type Pb-Zn deposits in carbonate rocks, 2) epithermal gold deposits associated with fault structures or with igneous rocks such as the Sweetgrass Intrusions or Crowsnest Volcanics in southern Alberta, 3) gold or other heavy precious metals in placer or paleoplacer settings, 4) sandstone-type or lignite-related uranium deposits in Mesozoic and Tertiary clastics or in basal Phanerozoic rocks, and 5) niobium-rare earths, uranium or other commodities such as diamonds associated with carbonatite, kimberlite or other ultramafic breccia pipes that cut through the Phanerozoic strata.

There is also potential for discovery of base metal or precious metal deposits in the Precambrian rocks that underlie the Phanerozoic strata. At present only a few economically important deposits in Precambrian rocks have been discovered, such as the Namew Lake (M4) and Spruce Point (M2) mines in Manitoba, and the McIlvenna Bay deposit (S6) in Saskatchewan. These Precambrian-hosted deposits typically have been discovered beneath only a few tens of metres or less of Phanerozoic strata. In the future however, it may be possible to discover and exploit such deposits at greater depths.

One or more of the large iron deposits that exist in Phanerozoic strata, for example at Clear Hills (A15) in Alberta and Pasquia Hills (S14) in Saskatchewan, or in the deeply buried Precambrian rocks such as at Choiceland (S12) and Kelsey Lake (S13) in Saskatchewan, are resources that could be developed in future under favorable economic conditions. Lastly, the magnetite occurrences at Ice River (B36) and near Mackenzie (B37), British Columbia, and the paleoplacer deposits that exist in Upper Cretaceous rocks such as at Burmis (A13) and Dungarvan Creek (A14) in Alberta, may have potential as sources of magnetite for coal beneficiation or possibly of some other metal or heavy mineral associated with the magnetite.

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Appendix 34.I Summary of available data for selected industrial (nonmetallic) mineral deposits in the Western Canada Sedimentary Basin.
Note: Deposits in this table are listed first in alphabetical order by major commodity; and second (i.e., within commodities), sequentially in order of NTS grid number and latitude-longitude location, which results in a geographic arrangement generally from southeast to northwest. ID numbers with an asterisk (*) indicate deposits or occurrences that have not been plotted on Figure 34.5 because of overcrowding of deposit symbols.

ID	Name	NTS	Lat.(N)Long.(W) Deg. Min. Sec.	Commodities	Geological description	Reserves, resources or development work	Reference(s)
M1	Thornhill	62G	49 13 19 98 12 14	Bentonite	Cretaceous Vermilion River Fm.		M.I. 62G/1 BNT 1
S4	Truax-Avonlea	72H	49 55 24 104 57 06	Bentonite (Swelling)	Late Cretaceous Bearpaw Fm.	Estimated reserves in excess of 10 million tons	Monea (1984); Guliov and Buller (1987); S.E.M. Assessment Files 73H15-0001 to 73H15-0008, Truax Area; Brady (1962)
A5	Drumheller	82P	51 28 54 112 42 40	Bentonite	Upper Cretaceous Horseshoe Canyon bentonite, light olive gray through olive gray to dusky brown massive, waxy, slightly silty, breaks into pieces <2.5 cm square; thick overburden		Scafe (1975); Babet (1966); Byrne (1955)
A7	Rosalind	83A	52 39 34 112 26 20	Bentonite	Bentonite deposit in Upper Cretaceous Horseshoe Canyon Fm., 2.7-3.3 m thick, main zone 166 m wide and 1.2 km long, individual seams up to 0.33 m thick, thin overburden; the bentonites exhibit good to excellent yields, low grit content	Estimated reserves more than 1 million tons. Production started in 1959, has continued since	Scafe (1975); Babet (1966); ARC Econ. Mins. Files; Ross (1964); Anderson and Plein (1962)
A8	McLeod River	83F	53 27 40 116 38 35	Bentonite	Paleocene/U. Cretaceous Saunders Gp. bentonite, 2-2.7 m thick, almost pure white; 7 m thick overburden	Small quantity was mined for cosmetic use in the 1930's	Scafe (1975); Babet (1966); ARC Econ. Mins. Files; Ross (1964); Byrne (1955); Allan (1931)
A9	Onoway	83G	53 49 29 114 17 09	Bentonite	Upper Cretaceous Horseshoe Canyon Fm. bentonite, in scattered lenses up to 1.7m thick, greenish cream, thin overburden; fair yields, moderate grit content and discontinuity of beds	Estimated reserves more than 300,000 tons. Production low, intermittent, started in 1960	Scafe (1975); Babet (1966); Ross (1964)
M2	Kildonan	62I	50 00 00 97 14 00	Clay - expandable	Stratified blue clay deposit		Bamburak (*pers. comm.*, 1990)
M3	Ste. Rose du Lac	62J	50 59 38 99 29 57	Clay - brick	Lower Cretaceous Swan River Fm.		M.I. 62 J/13 SNL 2
A12	Cypress Hills	72E	49 32 44 110 10 25	Clay - stoneware /refractory	Quarry 66 (IXL). Upper Cretaceous Whitemud Fm. 3.6 m light-med. gray clay with 0.6 m kaolinitic sand at base of Whitemud		Hamilton, Scafe and Laidler (1988)
A14	Cypress Hills, Eagle Butte	72E	49 37 58 110 29 23	Clay - stoneware	Quarry 45 (IXL). Upper Cretaceous Whitemud Fm.; light gray and dark brown shale with 2 ft. of pale gray sandstone at top; total thickness 20 ft. section		Crockford (1951); Hamilton, Scafe and Laidler (1988)
A16	Cypress Hills, Fly Lake	72E	49 39 43 110 22 36	Clay - stoneware	Quarry 34 (IXL). Kaolinitic sand unit, 2-3 m thick, in Upper Cretaceous Whitemud Fm.		Crockford (1951); Hamilton, Scafe and Laidler (1988)
A19	Dunmore	72E	49 58 04 110 36 25	Clay - brick	Clay deposit in Upper Cretaceous Judith River Fm.; 2 m of black clay with numerous plant remains overlain by gray, sandy clay and underlain by buff clay; clay beds lenticular	Production started by Alberta Clay Products Company in 1911	Ries and Keele (1912); Ries and Keele (1913); Scafe (1991)
S12	Ravenscrag Butte	72F	49 28 48 109 01 56	Clay - stoneware	Upper Cretaceous Whitemud Formation	Unknown	Worcester (1950)
S13	Ravenscrag	72F	49 28 48 109 10 00	Clay - stoneware	Upper Cretaceous Whitemud Formation	Unknown	Worcester (1950)
S14	Eastend	72F	49 31 19 108 54 02 and 49 34 02 108 46 58	Clay - stoneware, refractory; kaolin	Upper Cretaceous Whitemud Formation	Unknown	Worcester (1950); Crawford and Carlson (1953); Davis (1918); Carlson and Babey (1955); McLearn and McMahon (1933); Alcan International Ltd. (1977); Brady (1962); Pruett (1988); S.E.M. Assessment Files for NTS 72F,G,H for kaolin, clay; Lindoe (1965)
S15	Rockglen	72G	49 13 05 106 04 19	Clay - stoneware	Tertiary (Paleocene) Ravenscrag Formation (Willow Bunch Member)	Unknown	Worcester (1950); Field and Hudson (1979)
S16	Gollier Creek	72G	49 23 34 106 12 24	Clay - kaolin, ball, stoneware	Upper Cretaceous Whitemud Formation	Estimated geological reserves of kaolinized sediments 375 million tons	Worcester (1950); Crawford and Carlson (1953); McLearn and McMahon (1933); Albon (1957); Master (1987); Spyker et al. (1954)
S17	Wood Mountain	72G	49 23 34 106 20 28	Clay - kaolin, ball, stoneware	Upper Cretaceous Whitemud Formation	Estimated geological reserves of kaolinized sediments 375 million tons	Worcester (1950); Crawford and Carlson (1953); McLearn and McMahon (1933); Albon (1957); Master (1987); Spyker et al. (1954)

ID	Name	NTS	Lat.(N)Long.(W) Deg. Min. Sec.	Commodities	Geological description	Reserves, resources or development work	Reference(s)
S18	Fir Mountain Area	72G	49 23 34 106 28 33	Clay - kaolin, ball, stoneware	Upper Cretaceous Whitemud Formation	Estimated geological reserves of kaolinized sediments 375 million tons	Worcester (1950); Crawford and Carlson (1953); McLearn and McMahon (1933); Albon (1957); Master (1987); Spyker et al. (1954)
S29	Dirt Hills	72I	50 00 13 105 12 49	Clay - refractory	Upper Cretaceous Whitemud Formation, kaolinized sands and associated plastic kaolinitic clay	Unknown	Worcester (1950); Davis (1918); Ries and Keele (1913); Byers (1969)
S30	Cactus Hills	72I	50 05 27 105 29 11	Clay - refractory	Upper Cretaceous Whitemud Formation, kaolinized sands and associated plastic kaolinitic clay	Unknown	Worcester (1950); Davis (1918); Ries and Keele (1913); Byers (1969)
S31	Regina	72I	50 26 26 104 41 13	Clay - expandable	Glacial Lake clays	Reserves reported as abundant	Sacuta (1956); Davis (1918); Ries and Keele (1913)
A20	Redcliff	72L	50 04 10 110 47 20	Clay - brick	Upper Cretaceous Oldman (?) Fm. shales: 1) yellow 3 - 4 m bed; 2) dark gray 2 m bed; 3) light buff, sandy 1.5 m bed		Ries and Keele (1912); Scafe (1991)
S37	Saskatoon - Sutherland	73B	52 10 55 106 34 18	Clay - expandable	Glacial lake clay deposits	Not available.	Sacuta (1956); Carlson and Babey (1955)
A31	Blairmore	82G	49 36 14 114 26 27	Clay - brick	Jurassic Fernie Fm. shales: dark gray shale, marine, fossiliferous; dark brown shale, very calcareous, formerly used in making cement		Crockford (1951); Scafe (1991)
A35	Taber	82H	49 49 20 112 08 18	Clay - brick	Shale in Upper Cretaceous Judith River Fm., dark and somewhat gypsiferous, about 1m thick, underlies lignite seam, very plastic, smooth		Ries and Keele (1913); Scafe (1991)
A43*	Sandstone	82J	50 45 14 114 02 08	Clay - brick	Shales in Paleocene Porcupine Hills Fm: gray and blue shale mixture as used for brick making, calcareous; black through yellowish green shales, some carbonate and sand, ~6 m; greenish gray shales with sandstone interbeds to 0.6 m thick, some carbonate		Ries and Keele (1912); Worcester (1932)
A44	DeWinton	82J	50 49 36 114 00 44	Clay - expandable	Mudstones, light olive gray to olive gray, 0.30-3 m, massive, minor silt, noncalcareous; Tertiary Paskapoo and Porcupine Hills fms.		Scafe(1980); Scafe(1991)
A46*	Brickburn	82O	51 03 34 114 09 07	Clay - brick	Approximately 5.4 m of Paleocene Porcupine Hills Fm. shale, gray green, sandy, interbedded sandstone		Ries and Keele (1912)
A47	Calgary-Bow River A	82O	51 03 34 114 10 30	Clay - brick	Paleocene Porcupine Hills Fm. shale, buff to greenish brown, some grit, 7 m thick, with two major sandstone interbeds, some calcareous bands		Worcester (1932)
A48*	Calgary-Bow River B	82O	51 04 27 114 10 30	Clay - brick	Approximately 5.5 m of Paleocene Porcupine Hills Fm. shale, buff to greenish brown, gritty; 2 - 4 m overburden		Worcester (1932)
A49*	Lac des Arcs	82O	51 04 27 115 10 31	Clay - shale	Impure shaly limestone and shale, in places dolomitic, in Mississipian Banff Fm.		Holter (1976); Goudge (1945); Fox (1981)
A50	Exshaw (Seebe)	82O	51 05 19 115 04 56	Clay - shale	Quarry in section of Upper Cretaceous Wapiabi Fm. dark gray silty shale, lower part of Wapiti Fm.; about 15m exposed in pit		Scafe (1978); Fox (1981); Scafe (1991)
A51	Cochrane	82O	51 11 26 114 28 39	Clay - brick	Dark gray calcareous clay in Paleocene Porcupine Hills Fm.; very plastic		Ries and Keele (1912); Ries (1915); ARC Econ. Mins. Files (1948); Scafe (1991)
A53*	Innisfail	83A	52 01 09 113 56 36	Clay - brick	Pleistocene clay comprising alternate bands of sand, silty clay, and stiff clay, in horizontal layers 15-30 cms thick		Keele (1915)
A55	Red Deer	83A	52 16 00 113 27 52	Clay - brick	Pleistocene clay, sandy, laminated, calcareous, less than 2 m thick; overlies less than 1 m of yellowish, jointed, silty clay		Ries and Keele (1912)
A65	Vegreville	83H	53 29 23 112 03 25	Clay - brick	Pleistocene clay, brownish, noncalcareous, very sandy		Keele (1915)
A67	South Edmonton	83H	53 31 08 113 31 54	Clay - brick	Pleistocene glacial clay of considerable extent		Ries and Keele (1912)
A69*	North Edmonton	83H	53 35 30 113 37 48	Clay - brick	Pleistocene clay, yellow, very sandy, dense, some gypsum, approx. 4.5 m thick	Used for common brick	Ries and Keele (1913)
A71	Edmonton NW (St. Albert)	83H	53 38 59 113 40 45	Clay - expandable	Clay, Pleistocene glacial lacustrine, olive gray, slightly silty, calcareous		Scafe (1978); Scafe (1991)

Appendix 34.I *(continued)*

ID	Name	NTS	Lat.(N)Long.(W) Deg. Min. Sec.	Commodities	Geological description	Reserves, resources or development work	Reference(s)
A72	Namao	83H	53 45 05 113 32 10	Clay - expandable	Upper Cretaceous Wapiti shale, olive gray, slightly silty, noncalcareous, gradational lower contact, about 0.25m; over shale, dusky yellowish brown, noncalcareous, ironstone nodules at contact with a siltstone above		Scafe (1991)
A73	Smoky Lake	83I	54 07 46 112 27 58	Clay - brick	Upper Cretaceous Belly River (?) clay, yellowish, sandy; 1.2 m thick bed	Used for making stiff-mud brick	Allan (1921); Hamilton and Babet (1975)
A74	Athabasca	83I	54 41 49 113 16 07	Clay - brick	Pleistocene glacial lacustrine clay, brownish gray, very calcareous	Blended with other local clays for brick	ARC Econ. Mins. Files; Scafe (1991)
A76	Grande Prairie	83M	55 08 56 118 48 25	Clay - brick	Pleistocene clay, yellowish, silty, calcareous	Used for sand mould brick	Allan and Carr (1946); Scafe (1991)
M5	Poplarfield	62I	50 54 20 97 40 17	Dolomite	Silurian Interlake Group		M.I. 62I/13 DOL 2
M6	Rosehill	62O	51 04 57 98 39 22	Dolomite	Devonian Winnipegosis Fm.		M.I. 62O/2 DOL 1
M7	Grand Rapids	63G	53 08 51 99 17 25	Dolomite	Silurian Atikameg and Moose Lake fms.		M.I. 63G/3 DOL 1
M8	Paterson	63J	54 27 25 99 57 27	Dolomite - dimension stone	Ordovician Stony Mountain Fm.		M.I. 63K/8 STN 1
M9	Cormorant Lake	63K	54 11 43 100 32 10	Dolomite - dimension stone	Ordovician Stony Mountain Fm.		M.I. 63K/2 STN 1
S41	Deschambault - Limestone Lakes	63L	54 39 30 103 25 00	Dolomite - dimension stone	Ordovician Red River Formation high density dolomite	Extensive resource, limited quarrying for building stone	Kupsch (1952); Mysyk (1985); Guliov (1989)
A80	Crowsnest Lake	82G	49 37 40 114 38 08	Dolomite	Upper part of Devonian-Fairholme Group. Gray dolomite outcrop on small knoll south of highway; 30 m thickness exposed	Size of deposit: medium	Holter (1976)
A82	Castle Mountain	82O	51 15 48 115 53 47	Dolomite	Cambrian Eldon Fm. dolomite, dark blue-gray, fine grained, pure dolomite	Small quarry, 55.48% $CaCO_3$; 44.17% $MgCO_3$	Goudge (1945)
A88	Brooks	72L	50 33 00 111 53 40	Formation brine - calcium chloride	Formation water from Upper Devonian Beaverhill Lake Fm. is the brine source; consists of about 3 parts Ca to 1 part Na	Formation reservoir properties unknown; size of deposit: large; production not reported	Hamilton (1969); Holter (1970)
S44	PCS Cory	73B	52 06 00 106 47 21 (Mine Shaft Location)	Formation brine - calcium chloride	Middle Devonian, Prairie Formation sylvite mineralization in marine evaporite	Not available	Holter (1969); Fuzesy (1982); Buchinski (1988)
A89	Drumheller	82P	51 23 39 112 34 14	Formation brine - calcium chloride	Formation water from Upper Devonian Beaverhill Lake Fm.; well depth 1,666.7 m	Size of deposit: large; operation began in mid-1981	Pers. comm. (General Chemicals)
A90	Slave Lake	83O	55 15 54 114 17 45	Formation brine - calcium chloride	Formation brine field in M. Devonian Keg River Fm. Producing zone 1685 - 1693 m; well depth 1736 m	Products are: 77% $CaCl_2$ flake; 90% $CaCl_2$ flake; 35% $CaCl_2$ brine	Pers. comm. (Tiger Chemicals)
A91	Calling Lake	83P	55 10 38 113 13 23	Formation brine - calcium chloride	M. Devonian Keg River Fm.; depth of well about 1,500 m; top of Keg River Fm. 1363 m	Variable production; plant capacity 800 cu.m/day; one well producing	Pers. comm. (Ward Chemicals)
A92	St. Mary River	82H	49 30 07 112 57 11	Gemstone	Ammonites in Upper Cretaceous Bearpaw Fm.; have undergone unique metamorphosis resulting in brilliantly coloured gemstones known as Ammolite; ammonites found in ironstone occurrences in tight shale beds impervious to moisture	Estimated over 1 billion ammonites to be found under Alberta Plains; Korite Limited is only currently active mine	Vandervelde (1992); Wilson (1984)
M11	Silver Plains	62H	49 27 30 97 15 00	Gypsum	Subsurface deposit, in Jurassic Amaranth Fm., underground mining to 100 m depth from 1964-75		M.I. 62H/6 GYP 1
M12	Amaranth	62J	50 33 03 98 46 28	Gypsum	Jurassic Amaranth Fm.	Combined production 100,000 tpa	M.I. 62J/10 GYP 1, GYP 2
M13	Gypsumville	62O	51 47 51 98 31 40	Gypsum	Jurassic Amaranth Fm., infills Lake St. Martin crater, 10 m or more in thickness, overburden <2 m		M.I. 62O/15 GYP 1, GYP 4
B11	Lussier River-Coyote Creek	82J/4	50 09 00 115 38 00	Gypsum	Isolated occurrences of gypsum have been traced along both limbs of syncline between Lussier River and Coyote Creek; anhydrite begins at 20 - 25 m from surface	Potential estimate 20-40 million tonnes (SB); Production 1990: 135,000 tonnes; total reserves calculated in 1984: 7 million tonnes of gypsum	Butrenchuk (1989b)
B13	Elkhorn	82J/5	50 28 00 115 52 00	Gypsum	Southern extension of Burnais Fm. Beds exploited by Windermere quarries	10 - 20 million tonnes estimate (SB)	Butrenchuk (1989b)
B14	Windermere	82J/12	50 30 00 115 53 00	Gypsum	Gypsum occurs in a northwesterly trend along a strike; length of 5 km north and south of Windermere Creek; it is part of Devonian Burnais Formation; at depth of 20 - 40 m from surface the gypsum turns into anhydrite	Production 1990: 410,000 tonnes; total production since 1950 is over 6.8 million tonnes	Butrenchuk (1989b)
A103	Paintearth Mine (Tannathin)	83A/8	52 25 36 112 11 57	Leonardite	U.K. Horseshoe Canyon Fm., coal measures 45-70 m above base; leonardite mined from bed 1.1 m thick; carbonaceous humic-rich shale, used in drilling fluids	Mined from 1959 - 80; reported production 2.6 Kt (mined as "coal")	ARC Econ. Mins. Files; ERCB 88-45
M14	Tyndall - Garson	62I	50 05 00 96 42 00	Limestone, dimension stone	Ordovician Red River Fm., dolomitic limestone in lower half Selkirk Member, 6.5-9 m quarriable section, 2-4 m overburden	Not available	M.I. 62I/2 STN
M15	Lily Bay Cement	62J	50 43 43 98 13 45	Limestone	Devonian Elm Point Fm.		M.I. 62J/16 LST 1
M16	Spearhill	62O	51 19 09 98 22 34	Limestone	Devonian Elm Point Fm.		M.I. 62O/8 LST 1
M17	Faulkner	62O	51 24 23 98 47 53	Limestone	Devonian Elm Point Fm.	300,000 tpa	M.I. 62O/7 LST 2
M18	Steep Rock	62O	51 26 53 98 48 03	Limestone	Devonian Elm Point Fm., grades 95-99% $CaCO_3$	Not available	M.I. 62O/7 LST 1
M19	Paradise Beach	62O	51 34 52 99 46 57	Limestone	Devonian Dawson Bay Fm.		M.I. 62O/12 LST 2
M20	Mafeking	63C	52 48 13 101 09 44	Limestone	Devonian Souris River Fm., grades 95-98% $CaCO_3$		M.I. 63C/14 LST 1
A107	Blairmore	82G	49 36 14 114 25 05	Limestone	Mississipian Banff Fm. limestone;120 m exposed; includes dark gray, medium crystalline dolomitic limestones with shale interbeds and abundant chert lenses	Avg. $CaCO_3$ 67.39%; Avg. $MgCO_3$ 14.24%; SiO_2 17.09%.	Holter (1976)
A108	Crowsnest Lake	82G	49 37 59 114 40 00	Limestone	Limestone quarry in Mississipian Livingstone Fm. Consists of two 37 m thick high-grade limestone units, separated by 11 m thick dolomitic limestone unit	Estimated to contain 1.2 million tonnes of high purity limestone; at 1981 production levels, the quarry will be exhausted by 1994	Macdonald and Hamilton (1981); Holter (1976); Goudge (1945)
A111	Exshaw	82O	51 03 34 115 10 31	Limestone	The 33 m of Devonian Palliser Fm. strata being quarried are relatively low in Mg and consist mainly of fine, brittle, fine grained, dark gray, high Ca limestone together with minor beds that are mottled with dolomite	Size of deposit: large	Holter (1976); Goudge (1945)
A112	Canmore	82O	51 03 34 115 16 06	Limestone	Mississipian Livingstone Fm. limestone; very fine-grained, dark bluish gray, in massive, indistinct beds flecked with tiny crystals of black calcite	Large operation started by Alberta Portland Cement Co. in 1906-1914	Holter (1976); Goudge (1945)
A113	Kananaskis QB	82O	51 04 47 115 07 33	Limestone	Cambrian Eldon Fm., composed of dark gray, finely crystalline variegated and mottled limestone and interbedded dolomite; the quarry is in steeply dipping bands of very light coloured limestone, which appear to run oblique to the bedding	Size of deposit: medium	Goudge (1945), p.108. Hamilton (1987), p.17-23, 34, 36, 47, 48. N.M.I. Record 115062
A114	Corkscrew Mountain	82O	51 57 44 115 17 16	Limestone	Limestone quarry in Shunda/Pekisko fms., Mississippian	Size of deposit: medium	Holter and Hamilton (1989)
A116	Nordegg	83C	52 28 20 116 03 07	Limestone	Limestone quarry in Mississipian Pekisko Fm.; three major units: 10 m gray-weathering, dark gray to black, massive, coarse-grained, high-calcium limestone; underlain by 15-18 m of magnesian limestone, over high-calcium limestone zone	Size of deposit: medium; quarry opened for ballast before 1944; presently worked for rip rap	Holter (1976); Matthews (1961); Goudge (1945)
A117	Henry House	83D	52 56 13 118 02 07	Limestone	43 m of Devonian Palliser Fm. limestone in quarry; very fine grained, nearly black, in beds up to 2 m thick; a few minor beds of mottled magnesian limestone observed, particularly in upper part of face	Quarry operated 1917 to 1930 for production of Portland Cement	Goudge (1945)
A121	Cadomin	83F	53 00 38 117 19 33	Limestone	Limestone deposit in Upper Devonian Palliser Fm.: thick-bedded, gray and blue, fine-grained, high-calcium limestone intercalated with beds containing magnesium carbonate in 10-20% $MgCO_3$ range	Size of deposit: large; proven reserves 22 million tonnes	Holter (1976); Goudge (1945)
A122	Roche Miette	83F	53 10 14 117 57 44	Limestone	Devono-Carboniferous Mount Hawk Fm.(?) limestones; beds of high-calcium limestone, up to 12 m thick, interbedded with beds of impure magnesian limestone, up to 13.7 m thick	Quarry formerly worked for lime production	Goudge (1945)
A123	Jasper Gate	83F	53 13 43 117 48 57	Limestone	Quarry in steeply dipping beds of Devonian Palliser Fm. limestones; high calcium rock, typically dark gray, massively bedded, finely crystalline, mottled and dolomitic in part; formation varies between 180 to 240 m in thickness	97% $CaCO_3$; 3% $MgCO_3$	Holter (1976)

Appendix 34.I *(continued)*

ID	Name	NTS	Lat.(N)Long.(W) Deg. Min. Sec.	Commodities	Geological description	Reserves, resources or development work	Reference(s)
B18	Baker Creek - Sukunka R.	93P/4	55 09 09 121 55 02	Limestone	Light gray limestone of the Mississippian Rundle Group, minimum width of 45 m	A short-lived production in 1984/1985 for agriculture and highway construction - poor market conditions; reserves 40 million tonnes of chemical lime grade	Fischl (1992)
B19	Mount Brussilof	82J/13E	50 47 20 115 40 40	Magnesite	Sparry magnesite replacing dolomite of Middle Cambrian Cathedral Formation; deposit is part of the 15 km long magnesite belt located adjacent and east of the Cathedral paleo-escarpment	9.5 million tonnes 95% MgO; 13.6 million tonnes 93-95% MgO; 17.6 million tonnes 92% MgO; in calcined product; production 1990: 170,000 tonnes	Grant (1987); MacLean (1988); Simandl and Hancock (1991)
A134	Marlboro	83F	53 32 54 116 47 25	Marl	Fluvial and lacustrine marl deposit, deposition since last deglaciation; the marl ranges from 1-2.75m thick with all C.E.E. values 74% and most 85%; generally the marl lies below the water table		Govett and Byrne (1958); Holter (1970); Macdonald (1982)
A136	Duffield	83G	53 25 55 114 17 00	Marl	Abandoned channel oxbow lake marl deposit, 0.5-3 m thick; overburden 0.3 m; lies 30 m below surrounding upland and 3 m above current river level; some sections of deposit well drained, while others are wet	Poor-good quality deposit	Macdonald (1982)
A142	Halfway Lake	83I	54 09 31 113 30 57	Marl	Marl deposits in Recent glaciofluvial and glaciolacustrine sediments, found north of, in, and south of Halfway Lake; lake shallow with carbonate bottom; average C.C.E. 73-75% (1 m thick)	Large deposit; plant established in 1973 to produce cement	Macdonald (1982); Holter (1972)
A143	McGregor	83J	54 06 05 115 23 16	Marl	Hillside seepage marl deposit; thickness ranges from 3.6 m at center to 0.3 m at margin; layers of peat interbedded with the non-tufaceous marl; C.C.E. values quite variable with most from 80-85%, with organic rich layers 40-60%; overburden 0.3m	Moderate size deposit, fair-good quality	Macdonald (1982)
A148	Grimshaw	84C	56 06 31 117 38 33	Marl	Deposit is a mound of marl 13 m high with numerous tufa fragments up to 30 cm long; lensoidal in shape, max. thickness at center 4 m, diameter 360 m; samples up to 96.8% C.C.E., avg. 85%; avg. moisture content 20%, water table 3.5 m below surface	Moderately large deposit; good quality; in 1976 some production and local sale as agricultural lime	Macdonald (1982)
B34	Crow	82G/10	49 39 45 114 42 30	Phosphate	A one metre thick phosphate of Fernie Formation repeated tectonically four times has 26.20% P2O5 and 757 ppm Y	Consistent bed, 1 - 2 m thick (locally 2 - 3 m), between 11% and 29% P_2O_5, averaging 17% P_2O_5; can be traced along strike for approx. 300 km, the Y values on average are 650 - 700 ppm (occasionally may reach 1300 ppm in sample)	Butrenchuk (in press); Macdonald (1987)
S56	Rocanville	62K	50 27 45 101 32 33	Potash	Middle Devonian Prairie Formation, sylvite mineralization in marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S57	Esterhazy	62K	50 38 25 101 51 18	Potash	Middle Devonian Prairie Formation, sylvite mineralization and by-product salt from marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S58	Esterhazy	62K	50 43 43 101 59 40	Potash	Middle Devonian Prairie Formation, sylvite mineralization and by-product salt from marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S60	Belle Plaine	72I	50 26 26 105 14 13	Potash	Middle Devonian Prairie Formation, sylvite mineralization with halite	Not available	Holter (1969); Fuzesy (1982)
S61	Allan	72O	51 55 32 106 04 28	Potash	Middle Devonian Prairie Formation, sylvite mineralization in marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S64	Lanigan	72P	51 50 18 105 11 40	Potash	Middle Devonian Prairie Formation, sylvite mineralization	Not available	Holter (1969); Fuzesy (1982)
S65	Colonsay	72P	51 55 32 105 45 40	Potash	Middle Devonian Prairie Formation, sylvite mineralization in marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S66	Cominco (Vanscoy)	73B	52 00 46 107 04 29	Potash	Middle Devonian, Prairie Formation sylvite mineralization in marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S67	Patience Lake (Potash Company of America)	73B	52 06 00 106 21 39	Potash	Middle Devonian, Prairie Formation, sylvite mineralization in marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S68	PCS Cory	73B	52 06 00 106 47 21 (Mine Shaft Location)	Potash	Middle Devonian, Prairie Formation sylvite mineralization in marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S73	Waldeck	72J	50 21 13 107 35 07	Pumicite	Probably Eocene-Oligocene	Unknown	Worcester (1950); Crawford (1955)
A166	Willow Creek	82J/1	50 07 36 114 08 25	Pumicite	Recent (?) age, filling surface depression along with organic muds & marls; ash bed about 0.4 m thick, covered by 0.7 m of black mud, 80% - 2000 mesh	Small deposit, est. 1,000 - 1200 m^3; excavated on small scale for use in cleansing compounds 1942-51	ARC Econ. Mins. Files
B44	Nicholson	82N/2W	51 12 40 116 51 33	Quartzite	Massive quartzite of the Ordovician Mount Wilson Formation, SiO_2 99.85%; lump silica producer	3 million tonnes (1985); Production 1990: 36,000 tonnes	Foye (1987)
S74	Esterhazy	62K	50 38 25 101 51 18 and 50 43 43 101 59 40	Salt	Middle Devonian Prairie Formation, sylvite mineralization and by-product salt from marine evaporite	Not available	Holter (1969); Fuzesy (1982)
S75	Belle Plaine	72I	50 26 26 105 14 13	Salt	Middle Devonian Prairie Formation, sylvite mineralization with halite	Not available	Holter (1969); Fuzesy (1982)
S76	Saskatoon Chemicals (Weyerhaeuser)	73B	52 11 14 106 38 47	Salt (NaCl)	Middle Devonian, Prairie Formation salt beds	Not available	Holter (1969)
S77	Unity	73C	52 26 57 109 05 54	Salt	Middle Devonian Prairie Formation	Extensive reserves	Holter (1969)
A168	Hughenden	73D	52 29 06 110 57 06	Salt (storage)	Mid-Devonian Upper Elk Point Fm. Prairie Evaporite. Salt interval: 4500'-4824' T.D., 4496'-4857' T.D., 4493'-4851' T.D.; cored: 4493'-4851'	Salt cavern for underground storage of petroleum products	Hamilton (1971); ERCB Well Files
A169	Hardisty	73D	52 38 42 111 17 15	Salt (storage)	Mid-Devonian Upper Elk Point Fm. Prairie Evaporite. Salt interval: 4464'-4865' T.D., 4446'-4816' T.D., 4435'-4811' T.D., 4458'-4826' T.D.	Salt cavern for underground storage of petroleum products	Hamilton (1971); ERCB Well Files
A170	Duvernay	73E	53 46 49 111 42 08	Salt	Mid-Devonian Lower Elk Point Fm. Upper Lotsberg Salt. Salt interval: 4395'-4740'; cored 4403'-4736'		Hamilton (1971); ERCB Well Files
A171	Lindberg	73E	53 52 04 110 38 12	Salt	Mid-Devonian Prairie Evaporite salt interval: 2631'- 3073' T.D.; cored: 2631'-3073'		Hamilton (1971)
A172	Fort McMurray	74D	56 42 16 111 20 51	Salt	Mid-Devonian Upper Elk Point Fm. Prairie Evaporite salt; salt interval: 723'-934'; cored 623'-934'		Hamilton (1971); ERCB Well Files; Allan (1943)
A173	Fort Saskatchewan	83H	53 44 12 113 11 21	Salt	Mid-Devonian Lower Elk Point Fm.; salt interval: 6091' n.p.; cored: 6125'-27'		Hamilton (1971)
A174*	Fort Saskatchewan	83H	53 45 05 113 09 52	Salt (storage)	Mid-Devonian Lower Elk Point Fm. Upper Lotsberg salt, interval: 6080'-6332', cored 6214'-6304'; 6110'-6343', cored 6110'-6327'; 6091'-6326', cored 6122'-6326'; 6072'-6318', cored 6072'-6318'	Salt cavern for underground storage of petroleum products	Hamilton (1971); ERCB Well Files; Allan (1943)
A175	Bruderheim A	83H	53 47 35 112 52 57	Salt	Mid. Devonian Lower Elk Point Subgroup - Upper Lotsberg salt; salt interval 1751-1841 m; cored 1745-1769.5 m	Salt brining operation for $NaClO_3$ manufacture; salt production capacity 50 K tpa	ARC Econ. Mins. Files
A176	Bruderheim B	83H	53 48 01 112 53 41	Salt	Mid. Devonian Lower Elk Point Subgroup - Upper Lotsberg salt; salt interval 1750-1840 m	Salt brining operation for $NaClO_3$ manufacture; salt production capacity 55 K tpa	ARC Econ. Mins. File
A177*	Fort Saskatchewan	83H	53 48 34 113 08 22	Salt (storage)	Mid-Devonian Lower Elk Point Fm.; Upper Lotsberg salt; salt interval: 5985'- 6232'	Salt cavern for underground storage of petroleum products	Hamilton (1971); ERCB Well Files; Allan (1943)
A178	Redwater	83H	53 50 19 113 05 24	Salt (storage)	Mid-Devonian Lower Elk Point Fm. Upper Lotsberg salt; salt interval: 5804'- 6062'; cored 5846'- 6062'	Salt cavern for underground storage of petroleum products	Hamilton (1971); ERCB Well Files; Allan (1943)
A179	Brocket	82H	49 32 44 113 48 35	Sandstone - building stone	Tertiary Paskapoo Fm. heavy sandstone, 7 m thick; fine to medium gray with slightly brownish cast and with clean "peppery" appearance		Parks (1916)
A180	Porcupine Hills	82H	49 44 05 113 37 45	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone, 4 m thick; stone of external weathered zone uniform grayish colour, blue cores show in lower layers	Small amount quarried	Parks (1916)
A181	Monarch	82H	49 49 20 113 13 21	Sandstone - building stone	Tertiary Paskapoo Fm. sandstones, medium to fine grained, with distinctly blue colour; little reediness seen in specimen and stone is almost devoid of speckled appearance		Parks (1916)
A182	High River B	82I	50 30 23 113 47 48	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone on banks of Little Bow river; stone medium grained, uniform grayish with yellowish green cast; little evidence of reediness	Small amount quarried	Parks (1916)

Appendix 34.I *(continued)*

ID	Name	NTS	Lat.(N)Long.(W) Deg. Min. Sec.	Commodities	Geological description	Reserves, resources or development work	Reference(s)
A183	High River A	82I	50 34 45 113 53 39	Sandstone - building stone	15 m bank of heavy sandstone in Tertiary Paskapoo Fm., covered with variable amount of drift; lenticular beds with pronounced crossbedding; medium-grained, uniform grayish sandstone with slightly yellowish green cast and little evidence of reediness	Small amount quarried	Parks (1916)
A184*	High River C	82I	50 36 30 113 50 53	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone	Inconsiderable output used for foundation	Parks (1916)
A185	Sandstone	82J	50 46 06 114 02 08	Sandstone - building stone	Section of sandstone and shale beds in Tertiary Paskapoo Fm.; sandstone beds up to 1 m thick; fine grained, light grayish colour with cast of yellow; some beds badly shattered with considerable amount of hardhead		Parks (1916)
A186	Pigeon Creek	82O	51 01 50 115 14 42	Sandstone- dimension stone	Dolomitic siltstone from Triassic Spray River Fm.; hard, flaggy, medium gray material known as "Rundle Rock"; contains lamination and beds ranging in thickness from 0.5 cm to over 1 m	Thunderstone Quarries opened in 1961; Rundle Rock sold as flagstone, dry pack sheets and landscaping stone	Edwards (1991) (Guidebook); Fox (1981)
A187*	Calgary	82O	51 02 42 114 06 19	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone; formation practically horizontal but beds lenticular; 1.8 m sandstone in two variable beds (poor colour, used for rubble); 8.5 m sandstone in beds up to 1.2 m thick (avg. 6 m good buff stone); 3 m solid sandstone bed	Quarry originally opened in 1902. Operations later prohibited by conditions under which land was sold for building lots	Parks (1916)
A188*	Brickburn	82O	51 03 34 114 09 07	Sandstone - building stone	Section in Tertiary Paskapoo Fm. in river bank; 7.6 m heavy bedded sandstone, pronounced lenticular character and irregular jointing; stone is fine grained and buff coloured toward top of section	Quarry in operation 1910 - 1914	Parks (1916)
A189	Canmore	82O	51 07 57 115 23 05	Sandstone - dimension stone	Dolomitic siltstone from Triassic Spray River Fm.; hard, flaggy, medium gray material known as "Rundle Rock"; contains lamination and beds ranging in thickness from 0.5 cm to over 1 m	Production of Rundle Rock building stone seasonal over past 35 yrs.	Fox (1981); Edwards (1991)
A190	Rocky View	82O	51 08 49 114 04 56	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone; section at greatest height of dome-shaped quarry face (10.5 m): 6 m soil, thin stone and shale; 3 m buff sandstone; 1.2 m hard blue sandstone; buff sandstone; formation is broken; differences in grain, in reediness	Quarries not worked since 1910	Parks (1916)
A191*	Glenbow	82O	51 09 41 114 23 04	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone; 7.6 m drift, thin stone and shale; 3 m sandstone, partly in heavy beds; 0.6-1.5 m shale; 6 m sandstone, mostly heavy beds; stone essentially buff type but shows considerable variation in grain, colour, scaly structure	Extensive quarrying till 1909; cessation in operation due to increase in blue hardhead and considerable overburden	Parks (1916)
A192	Cochrane	82O	51 12 18 114 28 39	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone; quarry section: 3 m soil, shale and thin sandstone; 2 m sandstone (mostly thin, with some good stone toward bottom); 6.4 m sandstone in heavy beds with irregular partings	Large amount quarried	Parks (1916)
A193	Didsbury	82O	51 38 32 114 07 50	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone; quarry section: 1.4 m drift; 2 m thin bedded stone; 1.2 m heavy bedded stone; lower heavy bedded stone is divided by curved parting planes into lenticular beds; main joints 1.5 m apart; medium to fine grained, gray	Quarried on small scale	Parks (1916)
A194	Innisfail A	82P	51 58 32 113 43 45	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone; upper 1.5 m thin-bedded, lower part heavy bedded with irregular planes of parting; uniform bluish gray colour	Quarried on small scale	Parks (1916)
A195	Innisfail B	83A	52 02 02 113 55 10	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone exposure; upper 1.8 m of stone thin bedded and shattered; lower stone in variable beds with lenticular planes of parting; fresh stone gray, weathers yellow; stone is fine grained, grayish with distinctly reedy structure		Parks (1916)
A196	Red Deer	83A	52 16 00 113 49 27	Sandstone - building stone	Tertiary Paskapoo Fm. sandstone; 4.5 m drift over 2.4 m exposed sandstone; beds horizontal but bedding planes not regular; avg. thickness about 25 cm; weathered stone uniform gray with some evidence of reediness and false bedding		Parks (1916)
A197	Entwistle	83G	53 35 31 114 59 46	Sandstone - building stone	Tertiary Paskapoo and Edmonton Fm. sandstone; section: 6 m drift; 8.5 m blue and buff sandstone in fairly heavy, irregular beds, some hard, flinty bands; 9 m gray sandstone, beds 25 cm - 1 m thick; stone coarse grained, uniform colour, little reediness		Parks (1916)
M22	Black Island	62P	51 15 00 96 23 00	Silica sand	Ordovician Winnipeg River Fm., high purity silica sand	Estimated reserves 20 million t, quarry capacity 180,000 tpa	M.I. 62P/1 SIA 1
S78	Red Deer River	63C	52 58 42 101 44 34	Silica sand	Early Cretaceous Mannville Formation	Estimated 14 million tonnes reserve locally; production to date is minor	Beck (1974); Babey (1955); Wickenden (1945); Collings and Andrews (1986, 1989); Northern Silica Limited (1968); Red Deer Silica Inc. (1986)
B46	Mount Moberly	82N/ 7W	51 22 18 116 57 49	Silica sand	A friable phase of the Ordovician Mount Wilson Formation; at the mine site up to 200 m thick, 99.5% SiO_2, less than 0.1% Fe_2O_3	Geological reserves estimated at 10 million tonnes; production 1990: 90,000 tonnes	Foye (1987)
A203	Bruderheim	83H	53 51 11 112 55 00	Silica sand	Upper Pleistocene glacial outwash sand; post- depositional modification has resulted in presence of thin film of iron oxide on sand grains, giving deposit a yellow colour	88.79% of natural sand retained on 100-mesh sieve	Carrigy (1970)
S83	Sybouts Lake East	72H	49 02 14 104 24 29	Sodium sulphate	Saline lake deposit; permanent and intermittent crystal beds and brine	Original reserve estimated at 3.5 million tons Na_2SO_4	Cole (1926); Tomkins (1954); Last (1984)
S86	Frederick Lake	72H	49 44 27 105 19 34	Sodium sulphate	Saline lake deposit; permanent crystal bed and brine	Original reserve estimated at 3.7 million tons Na_2SO_4	Cole (1926); Tomkins (1954); Last (1984)
S87	Bishopric (Frederick Lake)	72I	50 00 13 105 45 34	Sodium sulphate	Saline Lake; brine, intermittent and permanent crystal beds	Original reserve estimated at 2.4 million tons Na_2SO_4	Cole (1926); Tomkins (1954); Last (1984)
S88	Chaplin Lake	72J	50 21 13 106 37 23	Sodium sulphate	Saline Lake; brine with intermittent and permanent crystal beds	Original reserve estimated at 3 million tons Na_2SO_4	Tomkins (1954); Last (1984)
S91	Verlo	72K	50 21 13 108 24 37	Sodium sulphate	Saline Lake deposit; permanent and intermittent crystal beds and brine	Original reserves estimated at 950,000 tons Na_2SO_4	Tomkins (1954); Worsley (1975)
S92	Ingebright South	72K	50 21 13 109 22 22	Sodium sulphate	Saline lake deposit; permanent crystal bed	Original reserves estimated at 9 million tons Na_2SO_4	Cole (1926); Tomkins (1954); Last (1984)
S94	Snakehole Lake	72K	50 34 12 108 24 47	Sodium sulphate	Saline Lake deposit; permanent and intermittent crystal beds and brine	Original reserves estimated at 1.7 million tons Na_2SO_4	Cole (1926); Tomkins (1954); Last (1984)
S95	Alsask	72N	51 18 52 109 52 15	Sodium sulphate	Saline lake brine and intermittent and permanent crystal beds	Estimated initial reserves 2.6 million tons Na_2SO_4	Cole (1926); Tomkins (1954); Last (1984)
S98	Berry Lake	73A	52 00 27 105 34 24	Sodium sulphate	Saline Lake deposit, crystal beds with intermittent brine	Estimated reserves 800,000 tons	Cole (1926); Tomkins (1954); Last (1984)
S102	Whiteshore Lake	73C	52 06 06 108 17 07	Sodium sulphate	Saline lake deposit as brine and intermittent and permanent crystal beds	Estimated initial reserves of 6.5 million tons anhydrous salt	Cole (1926); Tomkins (1954)
A211	Metiskow	73D	52 21 14 110 44 9	Sodium sulphate	Lake Brine, contains about 11% sodium sulphate and about 12% sodium carbonate; permanent crystal bed, 6-10 m thick over most of deposit, but over southern part of lake is over 15 m thick	The only Alberta deposit of commercial value; reserves about 3 million t; production began in mid-1969 for high purity sodium sulphate for use in detergents; production about 65,000 tpa	Broughton (1976); Govett (1958); Cole (1926)
S104	Steelman	62E	49 18 42 102 37 21	Sulphur	Sour gas field	Production 7	Oilweek, Jan. 21, 1991
S105	Regina	72I	50 31 40 104 32 58	Sulphur (by-product)	By-products of heavy oil upgrader	Production 250 tonnes per day	
A214	Fort McMurray	74E	57 00 33 111 29 39	Sulphur	Sulphur in crude bitumen extracted from Athabasca Oil Sands; Cret. McMurray Fm.; S content 5% by weight of bitumen	Sulphur extraction plant; recovery capacity 441 tpd; reserves: 5.8 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A215	Mildred Lake	74E	57 02 18 111 34 29	Sulphur	Sulphur in crude bitumen extracted from Athabasca Oil Sands; Cret. McMurray Fm.; S content 5% by weight of bitumen	Sulphur extraction plant; recovery capacity 1255 tpd; reserves: 10.8 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A216	Coleman (Savannah Creek)	82G	49 37 59 114 34 35	Sulphur	Sour gas field; producing zones: Miss. Rundle and Dev. Wabamun; H_2S content 24%	Sulphur extraction plant; recovery capacity 389 tpd; reserves: 2.5 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A217	Waterton	82G	49 18 13 114 00 35	Sulphur	Sour gas field; producing zones: Miss. Rundle and Dev. Wabamun; H_2S content 19%	Sulphur extraction plant; recovery capacity 3,107 tpd; reserves: 7.3 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A218	Mazeppa (Okotoks)	82I	50 38 34 113 46 54	Sulphur	Sour gas field; producing zones: Miss. Rundle and Dev. Wabamun; H_2S content 36%	Sulphur extraction plant; recovery capacity 577 tpd	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A219	Okotoks	82I	50 43 29 113 56 25	Sulphur	Sour gas field; producing zones: Miss. Rundle and Dev. Wabamun; H_2S content 34%	Sulphur extraction plant; recovery capacity 431 tpd; reserves: 2.1 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18

Appendix 34.I *(continued)*

ID	Name	NTS	Lat.(N)Long.(W) Deg. Min. Sec.	Commodities	Geological description	Reserves, resources or development work	Reference(s)
A220	Turner Valley (Diamond)	82J	50 35 37 114 09 03	Sulphur	Sour gas field; producing zone: Miss. Rundle; H_2S content 2.5%	Sulphur extraction plant; recovery capacity 10.7 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A221	Quirk Creek	82J	50 45 14 114 29 50	Sulphur	Sour gas field; producing zone: Miss. Rundle; H_2S content 9%	Sulphur extraction plant; recovery capacity 299 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A222	Jumping Pound	82O	51 07 57 114 34 14	Sulphur	Sour gas field; producing zone: Miss. Rundle; H_2S content 6%	Sulphur extraction plant; recovery capacity 597 tpd; reserves: 2.8 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A223	Wildcat Hills	82O	51 13 11 114 38 25	Sulphur	Sour gas field; producing zone: Miss. Rundle; H_2S content 4%	Sulphur extraction plant; recovery capacity 177 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A224	Crossfield E.	82O	51 23 41 114 02 09	Sulphur	Sour gas field; producing zone: Dev. Wabamun; H_2S content 34%	Sulphur extraction plant; recovery capacity 1,797 tpd; reserves: 2.2 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A225	Carstairs-Crossfield	82O	51 32 25 114 12 00	Sulphur	Sour gas field; producing zone: Miss. Elkton; H_2S content 0.5%	Sulphur extraction plant; recovery capacity 65 tpd	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A227	Burnt Timber	82O	51 34 09 114 51 22	Sulphur	Sour gas field; producing zones: Miss. Rundle and Dev. Wabamun; H_2S content 13%	Sulphur extraction plant; recovery capacity 489 tpd reserves: 1.2 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A228	Harmattan	82O	51 41 09 114 29 06	Sulphur	Sour gas field; producing zone: Miss. Rundle; H_2S content 46%	Sulphur extraction plant; recovery capacity 490 tpd. Reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A229	Olds	82O	51 44 39 114 07 50	Sulphur	Sour gas field; producing zone not stated; H_2S content 15%	Sulphur extraction plant; recovery capacity 389 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A230	Bearberry	82O	51 53 23 114 48 56	Sulphur	Devonian Leduc Fm., porous reef dolomite @ 4000 m depth; "ultra sour" natural gas reservoir; H_2S content 90%	Demo plant, 204 tpd capacity; reserves 70 M - 100 M t	Kitzan and Auger (1992)
A231	Caroline	82O	51 56 00 114 31 56	Sulphur	Sour gas field; producing zones: Miss. Rundle and Dev. Beaverhill Lake; H_2S content 0.8%	Sulphur extraction plant; recovery capacity 8.3 tpd; reserves: 25 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A232	Caroline - Swan Hills	82O	51 58 04 114 45 00	Sulphur	Devonian Beaverhill Lake Fm., sour gas reservoir; H_2S content 30 - 35%	Plant design capacity 4000 tpd 1.4 M tpy	Oilweek, Sept. 17, 1990; Prud'homme (1989); ERCB ST 91-18
A233	Innisfail	82O	51 58 37 114 03 37	Sulphur	Sour gas field; producing zone: Dev. Leduc; H_2S content 16%	Sulphur extraction plant, recovery capacity 163 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A234	Caroline (Garrington)	82O	51 59 29 114 45 02	Sulphur	Sour gas field; producing zones - Miss. Rundle and Dev. Beaverhill Lake	Sulphur extraction plant; recovery capacity 10.4 tpd	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A235	Crossfield (Balzac)	82P	51 11 45 113 55 35	Sulphur	Sour gas field; producing zones: Cret. Mannville, Miss. Rundle and Dev. Wabamun; H_2S content 17%	Sulphur extraction plant; recovery capacity 1,696 tpd; reserves: 2.1 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A236	Lone Pine Creek	82P	51 30 38 113 51 34	Sulphur	Sour gas field; producing zones: Dev. Wabamun and Leduc; H_2S content 10%	Sulphur extraction plant; recovery capacity 157 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A237	Lone Pine Creek	82P	51 35 00 113 50 10	Sulphur	Sour gas field; producing zones: Dev. Wabamun and Leduc; H_2S content 10%	Sulphur extraction plant; recovery capacity 283 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A238	Wimborne	82P	51 54 13 113 33 30	Sulphur	Sour gas field; producing zone: Dev. Leduc; H_2S content 13%	Sulphur extraction plant; recovery capacity 182 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A239	Nevis	83A	52 18 37 113 05 11	Sulphur	Sour gas field; producing zone: Devonian; H_2S content 4%	Sulphur extraction plant; recovery capacity 197 tpd	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A240	Joffre	83A	52 21 14 113 42 38	Sulphur	Sour gas field; producing zones: Cret. Mannville and Dev. Nisku; H_2S content 3.4%	Sulphur extraction plant; recovery capacity 25 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A242	Ram River (Strachan)	83B	52 09 06 115 19 18	Sulphur	Sour gas field; producing zone: Dev. Leduc; H_2S content 19%	Sulphur extraction plant; recovery capacity 4,572 tpd	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A243	Strachan	83B	52 13 28 115 10 44	Sulphur	Sour gas field; producing zone: Dev. Leduc; H_2S content 9%	Sulphur extraction plant; recovery capacity 953 tpd; reserves: 0.8 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A244	Homeglen Rimbey	83B	52 45 48 114 06 34	Sulphur	Sour gas field; producing zone: Dev. Leduc; H_2S content 1%	Sulphur extraction plant; recovery capacity 128 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A245	Brazeau River (Nordegg)	83B	52 46 40 115 39 26	Sulphur	Sour gas field; producing zones: Miss. Elkton-Shunda, and Dev. Nisku; H_2S content 1.3%	Sulphur extraction plant; recovery capacity 42 tpd; reserves: 2.9 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A246	Minnehik-Buck Lake	83B	52 56 17 114 50 06	Sulphur	Sour gas field; producing zone: Miss. Pekisko; H_2S content 0.1%	Sulphur extraction plant; recovery capacity 45 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A247	Brazeau River	83B	52 56 36 115 54 07	Sulphur	Sour gas field; producing zones: Miss. Elkton-Shunda, and Dev. Nisku; H_2S content 0.8%	Sulphur extraction plant; recovery capacity 110 tpd	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A248	Hanlan-Robb	83F	53 12 57 116 48 27	Sulphur	Sour gas field; producing zones: Dev. Nisku and Beaverhill Lake; H_2S content 9%	Sulphur extraction plant; recovery capacity 1,092 tpd; reserves: 2.9 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A249	Medicine Lodge	83F	53 28 32 117 02 10	Sulphur	Sour gas field; producing zone: Dev. Wabamun; H_2S content ?	Sulphur extraction plant; recovery capacity 45 tpd; reserves not stated	Oilweek, Jan. 21, 1991; ERCB ST 91-18
A250	Edson	83F	53 33 46 116 32 41	Sulphur	Sour gas field; producing zone: Miss. Elkton-Shunda; H_2S content 1.4%	Sulphur extraction plant; recovery capacity 288 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A251	Rosevear	83F	53 39 00 116 06 08	Sulphur	Sour gas field; producing zone: Dev. Beaverhill Lake; H_2S content 8%	Sulphur extraction plant; recovery capacity 171 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A252	Rosevear	83F	53 42 30 116 09 05	Sulphur	Sour gas field; producing zone: Dev. Beaverhill Lake; H_2S content 8%	Sulphur extraction plant; recovery capacity 110 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A253	West Pembina (Brazeau)	83G	53 02 22 115 57 48	Sulphur	Sour gas field; producing zones: Miss. Elkton-Shunda, and Dev. Nisku; H_2S content ?	Sulphur extraction plant; recovery capacity 520 tpd	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A254	Brazeau River	83G	53 11 06 115 44 38	Sulphur	Sour gas field; producing zones: Miss. Elkton-Shunda, and Dev. Nisku; H_2S content 7%	Sulphur extraction plant; recovery capacity 447 tpd	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A255	Bonnie Glen	83H	53 03 09 113 55 02	Sulphur	Sour gas field; producing zone: Dev. Leduc; H_2S content 0.4%	Sulphur extraction plant; recovery capacity 12.5 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A256	Redwater	83H	53 57 18 113 05 24	Sulphur	Sour gas field; producing zone: Dev. Leduc; H_2S content 2.6%	Sulphur extraction plant; recovery capacity 11 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A257	Kaybob S. III	83K	54 06 05 116 36 45	Sulphur	Sour gas field; producing zones: Trias., and Dev. Nisku and Beaverhill Lake; H_2S content 16%	Sulphur extraction plant; recovery capacity 3,557 tpd; reserves: 3.2 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A258	Windfall-Whitecourt	83K	54 11 19 116 12 45	Sulphur	Sour gas field; producing zones: Cret. Mannville, Miss. Rundle, and Dev. Nisku and Leduc; H_2S content 21%	Sulphur extraction plant; recovery capacity 1,330 tpd; reserves: 1.0 M t	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A259	Bigstone	83K	54 15 40 117 12 44	Sulphur	Sour gas field; producing zone: Dev. Wabamun; H_2S content 1.6%	Sulphur extraction plant; recovery capacity 385 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A260	Kaybob S.	83K	54 20 55 116 51 44	Sulphur	Sour gas field; producing zones: Cret. Mannville, and Dev. Wabamun and Leduc; H_2S content 16%	Sulphur extraction plant; recovery capacity 1,086 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A261	Simonette	83K	54 25 17 117 46 08	Sulphur	Sour gas field; producing zones: Cret. Mannville, and Dev. Wabamun and Leduc; H_2S content 16%	Sulphur extraction plant; recovery capacity 95 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A262	Sturgeon Lake	83K	54 56 42 117 14 32	Sulphur	Sour gas field; producing zone: Dev. Leduc; H_2S content 9%	Sulphur extraction plant; recovery capacity 98 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A263	Gold Creek	83L	54 49 44 118 38 50	Sulphur	Sour gas field; producing zones: Cret. Mannville and Dev. Wabamun; H_2S content 3%	Sulphur extraction plant; recovery capacity 43 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A264	Teepee Creek	83M	55 22 53 118 29 57	Sulphur	Sour gas field; producing zones: Trias. Doig, and Dev. Wabamun; H_2S content 8%	Sulphur extraction plant; recovery capacity 30 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A265	Sinclair-Hythe	83M	55 24 38 119 49 57	Sulphur	Sour gas field; producing zone: Trias. Doig; H_2S content 3%	Sulphur extraction plant; recovery capacity 256 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A266	Progress	83M	55 43 50 119 24 33	Sulphur	Sour gas field; producing zone: Trias. Halfway; H_2S content 0.7%	Sulphur extraction plant; recovery capacity 14 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A267	Rainbow	84L	58 26 56 119 14 25	Sulphur	Sour gas field; producing zones: Dev. Slave Point and Keg River; H_2S content 2%	Sulphur extraction plant; recovery capacity 139 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
A268	Zama	84M	59 03 34 118 52 01	Sulphur	Sour gas field; producing zone: Dev. Elk Point; H_2S content 8%	Sulphur extraction plant, recovery capacity 74 tpd; reserves not stated	Oilweek, Jan. 21, 1991; Prud'homme (1989); ERCB ST 91-18
B47	Pine River	93P/5	55 17 00 121 38 00	Sulphur	Sour gas field	1055 tpd	Oilweek, Jan. 21, 1991
B48	Taylor Flats	94A/2	56 06 58 120 53 50	Sulphur	Sour gas field, H_2S content 3%	460 tpd	Oilweek, Jan. 21, 1991
B49	Cypress	94B/16	56 47 00 122 21 00	Sulphur	Sour gas field	15 tpd	Oilweek, Jan. 21, 1991
B56	Fort Nelson	94J/10	58 40 00 122 38 00	Sulphur	Sour gas field; H_2S content 0.5-7%	1100 tpd	Oilweek, Jan. 21, 1991

Appendix 34.II Summary of available data for selected metallic mineral deposits in the Western Canada Sedimentary Basin.
Note: Deposits in this table are listed first in order of the deposit-type groupings as presented in Figures 34.1 and 34.7; and second, sequentially in order of NTS grid number and latitude-longitude location, which results in a geographic arrangement generally from southeast to northwest.

ID	Name	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities	Geological description	Reserves, resources or development work	Reference(s)
A2	North Saskatchewan River	83H	53 33 45 113 26 00 North Saskatchewan River, particularly in vicinity of Edmonton	Au (placer)	Placer gold occurs in recent river gravels of the North Saskatchewan River	None	Guild (1981); MacGillivray et al. (1984); Guisti (1983, 1986); Halferdahl (1965)
A3	Villeneuve	83H	53 41 37 113 51 04 Gravel quarries near Villeneuve	Au (placer)	Paleoplacer gold occurs in sand and gravel of the mid-Wisconsinan Empress Formation; gold is recovered as a byproduct of a gravel pit operation	Resources: uncertain; Edwards (1990) reports Au contents range from 0.22 to 0.575 g Au/t	Edwards (1990)
M1	Sylvia Zone and Farewell Lake	63K/8	54 24 25 100 08 57 and 54 29 06 100 02 45	Cu, Zn	Sylvia Zone and Farewell Lake are two separate deposits, about 10 km apart, in Proterozoic basement rocks of the Flin Flon-Snow Lake domain overlain by a thin veneer of Phanerozoic sedimentary rocks	Resources: (a) Sylvia Zone - 290 K tonnes grading 0.13% Cu, 3.4% Zn, 2.71 g Au/t and 29.1 g Ag/t; (b) Farewell Lake - 257 K tonnes grading 2.03% Cu	Bamburak *pers. comm.* (1990)
S6	McIlvenna Bay, Hanson Lake South area	63L	54 38 00 102 48 30	Cu, Zn, Pb, Ag, Au	Zoned volcanogenic Cu-Zn deposit stratabound in Precambrian (Aphebian) basement metavolcanic rocks overlain by a thin veneer of Paleozoic rocks; production scheduled for 1992 at about 2,700 tonnes per day	Resources: No. 2 lens - 9.8 M tonnes 0.95% Cu, 5.76% Zn, 0.42% Pb, 24.7 g Ag/t and 0.49 g Au/t. No. 1 lens - 0.82 M tonnes 2.23% Cu and 0.84% Zn, 15.3 g Ag/t and 0.74 g Au/t. No. 3 lens - 0.4 M tonnes of 1.6% Cu and 8.1% Zn	Koziol and Ostapovitch (1989); Northern Miner (1990a,b); Koziol (1990); S.E.M. Mineral Deposits Index #0209
B5	Burton	82G	49 19 38 115 07 45	Cu, Ag, Au	Chalcopyrite occurs in quartz-carbonate vein in argillite and quartzite of Helikian Roosville Formation of Purcell Supergroup	Production (1916-1918): 207 tonnes ore yielded 7.76 K tonnes Cu and 0.12 kg Ag	BCEMPR Minfile no. 82GSW013; BCEMPR Fieldwork (1979), p. 116
B7	Peacock Copper	82G	49 22 20 115 12 00	Cu, Ag	Chalcopyrite and pyrite occur in a quartz vein that cuts limestone believed to be Helikian Gateway Formation of Purcell Supergroup	Production (1925-1926): 22 tonnes ore yielded 5.32 K tonnes Cu and 1.18 kg Ag	BCEMPR Minfile no. 82GSW017; BCEMPR Ann. Rprt 1930-244
B15	Churchill Copper mine; Magnum	94K	58 30 42 125 24 06	Cu	Chalcopyrite and pyrite occur in 10 cm to 35 cm thick quartz-ankerite veins and as replacement masses in limestone adjacent to the veins; host is Helikian Aida Formation shale and dolostone	Production (1970-1975): about 498 130 tonnes which yielded 14.67 M kg of Cu; resources: 110,000 tonnes grading 3.25% Cu	BCEMPR Minfile no. 94K003; Carr (1971)
B18	Monarch-Kicking Horse Mine; Ottertail Valley and Ice River area	82N	51 24 50 116 26 10 Coordinates are for Monarch-Kicking Horse mine; Ottertail Valley is about 12 km SW, and Ice River is about 29 km S of Monarch-Kicking Horse mine	Pb, Zn, Ag, minor Cd; Cu also is present at some Ottertail Valley and Ice River area occurrences	Monarch-Kicking Horse: argentif. galena, sphalerite, minor pyrite and trace chalcopyrite in Mid. Camb Cathedral Fm.; Ottertail Valley: small prospects of Pb-Zn-Cu-Ag sulphides in Chancellor Fm.; Ice River: Pb-Zn-Cu sulphides in Ottertail/Chancellor Fm.	Monarch-Kicking Horse Prod. (1890-1957): 810,790 tonnes, yielding 46.25 M kg (5.7%) Pb, 71.31 M kg (8.8%) Zn, 25.12 M g Ag (31 g Ag/t) and 9.0 K kg Cd, several showings at Ottertail Valley and Ice River area have old underground workings (Allan, 1914)	BCEMPR Minfile no. 82N019; Dawson (1886); Allan (1914); Brown (1948); Ney (1957); Westervelt (1979); Grieve and Höy (1981); Höy (1982)
N4	Pine Point Pb-Zn District	85B/16	At least 100 Pb-Zn deposits exist between about 60 40 00 115 00 00 to 61 00 00 114 00 00	Pb, Zn	The Pb-Zn deposits exist in Presqu'ile facies dolomite in carbonate rocks of Middle Devonian Pine Point, Sulphur Point and Slave Point Formations; at least 100 Pb-Zn deposits have been discovered and 48 of the deposits have been mined	Production (from 1964 to closure in 1988): about 62 M tonnes ore grading 2.7% Pb and 6.4% Zn from 48 separate deposits	Skall (1975); Carter (1987); Gibbins (1988; pers. comm., 1991)
B23	Robb Lake	94B	56 56 06 123 44 00	Pb, Zn	Galena, sphalerite and pyrite occur primarily in tabular and lenticular zones parallel to bedding in dolostone breccia in Devonian Stone Formation	Resources: 5.5 M tonnes grading 7.3% combined Pb+Zn	BCEMPR Minfile no. 94B005; BCEMPR GEM 1975-E156; BCEMPR Prel. Map 65 (1989).
B26	Cirque	94F	57 30 30 125 07 54	Pb, Zn, Ag, Ba	Stratiform massive barite with pyrite, galena and sphalerite in shale of Devonian Gunsteel Formation; mineralized body overlies graphitic chert and shale, and is overlain by argillite	Diluted mineable reserves: 22.084 M tonnes grading 2.8% Pb, 9.4% Zn and 60 g Ag/t for the North orebody; total resources: 32.2 M tonnes grading 2.2% Pb, 7.9% Zn and 48 g Ag/t	BCEMPR Minfile no. 94F008; BCEMPR Assess. Rept. 9225; BCEMPR, Stage 1 Development Submission, Feb. 1991
B27	Mt. Alcock	94F	57 41 00 125 24 00	Pb, Zn, Ag, Ba	Barite horizon with fine diffuse bands of galena and sphalerite in Devonian Gunsteel Formation shale	7% combined Pb+Zn and 35 g Ag/t across 7 to 11 m	BCEMPR Minfile no. 94F015; George Cross Newsletter June 15, 1990
N7	Prairie Creek (Cadillac) property	95F/ 7,10	61 33 30 124 47 30	Pb, Zn, Ag, Cu, Cd	15 showings of Pb-Zn-Ag occur over a strike length of 32 km along a shear zone that strikes 010 degrees; all showings are in veins that cut Ordovician to Devonian carbonates; the No. 3 zone is more than 600 m long and averages about 4.9 m wide	Resources: No. 3 zone contains about 1.45 M tonnes of 11.2% Pb, 12.2% Zn, 0.44% Cu, 190 g Ag/t and 0.1% Cd; resources also exist in the No. 7 and No. 8 zones	EMR Mineral Inventory File 95F/10,7-Pb1; Brophy, et al. (1984); Douglas and Norris (1960); Skinner (1961); Padgham et al. (1974); Thorpe (1972); Padgham (1975)
M2	Spruce Point Mine	63K/9	54 32 40 100 24 40	Zn, Cu	Volcanogenic massive sulphide deposit in Proterozoic basement volcanic rocks of the Flin Flon-Snow Lake domain, overlain by a thin veneer of Phanerozoic sedimentary rocks	Production (to end 1988; 1989-1990 unknown): 1.364 M tonnes grading 2.36% Cu, 2.8% Zn, 2.0g Au/t and 25.0 g Ag/t. Resources (1987): 567 K tonnes grading 2.15% Cu, 1.7% Zn, 1.44 g Au/t and 15.0 g Ag/t	Ferreira and Fedikow (1990); Bamburak (*pers. comm.*, 1990)
M3	Nose deposit at Manigotagan Lake (also called Minago River deposit)	63J/3	54 05 18 99 11 12	Ni, Cu, minor PGE	Disseminated Ni-Cu minerals in Precambrian basement ultramafic rocks overlain by 76 m of Paleozoic strata; deposit near-vertical tabular body, strikes 135°; minerals comprise pentlandite and millerite, minor amounts violarite and heazlewoodite	Resources: about 2.0 M tonnes grading 1.64% Ni, or about 10.9 M tonnes grading 1.17% Ni, with byproduct credits for Cu, Pt, Pd, Au and Ag; as well, there is about 0.9 M tonnes of 1.17% Ni in a few other zones	Athayde (1989); M. I. card 63J/3 NI 1; Bamburak (*pers. comm.*, 1990)
M4	Namew Lake Mine (also Goose Lake area about 25 km N of Namew Lake)	63K/4	54 11 42 101 44 54	Ni, Cu, PGE	Solid sulphide lens, breccia ore and disseminated sulphides in Precambrian basement ultramafic rocks overlain by 40 m flat-lying Ordovician dolostone and sandstone, and 6 m water; deposit exists in pipelike ultramafic sill; PGE occurrences at Goose Lake	Production (to end 1989): 272 K tonnes grading 1.61% Ni and 0.57% Cu. Diluted recoverable reserves (1990): between 61 m and 335 m levels, about 2.58 M tonnes grading 2.44% Ni, 0.9% Cu, 0.651 g Pt/t, 0.479 g Pd/t, 0.102 g Au/t and 4.11 g Ag/t	Pickell (1987); Athayde (1989); M. I. cards 63K/4 and 63K/5 PT 1, PYR 2; Kent (1976, 1980); Bamburak (*pers. comm.*, 1990); Phillips (1988)
S12	Choiceland iron formation near Fort-a-la-Corne	73H	53 18 00 104 33 35	Fe	Algoman-type banded magnetite-quartz iron formation in Precambrian basement rocks beneath about 600 m of Phanerozoic strata	Resources: about 453 M to 1,134 M tonnes at 30% Fe in a body about 1,525 m long by 120 m wide by 300 m deep	Harper (1975?); Cheesman (1964)
S13	Kelsey Lake	73H	53 34 30 104 25 00	Fe	Banded magnetite-chert and chert-silicate-magnetite iron formation in Precambrian basement rocks beneath unspecified amount of Phanerozoic strata	Resources: about 355 M tonnes at 24.6% Fe indicated, plus 145 M tonnes at 19.3% Fe inferred in a body about 4,650 m long by 130 m wide by 300 m deep	Anonymous (1975); Harper (1975?)
A13	Burmis	82G	49 36 14 114 18 19	Fe, Ti - Magnetite	Low grade, titaniferous magnetite of sedimentary (paleoplacer) origin occurs as thin and lensing, iron-rich zones at the top of the basal sandstone member of Upper Cretaceous Belly River Formation	Resources: estimated at less than 1.8 M tonnes grading 25% to 35% Fe	Mellon (1961)
A14	Dungarvan Creek	82H	49 11 46 113 55 03	Fe, Ti - Magnetite	Low grade, titaniferous magnetite of sedimentary (paleoplacer) origin occurs as thin and lensing, iron-rich zone at the top of the basal sandstone member of Upper Cretaceous Belly River Formation	Resources: estimated at less than 5.45 M tonnes grading 25% to 35% Fe	Mellon (1961)
B36	Ice River Complex	82N	51 09 35 116 21 40	Fe, Ti-rich phase in ultramafic-carbonatite	Alkaline ultramafic complex with carbonatite core; nepheline syenite facies contains up to 20% sodalite; some mafic phases are rich in titaniferous magnetite; intruded into Cambro-Ordovician Goodsir Formation	Moose Creek deposit: 1.9 M tonnes of magnetite in talus slope deposit; 5.5% Fe_3O_4 for coal processing heavy media separation	Pell (1987, *in press*)
A15	Clear Hills (Peace River) Iron Deposit	84D	56 54 04 118 43 26	Fe	Upper Cretaceous Bad Heart Formation sandstone contains oolitic iron-rich facies (goethite, nontronite, siderite and ferruginous opal); minette-type deposit, comprises flat-lying ferruginous oolite bed overlain by <20-60m overburden	Resources: at least 1,000 M tonnes of between 32% and 36% Fe in four separate blocks; thickness ranges from 2.4 m to 6.7 m	Hamilton (1980); Kidd (1959); Bertram and Mellon (1975)
B37	Falcon	93O	55 42 00 123 20 00	Fe	Hadrynian Misinchinka Fm. clastic-carbonate sequence; taconite style iron in schistose argillite and graywacke; magnetite, with some hematite, in 3 horizons each 30 - 90 m wide, 1200+ m in length, dipping steeply	Reserves: Upper unit - 3.18 M tonnes of 38.7% Fe; lower unit - 1.82 M tonnes of 36.4% Fe	BCEMPR Minfile no. 930016
S14	Pasquia Hills	63E	Scarp between 53 26 15 102 09 00 and 53 30 30 102 38 00	Mn, Fe, plus trace Ba, Cr, Ca, Cu, Au, Pb, Mo, Ni, Ag, Ti, V, Zn, Zr	Nodular concretions rich in manganese and iron in the basal 100 m of Upper Cretaceous Riding Mountain Formation siltstone and shale	Resources: about 5 M to 6 M tonnes of nodules averaging about 17% Mn and 20% Fe	Beck (1974)
B38	Rock Canyon Creek	82J/3E	50 12 30 115 08 00	REE, Nb, Phosphate; possibly related to a buried carbonatite	Metasomatically altered (fenitized) zone in basal Devonian carbonate over 1 km in length with REE, carbonate and phosphate, fluorspar and niobium values	None	Pell (*in press*)

Appendix 34.II *(continued)*

ID	Name	NTS	Lat. (N) Long. (W) Deg. Min. Sec.	Commodities	Geological description	Reserves, resources or development work	Reference(s)
B40	Wicheeda Lake	93I/5; 93J/8,9	54 31 00 122 04 00	REE, Nb in carbonatite	Local values of up to 1% Nb_2O_5; 2.6% to over 4% REE	Carbonatite plugs, dykes and sills cut Lower Ordovician Chushina and Middle Ordovician Skoki formations	Pell (*in press*)
B41	Aley; Includes Ospika River ultramafic (kimberlitic) pipe	94B	56 27 00 123 44 50	Nb, REE, Apatite in carbonatite. kimberlitic pipe at Ospika River	Carbonatite complex 3-3.5 km in diameter, of probable Late Dev.-Early Miss. age, has intruded Cambro-Ord. Kechika Gp and Ord. Skoki Fm carbonate and clastic rocks; associated carbonatite dykes contain REE carbonates; 50+ mineral species identified	20 M tonnes grading 0.7% Nb_2O_5	BCEMPR Minfile no. 94B027; BCEMPR Fieldwork (1985), p. 275-277; Mader (1987); Nelson and MacIntyre (1988); Mining Review (1991); Pell (*in press*)
B44	Cay property	94G	57 46 48 123 56 24	Germanium, gallium	Carbonate hosted, Mississippi Valley type Pb-Zn replacement deposits Devonian Dunedin Fm.	Up to 6,280 ppm Ge, and anomalous Ga to about 600 ppm occur in some Pb-Zn prospects at Robb Lake area	Leighton, Culbert and Pell (1989); BCEMPR Minfile no. 94G017
A16	Fort McMurray	74E	57 00 33 111 29 39	Vanadium, nickel	V and Ni occur as trace metals in bitumen component of Athabasca oil sands, captured in residual coke product from thermal cracking of separated bitumen; further concentrated in fly ash when coke burned as fuel, to 3.5% and 1.2% metallic V and Ni by wt	Fly ash production at Suncor plant not stated, but est. 150-200 tpd; facility in development at Suncor plant for recovery of V as V_2O_5	Hamilton and Mellon (1973)

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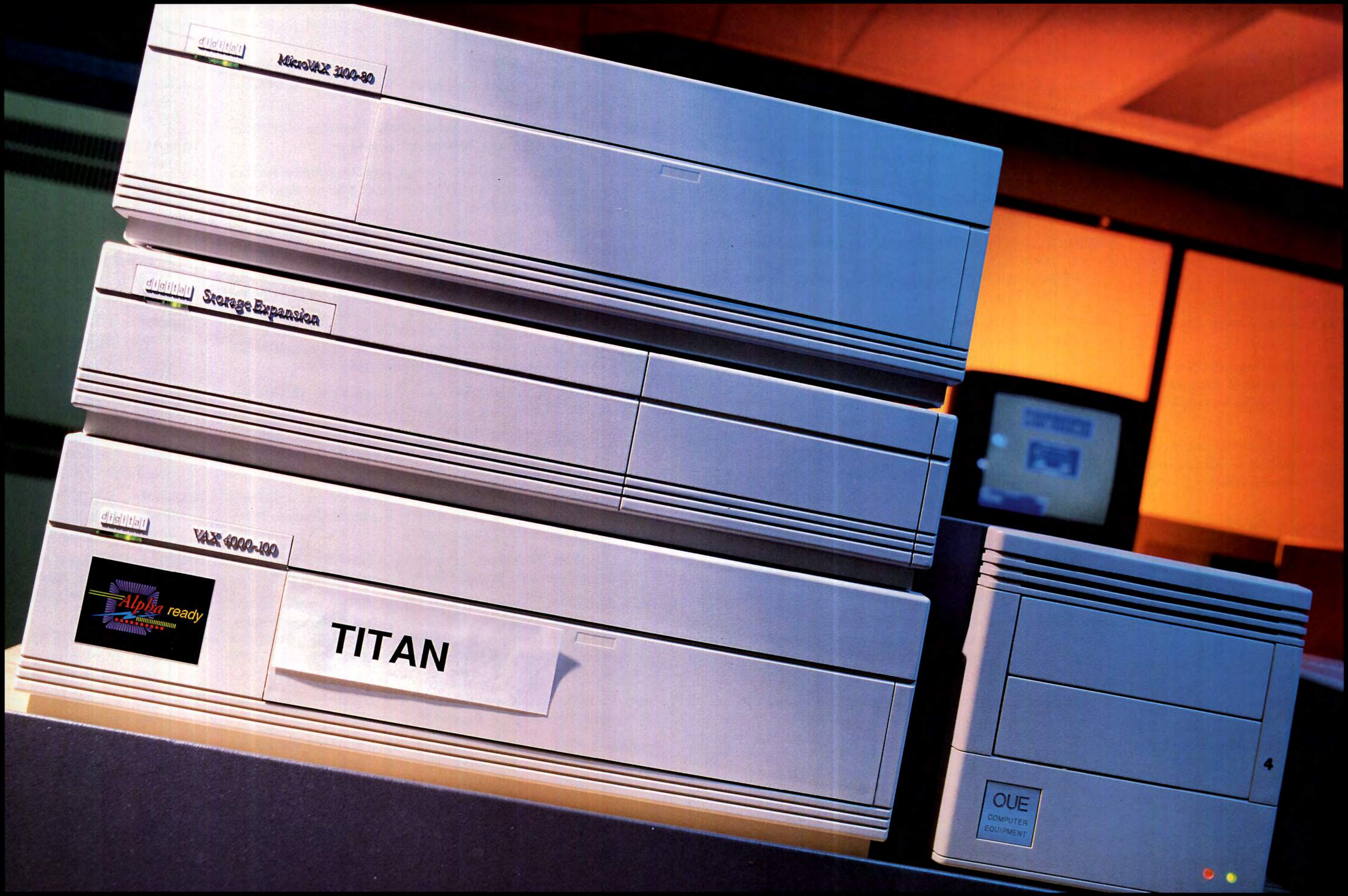

Frontispiece 35.0 Titan. Digital Equipment Corporation computer at the Alberta Research Council, Edmonton. "Titan" served as the principal processor for software development and data analysis in the Atlas project, over a period of seven years (1986-1993). Photograph by R. Siemens.